Research Square

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Development and validation of a digital hypertension risk prediction model for urban Indian adults

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Abstract

Background

Hypertension affects approximately 1.28 billion adults worldwide and is a major cause of cardiovascular disease, stroke and premature mortality, particularly in low- and middle-income countries. Validated risk prediction tools integrated with mobile health technologies may support early identification and prevention. This study developed and validated a hypertension risk prediction model for urban adults in Mysuru, India, and translated it into an artificial-intelligence-assisted smartphone application.

Methods

A community-based cross-sectional study was conducted from September 2022 to March 2024 in the urban field practice area of a tertiary medical college in Mysuru, Karnataka. Using cluster sampling, 517 adults aged ≥ 19 years were enrolled. Socio-demographic characteristics, lifestyle factors, anthropometric measurements and blood pressure were collected using a pretested semi-structured questionnaire. Hypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg or current antihypertensive treatment. Independent predictors were identified using multivariable logistic regression. A weighted risk score was derived from regression coefficients and evaluated using receiver operating characteristic analysis. External validation was performed in an independent sample of 100 participants through the smartphone application.

Results

Hypertension prevalence was 33.1% (n = 171). Ten independent predictors were identified: age 31–50 years, male sex, married status, illiteracy, obesity, inadequate physical activity, excess salt intake, alcohol use, diabetes mellitus and family history of hypertension. The model achieved an area under the curve of 0.72 (95% CI: 0.68–0.77), with 87.2% sensitivity and 63.8% specificity at a cut-off score of 19.5. External validation demonstrated 83% predictive accuracy.

Conclusions

The ten-factor risk score showed acceptable discrimination and was successfully integrated into a validated mobile application. It may support targeted prevention and community-based hypertension screening in similar urban Indian settings.

Background

Hypertension is a globally prevalent non-communicable disease (NCD) responsible for substantial cardiovascular morbidity and mortality. The World Health Organisation (WHO) estimates that 1.28 billion

adults aged 30–79 years are affected, with approximately two-thirds residing in low- and middle-income countries (LMICs) [1]. Despite its magnitude, nearly 46% of individuals with hypertension remain undiagnosed, and only 21% achieve adequate blood pressure control [2].

In India, the National Family Health Survey-5 (NFHS-5) reported hypertension prevalence rates of 24.0% in men and 21.3% in women aged ≥ 15 years nationally, with Karnataka recording 26.9% in men and 25.0% in women [3]. These figures reflect a growing epidemiological transition driven by rapid urbanisation, sedentary lifestyles, dietary changes and increasing rates of comorbid metabolic disorders such as diabetes and dyslipidaemia.

Hypertension is strongly associated with modifiable risk factors including excess salt and fat intake, physical inactivity, overweight/obesity, tobacco use and alcohol consumption, as well as non-modifiable factors such as age, sex, ethnicity and family history [4]. Epidemiological evidence consistently demonstrates that early lifestyle interventions can prevent or delay the onset of hypertension, underscoring the public health importance of identifying high-risk individuals before clinical disease develops [5–8].

Risk prediction models offer a structured, evidence-based approach to estimating an individual's probability of developing hypertension from readily measurable characteristics. Prior models developed in Canada, China and elsewhere have demonstrated acceptable discriminatory performance (area under the curve [AUC] 0.72–0.82) using logistic regression and machine-learning approaches [9–11]. However, population-specific models validated in Indian urban settings remain scarce, limiting their clinical translation.

The rapid proliferation of smartphones has created an unprecedented opportunity for scalable health interventions. Mobile health (mHealth) applications for hypertension self-management have demonstrated improvements in awareness and blood pressure control [12–14]. Integrating validated risk prediction algorithms into user-friendly applications can extend preventive services to communities with limited access to formal healthcare. Artificial intelligence (AI) and machine-learning technologies further augment risk stratification by identifying complex, non-linear relationships among risk factors and enabling continuous, real-time monitoring [15]. Despite this promise, AI-driven hypertension prediction tools tailored to the Indian urban population remain underdeveloped.

This study therefore aimed to: (i) determine the prevalence of hypertension among adults in the urban field practice area of a tertiary medical college in Mysuru; (ii) identify independent demographic, lifestyle and clinical predictors of hypertension through logistic regression; (iii) develop and internally validate a weighted risk prediction model; and (iv) deploy the validated model as a smartphone application and assess its predictive accuracy through external validation.

Methods

Study design and setting

A community-based cross-sectional study was conducted over 18 months (September 2022 to March 2024) in the urban field practice area served by the Urban Primary Health Centre (UPHC) of a tertiary medical college in Mysuru, Karnataka, India. The field practice area covers a total population of 7,842 individuals. The study is reported in accordance with the STROBE guidance for cross-sectional studies and, for the prediction-model component, the TRIPOD statement.

Participants

All adults aged ≥19 years residing in the study area were eligible. Individuals who were pregnant, critically ill, or who declined consent were excluded. A total of 517 participants were enrolled. The sample size was calculated using the formula $n = Z^2pq/d^2$, based on an estimated hypertension prevalence of 30.7% [16] ($p = 0.307$, $q = 0.693$, $Z = 1.96$, $d = 0.05$) with a 10% non-response correction, yielding a minimum of 490 participants.

Sampling technique

Cluster sampling was employed. The study area was divided into clusters based on geographic blocks. Clusters were selected by simple random sampling (lottery method), and all eligible households within selected clusters were enumerated. Within each household, one adult aged ≥19 years was recruited using systematic random sampling.

Data collection

Data were collected through face-to-face interviews using a pretested semi-structured questionnaire comprising four domains: (i) socio-demographic profile (age, sex, marital status, educational qualification, occupation, family type, socioeconomic status, religion and health insurance); (ii) lifestyle risk factors (physical activity, dietary habits, salt and oil consumption, tobacco and alcohol use, sleep duration and screen time); (iii) clinical history (diabetes mellitus, cardiovascular disease, dyslipidaemia, chronic kidney disease and thyroid disorders); and (iv) psychosocial assessment using the validated Depression, Anxiety and Stress Scale-21 (DASS-21). The questionnaire was developed by the investigators specifically for the present study, drawing on standard non-communicable-disease risk-factor tools, and was pretested on a small sample for clarity and content validity before data collection; it had not been published previously. The full English-language version of the questionnaire is provided as Additional file 2.

Anthropometric and blood pressure measurements

Weight (kg) and height (cm) were measured using calibrated equipment; body mass index (BMI) was calculated as weight/height² (kg/m²) and classified using WHO Asian-specific cut-offs [17]. Waist and

hip circumferences were measured in centimetres per WHO protocol, and the waist-to-hip ratio was computed accordingly [18]. Blood pressure was measured twice at 15-minute intervals using a validated digital sphygmomanometer after 5 minutes of seated rest, following the Indian Hypertension Control Initiative (IHCI) protocol [19]. The mean of the two readings was used. Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg, or current use of antihypertensive medication, as per JNC VIII criteria.

Development of the smartphone application

The final weighted risk score was translated into a freely available Android smartphone application, “BP Risk”, developed by the Department of Community Medicine, JSS Medical College, JSSAHER, and published on the Google Play Store [34]. The application guides the user through a short, structured set of questions corresponding to the ten predictor variables and instantly returns an individualised hypertension risk category (low or high risk of developing hypertension in the future) based on the validated cut-off score. Beyond risk prediction, the application incorporates four modules accessible from a central dashboard: a Risk Predictor, an online counselling feature providing contact details of physicians, a Health Information module covering the Indian Hypertension Control Initiative, blood-pressure monitoring procedures, the DASH diet, and the prevention, symptoms and management of hypertension, and a BP Recorder that allows users to log and interpret their blood-pressure readings. Screenshots of the application interface are shown in Fig. 1. The tool was designed to promote primary prevention and self-management, and to extend preventive services to community members with limited access to formal healthcare.

Statistical analysis

Data were entered and analysed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies and percentages. The chi-square test assessed associations between categorical predictors and hypertension status. Crude odds ratios (OR) with 95% confidence intervals (CI) were computed through univariate logistic regression for each candidate predictor. Variables with $p<0.05$ in univariate analysis were entered into a forward stepwise multivariable logistic regression model to identify independent predictors.

The risk prediction score was developed by multiplying each significant predictor’s β-coefficient by 10 and rounding to the nearest integer. Model discrimination was assessed by ROC curve analysis, with the AUC, sensitivity, specificity and optimal cut-off (Youden’s index) computed. The model was then externally validated using the developed smartphone application in an independent sample of 100 participants.

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee, JSS Academy of Higher Education and Research, Mysuru (reference number JSS/MC/PG/IEC-86/2022-23). Written informed consent was obtained from all participants, and data confidentiality was strictly maintained throughout the study.

Results

A total of 517 participants were included, of whom 171 (33.1%) had hypertension. The majority belonged to the 31–50-year age group (234; 45.3%), followed by the 51–70-year age group (142; 27.5%); participants aged 19–30 years and those aged 70 + accounted for 91 (17.6%) and 50 (9.7%), respectively. Females constituted 262 (50.7%) and males 255 (49.3%). Most participants were married (400; 77.4%), whereas 78 (15.1%) were unmarried. Illiteracy was observed in 152 (29.4%) participants, followed by high-school education in 125 (24.2%). Obesity was present in 248 (48.0%) participants. Alcohol consumption, diabetes mellitus and a family history of hypertension were reported by 138 (26.7%), 78 (15.1%) and 225 (43.5%) participants, respectively (Table 1).

Increasing age was significantly associated with hypertension ($p < 0.001$). Among hypertensive participants, 77 (45.0%) were in the 31–50-year group and 61 (35.7%) in the 51–70-year group. Hypertension was more common among married participants (148; 86.5%) than in the non-hypertensive group (252; 72.8%). A greater proportion of hypertensive participants were illiterate (63; 36.8%) than normotensive participants (89; 25.7%). Increased salt intake, alcohol consumption, diabetes mellitus and family history of hypertension were each significantly more frequent among hypertensive participants, as were depression, anxiety and stress (Table 2).

Among the anthropometric parameters, BMI was significantly associated with hypertension ($p = 0.001$). Obesity was observed in 86 (50.3%) hypertensive participants compared with 162 (46.8%) participants without hypertension, and overweight in 50 (29.2%) versus 59 (17.1%), respectively. In contrast, the waist–hip ratio was not significantly associated with hypertension ($p = 0.505$) (Table 3).

On univariate logistic regression, age, sex, marital status, educational status, physical inactivity, increased salt intake, alcohol consumption, obesity, family history of hypertension, diabetes mellitus, depression, anxiety and stress were significantly associated with hypertension (Table 4). After adjustment in the multivariable model, age 31–50 years, male sex, married status, illiteracy, obesity, inadequate physical activity, increased salt intake, alcohol consumption, diabetes mellitus and family history of hypertension remained independent predictors (Table 5).

A hypertension risk prediction score was derived from the β-coefficients of the independent predictors. Obesity contributed the highest score (8 points), followed by alcohol consumption and diabetes mellitus (7 points each), physical inactivity and family history of hypertension (6 points each), male sex and increased salt intake (5 points each), age 31–50 years and married status (4 points each), and illiteracy (3 points). The maximum attainable score was 55 points (Table 6).

The risk prediction model demonstrated acceptable discrimination, with an AUC of 0.72 (95% CI 0.68–0.77). At the optimal cut-off score of 19.5, the model showed a sensitivity of 87.2% and a specificity of 63.8%. External validation of the smartphone application in an independent sample of 100 participants demonstrated an overall predictive accuracy of 83% (Fig. 2).

Table 1
Socio-demographic profile of the study participants

Variable	Category	HTN absent, n (%)	HTN present, n (%)	χ^2	p
Age (years)	19–30	77 (22.3)	14 (8.2)	19.68	< 0.01*
	31–50	157 (45.4)	77 (45.0)		
	51–70	81 (23.4)	61 (35.7)		
	> 70	31 (9.0)	19 (11.1)		
Sex	Male	181 (52.3)	74 (43.3)	3.73	0.043*
	Female	165 (47.7)	97 (56.7)		
Marital status	Married	252 (72.8)	148 (86.5)	18.10	< 0.01*
	Unmarried	67 (19.4)	11 (6.4)		
	Divorced	9 (2.6)	1 (0.6)		
	Widowed	18 (5.2)	11 (6.4)		
Education	Illiterate	89 (25.7)	63 (36.8)	18.09	0.006*
	Primary	47 (13.6)	33 (19.3)		
	Middle	50 (14.5)	16 (9.4)		
	High school	88 (25.4)	37 (21.6)		
	Higher secondary	31 (9.0)	4 (2.3)		
	Degree	37 (10.7)	17 (9.9)		
	Postgraduate	4 (1.2)	1 (0.6)		
Health insurance	No	257 (74.3)	148 (86.5)	10.15	0.001*
	Yes	89 (25.7)	23 (13.5)		

*Values are n (%). p-values from the chi-square test; *p < 0.05 considered statistically significant. HTN, hypertension. Occupation, family type, socioeconomic status, religion and type of worker are reported in Additional file 1.*

Table 2
Behavioural and clinical risk factors of hypertension among the study participants

Risk factor	Category	HTN absent, n (%)	HTN present, n (%)	χ^2	p
Regular exercise	No	154 (44.5)	45 (26.3)	15.99	< 0.01*
	Yes	192 (55.5)	126 (73.7)		
Physical activity	Adequate	249 (72.0)	109 (63.7)	3.63	0.05*
	Inadequate	97 (28.0)	62 (36.3)		
Salt intake	Normal	297 (85.8)	160 (93.6)	6.66	0.010*
	Increased	49 (14.2)	11 (6.4)		
Family history of HTN	No	211 (61.0)	81 (47.4)	8.62	0.003*
	Yes	135 (39.0)	90 (52.6)		
Alcohol	No	270 (78.0)	109 (63.7)	11.94	0.001*
	Yes	76 (22.0)	62 (36.3)		
Diabetes mellitus	No	312 (90.2)	127 (74.3)	22.59	< 0.001*
	Yes	34 (9.8)	44 (25.7)		
Cardiovascular disease	No	344 (99.4)	161 (94.2)	14.01	< 0.001*
	Yes	2 (0.6)	10 (5.8)		
Dyslipidaemia	No	346 (100.0)	132 (77.2)	85.35	< 0.001*
	Yes	0 (0.0)	39 (22.8)		
Depression (DASS-21)	Normal	162 (46.8)	44 (25.7)	40.55	0.001*
	Mild	161 (46.5)	118 (69.0)		
	Moderate	19 (5.5)	0 (0.0)		
	Severe	4 (1.2)	9 (5.3)		
Anxiety (DASS-21)	Normal	197 (56.9)	43 (25.1)	58.28	0.001*
	Mild	127 (36.7)	103 (60.2)		
	Moderate	16 (4.6)	7 (4.1)		
	Severe	6 (1.7)	18 (10.5)		
Stress (DASS-21)	Normal	143 (41.3)	24 (14.0)	56.70	0.001*

Risk factor	Category	HTN absent, n (%)	HTN present, n (%)	χ^2	p
	Mild	186 (53.8)	121 (70.8)		
	Moderate	14 (4.0)	9 (5.3)		
	Severe	3 (0.9)	17 (9.9)		

*Values are n (%). p-values from the chi-square test; *p < 0.05 considered statistically significant. HTN, hypertension; DASS-21, Depression, Anxiety and Stress Scale-21. Non-significant lifestyle variables (diet, oil, junk food, smoking, smokeless tobacco, coffee, tea, sleep, screen time, heart rate) are reported in Additional file 1.*

Table 3
Anthropometric risk factors of the study participants

Parameter	Category	HTN absent, n (%)	HTN present, n (%)	χ^2	p
BMI	Underweight	37 (10.7)	9 (5.3)	17.57	0.001*
	Normal	88 (25.4)	26 (15.2)		
	Overweight	59 (17.1)	50 (29.2)		
	Obese	162 (46.8)	86 (50.3)		
Waist–hip ratio	Normal	262 (75.7)	134 (78.4)	0.44	0.505
	Abnormal	84 (24.3)	37 (21.6)		

*Values are n (%). p-values from the chi-square test; *p < 0.05 considered statistically significant. BMI classified using WHO Asian-specific cut-offs. Abnormal waist–hip ratio: ≥0.90 (men), ≥ 0.85 (women). HTN, hypertension.*

Table 4
Univariate logistic regression of factors associated with hypertension

Variable	Category	Crude OR	95% CI	p
Age (years)	19–30	1 (ref)	–	< 0.01*
	31–50	2.69	1.43–5.07	0.002*
	51–70	4.14	2.14–8.00	< 0.01*
	> 70	3.37	1.50–7.55	0.003*
Sex	Female	1 (ref)	–	0.05*
	Male	1.45	1.00–2.10	0.05*
Marital status	Unmarried	1 (ref)	–	< 0.01*
	Married	3.57	1.85–7.14	< 0.01*
Education	Illiterate (ref)	1 (ref)	–	0.006*
	Higher secondary	0.18	0.06–0.54	0.042*
Physical activity	Adequate	1 (ref)	–	0.05*
	Inadequate	1.46	0.98–2.15	0.05*
Salt intake	Normal	1 (ref)	–	0.012*
	Increased	0.42	0.21–0.83	0.012*
Alcohol	No	1 (ref)	–	0.001*
	Yes	2.02	1.35–3.03	0.001*
BMI	Underweight	1 (ref)	–	0.001*
	Overweight	3.48	1.53–7.91	0.003*
	Obese	2.18	1.00–4.73	0.048*
Family history of HTN	No	1 (ref)	–	0.003*
	Yes	1.74	1.20–2.55	0.003*
Diabetes mellitus	No	1 (ref)	–	< 0.01*
	Yes	3.18	1.95–5.20	< 0.01*

*OR, odds ratio; CI, confidence interval; ref, reference category; HTN, hypertension; BMI, body mass index. *p < 0.05. Odds ratios are presented with the lower-risk category as reference. NOTE TO AUTHORS: reference categories and CI orientation should be reconciled against the SPSS output before submission (see accompanying memo).*

Table 5
Multivariable logistic regression of independent predictors of hypertension

Predictor	Category	Adjusted OR	95% CI	p
Age 31–50 years	vs 19–30	1.43	[reconcile]	0.007*
Male sex	vs female	1.64	[reconcile]	0.05*
Married status	vs widowed	1.44	[reconcile]	0.003*
Illiteracy	vs postgraduate	1.29	[reconcile]	0.01*
Obesity	vs underweight	2.31	[reconcile]	0.004*
Inadequate physical activity	vs adequate	1.83	[reconcile]	0.01*
Increased salt intake	vs normal	2.63	[reconcile]	0.02*
Alcohol consumption	vs none	1.49	[reconcile]	0.005*
Diabetes mellitus	vs none	1.48	[reconcile]	0.010*
Family history of HTN	vs none	1.56	[reconcile]	0.006*

*Adjusted odds ratios from the forward stepwise multivariable model. OR, odds ratio; CI, confidence interval; HTN, hypertension. *p < 0.05. NOTE TO AUTHORS: 95% CIs in the original output are internally inconsistent (several do not bracket the point estimate) and must be re-extracted from SPSS before submission (see accompanying memo).*

Table 6
Weighted hypertension risk assessment score

Predictor	Category	Score
Age	31–50 years	4
Age	Other	0
Sex	Male	5
Sex	Female	0
Education	Illiterate	3
Education	Educated	0
BMI	Obese	8
BMI	Not obese	0
Marital status	Married	4
Marital status	Other	0
Adequate physical activity (> 150 min/week)	No	6
Adequate physical activity (> 150 min/week)	Yes	0
Salt intake	Increased (> 5 g/day)	5
Salt intake	Normal (≤ 5 g/day)	0
Alcohol use	Yes	7
Alcohol use	No	0
Diabetes mellitus	Present	7
Diabetes mellitus	Absent	0
Family history of hypertension	Present	6
Family history of hypertension	Absent	0
Maximum attainable score		**55**

Optimal cut-off score 19.5 (Youden's index); sensitivity 87.2%, specificity 63.8%; AUC 0.72 (95% CI 0.68–0.77).

Discussion

This study presents a validated hypertension risk prediction model and its deployment as a smartphone application, developed from primary data collected in the urban field practice area of Mysuru, South India. The observed hypertension prevalence of 33.1% exceeds national estimates from NFHS-5 (24%). It

is consistent with data from urban Indian cohorts: Ghosh and Kumar reported 30.7% in a pan-India survey [16], and Anchala et al. documented urban prevalence estimates approaching 33% in their meta-analysis of Indian studies [20].

Age emerged as a dominant non-modifiable predictor, consistent with the established physiology of progressive arterial stiffening and neurohormonal dysregulation with advancing years [21]. The association with male sex, while contrasting with some regional Indian data, likely reflects higher rates of alcohol and tobacco use among men in the study population [22]. The elevated odds among married individuals are partly attributable to age confounding and lifestyle convergence observed in longitudinal studies [23].

Obesity (BMI ≥ 25 kg/m², Asian-specific cut-offs) conferred the highest adjusted odds among modifiable predictors, reinforcing the central role of adiposity in blood pressure dysregulation through sympathoadrenal activation, insulin resistance, and stimulation of the renin–angiotensin–aldosterone system [24]. The high combined overweight/obesity prevalence in this population signals an urgent need for weight-management interventions. Physical inactivity and excess salt intake further support WHO recommendations for population-level sodium reduction and for promoting ≥ 150 minutes/week of moderate-intensity physical activity [25].

Alcohol consumption showed one of the stronger associations, consistent with systematic-review evidence of dose-dependent elevation of systolic and diastolic blood pressure [26]. Diabetes mellitus co-occurred in 15.1% of participants, reflecting the well-documented cardiometabolic clustering that characterises urban Indian populations and reinforcing the need for integrated NCD screening [27]. Family history quantifies heritable contributions, consistent with twin studies and polygenic risk models [28].

The risk prediction model (AUC 0.72) demonstrates acceptable discriminatory performance, comparable to the Canadian model by Chowdhury et al. (AUC 0.80) [29] and the Shanghai screening tool by Jiang et al. (AUC 0.82) [30]. The intentionally high sensitivity (87.2%) at the cut-off of 19.5 prioritises detection of true positives in a screening context, accepting a modest reduction in specificity (63.8%)-an appropriate trade-off for a primary-prevention tool.

The smartphone application, validated in an independent cohort of 100 participants, achieved 83% accuracy-competitive with published mHealth hypertension tools [13, 14]. AI-assisted mobile applications have been proposed as transformative tools for NCD prevention in LMICs, where access to specialist healthcare is limited [15, 31]. By embedding the validated scoring algorithm into an accessible interface, this study operationalises the risk model for community use, enabling self-assessment and facilitating timely health-seeking.

Educational level showed a significant inverse association with hypertension risk, consistent with global evidence on health literacy and uptake of preventive behaviours [32]. Psychosocial burden, as assessed by the DASS-21, was substantial. However, not independently significant in multivariable modelling; it

underscores pathways through sympathoadrenal activation and unhealthy coping behaviours that warrant attention in comprehensive cardiovascular risk management [33].

Strengths and limitations

Strengths include the use of primary community-based data, a robust sampling framework and the practical translation of the model into a deployable mHealth tool. Several limitations should be noted. The cross-sectional design precludes causal inference. The study was confined to one urban UPHC area in Mysuru, limiting generalisability to other Indian cities or rural settings. Self-reported dietary and behavioural data (e.g., salt and alcohol) may be subject to social desirability bias. Genetic risk factors were not assessed. Model calibration and internal validation by bootstrapping were not performed and are recommended before wider deployment. External validation in a larger, geographically diverse cohort is warranted.

Conclusions

This study identified ten independent predictors of hypertension in an urban South Indian adult population and constructed a weighted ten-item risk score (maximum 55 points) with an AUC of 0.72, a sensitivity of 87.2% and a specificity of 63.8% at a cut-off of 19.5. Hypertension prevalence was 33.1%, substantially exceeding national survey estimates and underscoring the severity of the urban NCD burden. The risk score was successfully deployed as a smartphone application, achieving 83% predictive accuracy on external validation. This mHealth tool has the potential to support community-level hypertension screening, empower individuals to take preventive action, and guide targeted public health interventions in comparable urban settings in India. Future longitudinal studies and multi-site external validation are recommended to strengthen the model's generalisability.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Ethics Committee of JSS Academy of Higher Education and Research, Mysuru (approval number JSS/MC/PG/IEC-86/2022-23). The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before enrolment.

Consent for publication

Not applicable. The manuscript does not contain any person's identifiable data, images or videos.

Availability of data and materials

Yes. The datasets generated and/or analysed during the current study are not publicly available owing to participant privacy and institutional data-governance restrictions, but are available from the

corresponding author (Sunil Kumar D) on reasonable request. The English-language study questionnaire is provided as Additional file 2 of this article.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

RM conceived and designed the study, collected and analysed the data, developed the smartphone application and drafted the manuscript. SKD conceptualised and supervised the study, guided the statistical analysis and critically revised the manuscript. HPG contributed to the study design, data interpretation and manuscript revision. RA and DY contributed to data collection, data management and literature review. AG and MPV contributed to the statistical analysis and critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures



Figure 1

Screenshots of the “BP Risk” smartphone application

(a) secure login screen; (b) main dashboard with the Risk Predictor, online counselling, health information and BP Recorder modules; (c) health information module; (d) low-risk and (e) high-risk prediction outputs. The application is available at https://play.google.com/store/apps/details?id=com.service.hypertensioncalculator [34].

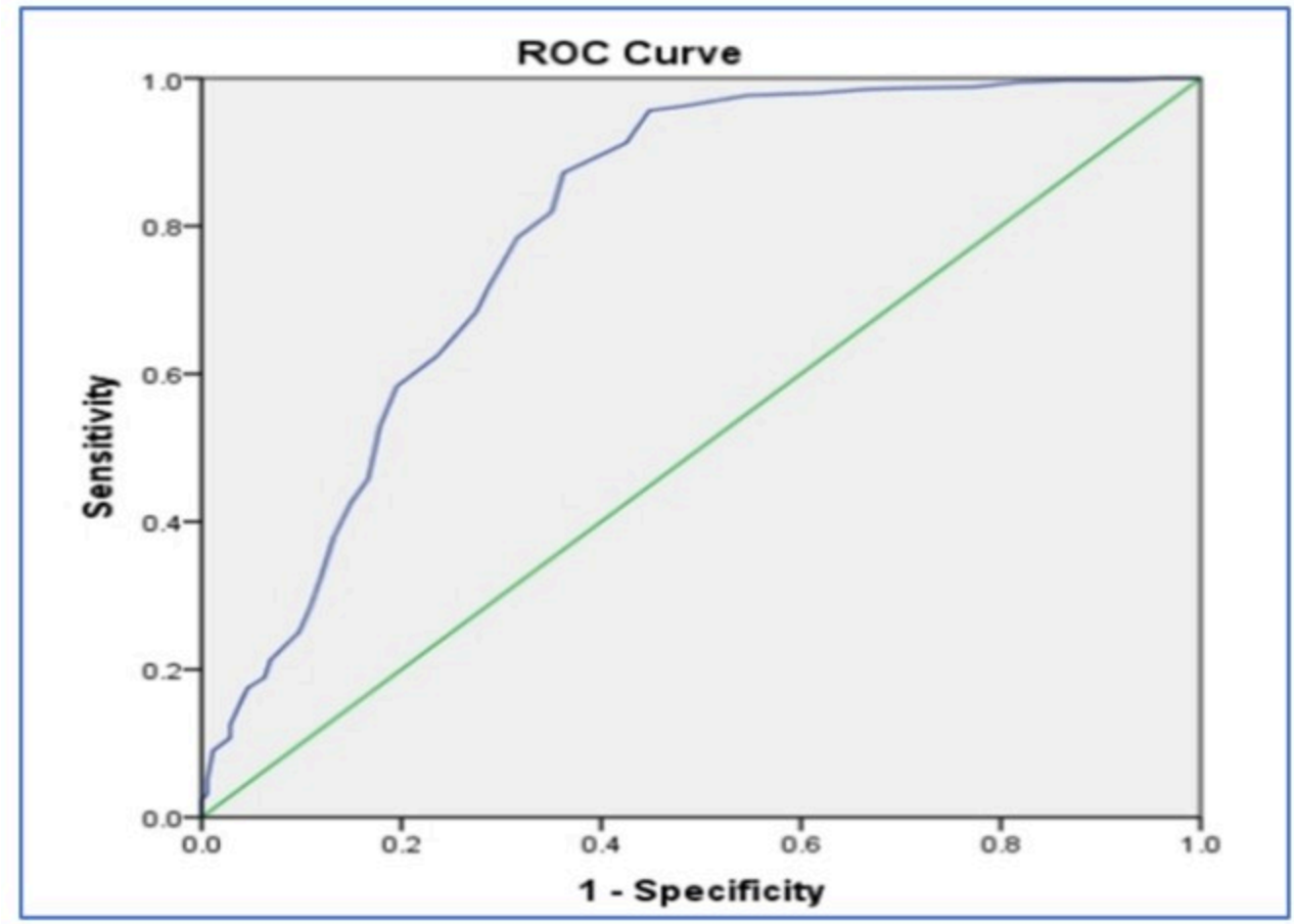


Figure 2

Receiver operating characteristic (ROC) curve of the developed hypertension risk prediction model

Supplementary Files

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

- Additionalfile1.docx
- Additionalfile2Questionnaire.docx