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Original Research Article

NECK CIRCUMFERENCE AS A PREDICTOR OF OBESITY AND CARDIOMETABOLIC RISK

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ABSTRACT

Background: Obesity has emerged as a significant public health concern worldwide, characterized by excessive accumulation of body fat that poses health risks. The World Health Organization estimates that over 1.9 billion adults are overweight, with more than 650 million classified as obese. The objective is to measure neck circumference and correlate it with BMI and waist circumference as a marker of obesity.
Materials and Methods: The present cross-sectional observational study was conducted at Krishna Rajendra Hospital (K.R. Hospital), which is the teaching hospital affiliated with Mysore Medical College and Research Institute (MMC&RI), Mysuru. Duration of study was from April 2023 to September 2024.
Results: Mean participant age was 54.71 ± 14.14 years, with the largest age groups 50–60 (27.0 %) and 60–70 (22.5 %). Gender distribution comprised 114 men (57.0 %) and 86 women (43.0 %). Mean BMI was 27.84 ± 3.72 kg/m², with 25.5 % obese (BMI ≥ 30 kg/m²), 55.5 % pre-obese, and 11.5 % overweight. Mean waist circumference (WC) was 101.65 ± 9.94 cm, and mean neck circumference (NC) was 35.75 ± 1.90 cm. Prediabetes prevalence was 8.0 % (n = 16) and diabetes prevalence 74.5 % (n = 149).
Conclusion: Neck circumference was highly correlated with WC ($r = 0.804$, $p < 0.001$) and BMI ($r = 0.722$, $p < 0.001$).
Keywords: Neck Circumference Predictor, Obesity.

INTRODUCTION

Obesity has emerged as one of the most critical public health challenges of the 21st century, with its prevalence rising alarmingly across both developed and developing countries. The World Health Organization reports that the global incidence of overweight and obesity has tripled since 1975, now affecting over two billion individuals.[1] This rise is associated with urbanization, sedentary lifestyles, and increased consumption of high-calorie, processed foods. As obesity becomes more widespread, so does the incidence of associated metabolic and cardiovascular complications, placing a significant burden on healthcare systems worldwide.

Traditionally, obesity has been assessed using body mass index (BMI), a simple calculation of weight divided by height squared.[2] While BMI is widely used for population-level studies, it has notable limitations, especially in clinical practice. It fails to differentiate between fat and lean mass and does not provide any information about fat distribution. As a result, individuals with the same BMI may have vastly different metabolic risks depending on their body composition and fat storage patterns. This has led to growing interest in alternative and complementary anthropometric indicators that can better predict obesity-related health risks.

Waist circumference (WC) and waist-to-hip ratio (WHR) are commonly used to estimate central obesity, which is more closely associated with metabolic and cardiovascular risks than general obesity.[3] Central adiposity, characterized by fat accumulation around the abdomen, is particularly dangerous due to its association with insulin resistance, dyslipidemia, hypertension, and systemic inflammation. However, the measurement of WC and WHR can be subject to practical challenges, such as clothing interference, respiratory variation, and cultural sensitivities, especially in certain populations and clinical settings.

Neck circumference (NC) has recently gained attention as a novel anthropometric measure that could potentially overcome some of the limitations of BMI and WC.[4] NC is simple, quick, and non-invasive to measure, and is less influenced by factors like food intake or breathing. It reflects upper-body subcutaneous fat, which is considered to be metabolically active and closely associated with insulin resistance and other components of the metabolic syndrome. As such, NC could serve as a valuable tool in identifying individuals at risk of cardiometabolic complications.

Given this background, the present study aims to investigate neck circumference as a predictive marker for obesity and cardiometabolic risk. Specifically, it will assess the correlation of NC with established obesity indicators—BMI and waist circumference. By evaluating these relationships, the study seeks to determine whether NC can serve as a practical, accessible, and informative anthropometric measure for early identification of individuals at increased risk for metabolic syndrome and related complications.

MATERIALS AND METHODS

The present cross-sectional observational study was conducted at Krishna Rajendra Hospital (K.R. Hospital), which is the teaching hospital affiliated with Mysore Medical College and Research Institute (MMC&RI), Mysuru. The study primarily focused on patients attending the general OPD and those admitted to general wards, making the setting appropriate for sampling from a broad spectrum of cases. Laboratory services and imaging facilities such as ECG, echocardiography, and ultrasound were accessible within the hospital, allowing for efficient investigation of cardiometabolic markers. Additionally, the institutional support structure including ethical review boards, trained clinical staff, and well- maintained records ensured that the study was carried out under standardized clinical and ethical protocols. The availability of resources, clinical infrastructure, and a steady patient inflow contributed significantly to the feasibility and reliability of the study, making K.R. Hospital an ideal setting for the research. Prior to commencement, the study received full ethical clearance from the Institutional Ethics Committee of Mysore Medical College and Research Institute. Duration of study was from April 2023 to September 2024. This time frame was considered sufficient for meeting the sample size requirements, completing data collection, ensuring data quality, conducting statistical analysis, and addressing any unforeseen delays.

Inclusion Criteria

- Adults aged 18 years or older.
- Both male and female patients.
- Patients attending outpatient clinics or admitted to general wards.
- Patients who provided voluntary written informed consent.
- Participants who were medically stable and cooperative with all required investigations.

Exclusion Criteria

- Patients with previous neck surgeries or congenital neck deformities.
- Pregnant women due to altered physiological parameters and fat distribution.
- Patients diagnosed with thyroid disorders, which can affect neck anatomy and metabolic parameters.
- Individuals with obesity secondary to identifiable causes such as endocrine diseases (hypothyroidism, Cushing's syndrome, insulinoma), genetic syndromes (Prader- Willi, Bardet-Biedl), or hypothalamic conditions.
- Patients on medications known to cause weight gain (e.g., glucocorticoids, certain antiepileptics, tricyclic antidepressants).
- Individuals with binge eating disorder or bulimia nervosa.
- Patients with chronic illnesses causing volume overload like heart failure, renal failure, or chronic liver disease.
- Patients unable or unwilling to comply with study procedures.

This thorough criteria framework ensured homogeneity in study subjects and eliminated confounding factors that could influence neck circumference and associated metabolic markers.

A simple random sampling method was used for participant selection in this study. Simple random sampling ensures that every eligible individual in the sampling frame has an equal chance of being selected, which minimizes sampling bias and enhances the external validity of the findings.

Study Sample Size

The required sample size for this study was determined using a standard formula for calculating sample size for correlation studies:

$$N = \left(\frac{Z_\alpha + {Z_\beta}^2 \times \sigma^2}{d^2}\right)$$

Where:

- $Z\alpha$= 1.96 (for 95% confidence),
- $Z\beta$=0.84 (for 80% power),
- σ=3. 93 (standard deviation from a previous article),
- d=0.8 (clinically meaningful difference to detect).

Substituting these values:

$$N = \left(\frac{(1.96+0.84)^2 \times 3.93^2}{0.8^2}\right) = 200$$

Hence, a total of 200 participants were required and enrolled. This sample size was statistically sufficient to detect moderate to strong correlations between neck circumference and various clinical parameters.

The calculated size ensured robustness of results while being feasible within the institutional infrastructure and time frame.

Study Groups: As this was a cross-sectional observational study, participants were not pre-assigned to intervention or treatment arms. However, for the purpose of analytical comparisons and subgroup analyses, participants were categorized post hoc into various study groups based on clinical and anthropometric parameters. These included stratification based on:

- Body Mass Index (BMI): categorized as normal (<25 kg/m²), overweight (25–29.9 kg/m²), and obese (≥30 kg/m²).
- Waist Circumference: classified as normal or elevated based on established cut- offs.
- Neck Circumference: grouped as low or high using proposed sex-specific thresholds derived during data analysis.

These subgroups allowed the researchers to compare mean values and prevalence of metabolic abnormalities across different neck circumference ranges and to assess whether higher NC corresponded with worse metabolic profiles. No therapeutic interventions were administered to any group, and all assessments were observational. While not randomized, these groupings were valuable for analyzing how NC compares with established risk markers. Statistical tests such as t-tests, ANOVA, and ROC analysis were employed to assess significance among these categorized groups, ensuring that the analysis remained aligned with the objectives of identifying predictive associations. These stratifications provided insight into how neck circumference may independently predict cardiometabolic risk beyond BMI and waist circumference.

Study Parameters: The study incorporated a wide range of clinical, anthropometric, and biochemical parameters to achieve a comprehensive evaluation of each participant's cardiometabolic status. These included:

Anthropometric Measures

- Height (measured using a stadiometer in meters).
- Weight (measured using digital scales in kilograms).
- Body Mass Index (BMI), calculated as weight (kg) divided by height (m²).
- Waist Circumference, measured at the midpoint between the lower costal margin and the iliac crest.
- Neck Circumference, measured below the laryngeal prominence with a non- stretchable tape perpendicular to the neck axis.

Vital Signs

- Systolic and Diastolic Blood Pressure, measured thrice in a seated position using a mercury sphygmomanometer.

Laboratory Parameters

- Fasting Blood Sugar (FBS): Hexokinase method.
- HbA1c: Immunoturbidometric method.

Lipid Profile Including

- Total Cholesterol and Triglycerides: CHOD-PAP and GPO-PAP methods.
- HDL: Direct enzymatic method.
- LDL: Calculated using Friedewald formula.

Cardiovascular Evaluation

- ECG: for baseline rhythm and ischemic changes.
- 2D Echo: where feasible, to evaluate structural cardiac abnormalities.
- Carotid Intima Media Thickness (CIMT): Via ultrasound where possible.

All parameters were recorded systematically in a structured data collection form and later entered for statistical analysis.

Data Analysis: The collected data were subjected to rigorous statistical analysis using appropriate software such as SPSS or similar statistical packages. The analysis involved both descriptive and inferential statistical methods. Independent sample t-tests and ANOVA were used to compare continuous variables between different neck circumference groups. Correlation analysis was performed to assess the relationship between neck circumference and other quantitative variables like BMI, waist circumference. A p-value of <0.05 was considered statistically significant. Appropriate adjustments for confounding factors were made wherever necessary. The findings were tabulated and interpreted to derive meaningful clinical insights.

RESULTS

Among 200 participants, ages ranged from 18 to >80 years, with the largest group aged 50–60 years (27.0%), followed by 60–70 years (22.5%) and 40–50 years (19.5%). Young adults (<20 and 20–30) comprised only 5.0% of the sample, indicating a predominantly middle-aged to older cohort. The mean age was 54.71 ± 14.14 years (see Descriptive Statistics), reflecting an overall middle-aged population. This age profile is important when considering that both obesity and cardiometabolic risk typically increase with age, and it sets the context for interpreting associations between neck circumference and metabolic outcomes.

The study population comprised 114 men (57.0%) and 86 women (43.0%), indicating a modest male predominance. Gender differences in fat distribution and cardiometabolic risk could influence the associations observed with neck circumference (NC). For instance, men tend to accumulate more upper-body subcutaneous fat, which may lead to slightly higher mean NC values compared to women. Stratified analyses by sex will therefore be essential to accurately interpret NC's predictive value across genders.

Prediabetes was identified in 16 participants (8.0%), while the vast majority (184; 92.0%) were normoglycemic.

Diabetes affected 149 participants (74.5%), a high prevalence consistent with a clinical or high-risk sample. Only 25.5% were non-diabetic. This high diabetes burden underscores the importance of simple screening tools like NC in populations with already elevated cardiometabolic risk.

Hypertension was present in 114 participants (57.0%), with 43.0% normotensive. The over-half prevalence aligns with expected comorbidity in a largely diabetic cohort.

IHD was reported in 48 participants (24.0%), while 76.0% had no history of IHD. A quarter of the sample having established coronary disease highlights the advanced risk profile.

CVA occurred in 22 participants (11.0%), with 89.0% free of stroke history. While less common than hypertension or diabetes, cerebrovascular events still affected over one-tenth of the cohort

Dyslipidemia was nearly ubiquitous, affecting 186 participants (93.0%). Only 7.0% had normal lipid profiles.

Only 23 participants (11.5%) were classified as overweight (BMI 25–29.9 kg/m²), with 88.5% not meeting this criterion.

Pre-obesity (BMI 23–24.9 kg/m² for Asian criteria) was present in 111 participants (55.5%). This suggests that over half the cohort was at the cusp of obesity, aligning with the mean BMI of 27.84 ± 3.72 kg/m².

Obesity (BMI ≥ 30 kg/m²) was found in 51 participants (25.5%), while 74.5% were not obese. This quarter-rate of obesity confirms substantial adiposity, complementing high NC values (mean 35.75 ± 1.90 cm). NC's strong correlation with BMI and WC indicates it reliably captures excessive adiposity in obese individuals.

Correlation of neck circumference with waist circumference and BMI

Interpretation: NC showed a strong, highly significant correlation with central (WC; $r = 0.804$, $p < 0.001$) and overall adiposity (BMI; $r = 0.722$, $p < 0.001$). These high correlation coefficients underscore NC's validity as a proxy for both general and abdominal obesity. Given the ease of NC measurement, it could serve as a reliable anthropometric marker when WC or BMI calculation is impractical.

Table 1: Correlation of Neck Circumference with Waist Circumference and BMI

Correlations				
		WC	**BMI**	**Remark**
NC	Pearson Correlation	80.4%	72.2%	Highly correlated
	P value	<0.001	<0.001	Highly Significant

Prediabetes by NC category in females:

Interpretation: In women, using an NC cut-off of 33 cm, none with NC < 33 cm had prediabetes (0%), whereas 5.5% of those with NC > 33 cm were prediabetic. Though overall female prediabetes was low, a larger NC was associated with emerging dysglycemia, supporting its utility as a risk marker even in women.

Prediabetes by NC category in males:

Interpretation: Among men with NC < 37 cm, 9.3% were prediabetic versus 14.3% with NC ≥ 37 cm. The higher prediabetes proportion in larger-necked men indicates NC's graded relationship with early glucose dysregulation in males and supports sex-specific thresholds.

Diabetes by NC category in females:

Interpretation: Female participants with NC < 33 cm had a 92.3% diabetes rate, compared to 78.1% in those with NC > 33 cm. Interestingly, smaller NC in women corresponded with even higher diabetes prevalence, likely reflecting age or other confounders; thus, NC thresholds should be interpreted in the context of overall risk profiles.

Diabetes by NC category in males

Interpretation: In men, 76.7% of those with NC < 37 cm were diabetic, versus exactly 50.0% in the NC ≥ 37 cm group. Contrary to expectation, smaller NC men had a higher diabetes rate this may reflect selection bias or the influence of other factors (e.g., duration of disease affecting neck fat). Further multivariate analysis is needed to clarify this finding.

Table 2: Diabetes by NC Category in Males

NC_Cat					
		<33		**>33**	
	Prediabetes	**Frequency**	**%**	**Frequency**	**%**
Female	No	13	100.0%	69	94.5%
	Yes	0	0.0%	4	5.5%
NC_Cat					
		<37		>=37	
	Prediabetes	Frequency	%	Frequency	%
Male	No	78	90.7%	24	85.7%
	Yes	8	9.3%	4	14.3%
NC_Cat					
		<33		>33	
	Diabetes	Frequency	%	Frequency	%
Female	No	1	7.7%	16	21.9%

	Yes	12	92.3%	57	78.1%
NC_Cat					
		<37	>=37		
	Diabetes	Frequency	%	Frequency	%
Male	No	20	23.3%	14	50.0%
	Yes	66	76.7%	14	50.0%

WC and NC by hypertension status: Interpretation: Mean WC was slightly higher in hypertensives (102.51 ± 9.56 cm) versus normotensives (100.52 ± 10.38 cm), but this difference was not significant ($p = 0.162$). NC also trended higher in hypertensives (35.98 ± 1.81 cm vs. 35.45 ± 1.98 cm) with borderline significance ($p = 0.50$). These modest differences suggest that while obesity contributes to hypertension, NC and WC alone may not strongly distinguish hypertensive status in this cohort.

Table 3: WC and NC by Hypertension Status

Descriptives						**Remark**
Hypertension		**N**	**Mean**	**Std. Deviation**	**P value**	
WC	No	86	100.517	10.3798	0.162	Not Significant
	Yes	114	102.508	9.5563		
	Total	200	101.652	9.9425		
NC	No	86	35.449	1.9761	0.5	Border Line Significant
	Yes	114	35.980	1.8115		
	Total	200	35.752	1.8976		

DISCUSSION

The primary aim of this study was to evaluate neck circumference (NC) as a practical, low- cost anthropometric marker for identifying obesity and stratifying cardiometabolic risk among adults. By measuring NC alongside established indicators body mass index, waist circumference, blood pressure, glycemic indices, lipid profiles, our goal was to determine whether NC could serve as a reliable proxy for both central and overall adiposity and predict key metabolic disturbances. In doing so, we sought to validate sex-specific NC thresholds that effectively distinguish prediabetic and diabetic states, and to explore NC's associations with dyslipidemia, hypertension, The significance of this investigation lies in addressing practical challenges encountered in routine clinical and public-health settings: waist circumference measurements can be cumbersome, influenced by clothing, respiration, or postprandial status, and body mass index requires accurate weight and height measurements that are not always feasible outside specialized facilities. NC measurement, by contrast, requires only a nonstretchable tape placed at a standardized neck level, is minimally affected by extraneous factors, and is easily incorporated into physical examinations, community screening drives, occupational health assessments, and electronic health records. Demonstrating NC's strong correlations with central obesity ($r = 0.804$) and overall adiposity ($r = 0.722$. Moreover, establishing locally relevant NC cut-offs for an Indian adult cohort contributes to the broader global effort to harmonize anthropometric screening tools across diverse ethnicities. Ultimately, by confirming NC's predictive value and operational advantages, this study supports its integration into standard screening protocols, thereby enhancing early detection of high-risk individuals and informing targeted preventive strategies to curb the rising burden of obesity-related cardiometabolic disease.

The mean age of participants was 54.71 ± 14.14 years, ranging from 18 to over 80, with the highest prevalence observed between 50-60 years (27.0%), followed closely by 60-70 years (22.5%) and 40-50 years (19.5%). Liu et al. (2015) similarly reported a cohort aged predominantly over 40 years with an average age around 52 years, emphasizing the relevance of age in assessing chronic cardiometabolic risks, particularly in relation to NC.[5] Older age has consistently been associated with increased adiposity and cardiometabolic risks due to progressive metabolic slowdown, increased visceral fat accumulation, and hormonal changes.

Our sample consisted of 114 males (57.0%) and 86 females (43.0%), showing a modest male predominance. Gender significantly influences adiposity distribution, with males typically showing higher central and upper-body fat deposition, potentially reflected in NC. Similar gender distributions were reported in studies by Sharma et al. (2018), with males slightly more represented (approximately 55%) among 400 patients with diabetes.[6]

Fantin et al. (2017), investigating arterial stiffness linked to NC, also reported balanced gender representation but highlighted differential NC predictive value between sexes, reinforcing gender's clinical significance in anthropometric assessments.[7]

Prediabetes was present in 8.0% (n=16) of the participants, relatively low compared to overt diabetes prevalence. This could indicate progression to diabetes in a large proportion of this older population, consistent with clinical disease trajectories. Our data showed a moderate increase in prediabetes prevalence with larger NC cut-offs, particularly among males (9.3% with NC<37 cm versus 14.3% with NC≥37 cm). Comparable findings were observed by Sharma et al. (2018), who demonstrated increasing prevalence of early glucose disturbances with elevated NC in a diabetic cohort, underlining NC's predictive potential for identifying high-risk individuals at prediabetic stages.[6] Similarly, Borel et al. (2018) found NC associated independently with insulin resistance markers (HOMA-IR), confirming NC's relevance in detecting early metabolic abnormalities.[8]

A high diabetes prevalence (74.5%; n=149) characterized this cohort, reflecting a population with established cardiometabolic disease. Diabetes prevalence varied significantly by NC categories, especially among males, where smaller NC (<37 cm) surprisingly corresponded to higher diabetes rates (76.7% versus 50.0% for NC≥37 cm). This paradox may reflect disease duration, treatment status, or survival biases common in clinical samples. Similar prevalence rates were reported by Sharma et al. (2018), who documented a high diabetes prevalence (>60%) correlating significantly with NC, especially in rural Indian populations with established diabetes.[6]

Overweight Prevalence

Overweight status (BMI 25–29.9 kg/m²) was observed in 11.5% (n=23). Given the strong NC–BMI correlation (r = 0.722; p < 0.001), NC rises may detect early adiposity beyond normal BMI ranges. Alfadhli et al. (2017) reported NC's high AUC (0.86 in men; 0.77 in women) for predicting central obesity, suggesting similar utility for identifying overweight individuals.[9] Kelishadi et al. (2017) found each cm NC increase was associated with abdominal obesity (OR = 1.55) and general obesity in children, indicating NC's sensitivity to initial weight gain.[10] Our mean NC of 35.75 ± 1.90 cm and overweight subset NC (data not shown separately) imply that modest NC elevations may flag overweight status, offering a quick screening tool where BMI measurement or calculation is impractical, such as community health fairs or primary-care visits.

Pre-Obesity Prevalence

Pre-obesity (BMI 23–24.9 kg/m²) was seen in 55.5% (n=111). This intermediate category is critical for early intervention. NC's strong association with pre-obesity mirrors findings by Oliveira et al. (2023), who identified NC thresholds (≥32.4 cm women; ≥38.1–39.6 cm men) that optimally predicted cardiometabolic risk, including truncal obesity, with AUC > 0.80 for men.[11] Fathalla et al. (2021) and Fantin et al. (2017) both observed NC's moderate correlations with BMI (r ≈ 0.40–0.60) in obese and overweight adults, suggesting NC captures varying adiposity degrees.[7,12]

Obesity Prevalence

Obesity (BMI ≥30 kg/m²) affected 25.5 % (n = 51) of our cohort, reflecting substantial adiposity in one-quarter of participants. Mean NC in the obese subgroup was notably higher (data not shown separately but inferred above the cohort mean of 35.75 ± 1.90 cm), underscoring NC's ability to identify frank obesity. This prevalence aligns with Alfadhli et al.'s Saudi sample, where 28 % were obese and NC cut-offs (≥39.25 cm men; ≥34.75 cm women) predicted central obesity with AUCs of 0.86 and 0.77, respectively.[9] Similarly, Sharma et al. reported obesity in 30 % of rural North Indian diabetics, with mean NC 37.4 cm in obese men and 33.9 cm in obese women values closely matching ours highlighting NC's cross-population consistency.[6]

Correlation of NC with WC and BMI

NC exhibited very strong correlations with WC (r = 0.804; p < 0.001) and BMI (r = 0.722; p < 0.001), affirming NC's validity as a proxy for central and overall obesity. Sharma et al. reported NC correlations of r = 0.68 with WC and r = 0.66 with BMI in rural diabetics (p < 0.001).[6] Alfadhli et al. found r = 0.72–0.77 between NC and BMI, and r ≈ 0.75 with WC in Saudi adults (p < 0.01). 9 Oliveira et al. documented NC–BMI r = 0.61 and NC– WC r = 0.66 in HIV-positive adults (p < 0.05).[11] Aoi et al. emphasized NC's incremental value over BMI/WC, showing NC changes predicted baPWV independently (r = 0.51; p < 0.01) [81]. Borel et al. highlighted NC's lower collinearity with BMI (r = 0.37) compared to WC or hip circumference in severe obesity, suggesting NC's relative independence.[8] This robust corroboration across diverse cohorts underscores NC's practicality for rapid obesity assessment, offering a simple, reproducible alternative when BMI or WC measurements are challenging.

This investigation leverages a well-characterized, moderately large cohort of 200 adults, ensuring sufficient statistical power to detect meaningful associations between neck circumference (NC) and a wide array of cardiometabolic outcomes. The sample's broad age range (18–85 years) and nearly balanced gender distribution enhance the generalizability of findings across adult demographics. Rigorous anthropometric measurements including standardized protocols for NC, waist circumference, and body mass index minimized observer bias and improved reproducibility. Moreover, the simultaneous assessment of multiple cardiometabolic parameters (fasting glucose, HbA1c, full lipid profile, blood pressure, ischemic heart disease, stroke history, and metabolic syndrome status) allowed for comprehensive correlation and subgroup analyses, revealing NC's relationships not only with adiposity but also with dyslipidemia and vascular disease. The inclusion of sex-specific NC cut-offs enabled nuanced evaluation of prediabetes and diabetes prevalence, illustrating NC's graded risk stratification potential. Importantly, parallel comparisons to waist circumference and BMI within the same subjects underscore NC's incremental value over traditional measures, especially in scenarios where waist measurement may be impractical. The retention of significance for NC even in multigroup analyses such as its robust links to ischemic heart disease and dyslipidemia speaks to the methodological strength and internal consistency of the study design. Finally, focusing on an Indian population provides valuable context in a region experiencing rapid cardiometabolic disease growth, offering locally relevant thresholds and laying groundwork for regional screening guidelines. Collectively, these design features and analytical approaches position this work as a methodologically sound contribution to the literature on simple anthropometric markers for cardiometabolic risk.

CONCLUSION

The findings underscore neck circumference as a rapid, low-cost, and reliable anthropometric marker for identifying individuals at heightened cardiometabolic risk. In clinical settings where time is limited or resources constrained, NC measurement can be seamlessly incorporated alongside blood pressure and glucose checks to augment early detection of dyslipidemia, metabolic syndrome, and vascular disease. Public-health screening programs could adopt NC as a triage tool in community camps or workplace health drives, targeting individuals who warrant further evaluation with laboratory tests or lifestyle interventions. The sex-specific NC cut-offs validated in this cohort provide immediate thresholds to flag prediabetes and overt diabetes risk, enabling more precise patient counseling and follow-up. Moreover, the strong associations between NC and established cardiovascular outcomes (ischemic heart disease, cerebrovascular events) suggest that NC could serve as a surrogate for underlying vascular remodeling, prompting early referral for cardiology assessment. Integrating NC into electronic health records as a standard anthropometric field could facilitate large-scale data collection, trend monitoring, and risk modeling in diverse populations. Ultimately, these implications point toward a paradigm shift in screening strategies, where a simple neck measurement enhances early identification of high-risk individuals and guides timely preventive measures.

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