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Original Article

Comparative Assessment of Neck and Waist Circumference as Predictors of Coronary Artery Disease Severity in Bangladesh

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ABSTRACT

Introduction: *Coronary artery disease (CAD) remains a major public health concern in Bangladesh, necessitating the identification of reliable and easily measurable predictors of disease severity. While waist circumference (WC) is a well-established anthropometric marker for cardiovascular risk, emerging evidence suggests that neck circumference (NC) may also be a significant predictor. This study aims to compare NC and WC as predictors of CAD severity in a Bangladeshi population.* ***Methods & Material:*** *This cross-sectional study was conducted at the Department of Cardiology, Dhaka Medical College, from May 2013 to April 2014. A total of 100 patients with angiographically confirmed CAD were included. Anthropometric measurements, including NC and WC, were recorded using standardized protocols. CAD severity was classified as mild, moderate, or severe based on angiographic findings. Correlation analysis and multivariable logistic regression were performed to assess the predictive ability of NC and WC. Receiver operating characteristic (ROC) curve analysis was conducted to determine the diagnostic accuracy of both measurements.* ***Results:*** *NC and WC were significantly higher in patients with severe CAD compared to those with mild or moderate disease ($p<0.001$). Both NC ($r=0.62$) and WC ($r=0.68$) showed strong positive correlations with CAD severity. In multivariable logistic regression, per cm increase in NC (adjusted OR: 1.45, 95% CI: 1.22–1.73, $p<0.001$) and WC (adjusted OR: 1.52, 95% CI: 1.29–1.81, $p<0.001$) were independently associated with increased CAD severity. ROC analysis revealed that WC (AUC = 0.82, cut-off ≥98 cm) had superior predictive performance compared to NC (AUC = 0.76, cut-off ≥39 cm).* ***Conclusion:*** *Both NC and WC are significant predictors of CAD severity in the Bangladeshi population. However, WC demonstrated a slightly stronger predictive ability. These findings suggest that NC could serve as a complementary, non-invasive screening tool in clinical settings, particularly when WC measurements are impractical.*

Keywords: *Coronary artery disease, neck circumference, waist circumference, anthropometry, cardiovascular risk predictors.*

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INTRODUCTION

Coronary artery disease (CAD) is a leading cause of morbidity and mortality worldwide, with a growing burden in low- and middle-income countries, including Bangladesh[1]. The prevalence of CAD in Bangladesh has been steadily increasing due to the rise in risk factors such as hypertension, diabetes, smoking, and sedentary lifestyles[2]. In 2015, the World Health Organization reported that cardiovascular diseases accounted for nearly 17% of all deaths in Bangladesh, with CAD being the most common condition[3]. Early detection and effective management of CAD are critical to improving patient outcomes, reducing healthcare costs, and alleviating the social and economic burden of this disease[4].

A key challenge in the management of CAD is assessing its severity accurately and efficiently. Traditional diagnostic tools, such as angiography and echocardiography, are often expensive, invasive, and not readily available in resource-limited settings[5]. This underscores the importance of identifying simple, non-invasive, and cost-effective predictors of CAD severity that can be easily incorporated into routine clinical practice, particularly in developing countries like Bangladesh[6]. Neck and waist circumference, both of which are easy to measure and widely used in clinical settings, have been suggested as potential indicators of CAD severity[7]. However, the relationship between these anthropometric

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measures and CAD severity remains unclear in many populations, particularly in South Asia.

The association between body measurements and CAD severity has been explored in various studies, with neck and waist circumference emerging as potential predictive markers[7]. Waist circumference, a measure of central obesity, has long been recognized as an indicator of increased cardiovascular risk due to its association with visceral fat accumulation, a key contributor to metabolic and cardiovascular disorders[7, 8]. Numerous studies have demonstrated that larger waist circumference is linked to increased CAD severity and poorer outcomes in Western populations[9, 10]. Similarly, neck circumference, which correlates with adiposity and fat distribution, has also been studied as a predictor of cardiovascular risk[11]. A few studies have found that increased neck circumference is associated with higher CAD risk, although this relationship is less well-established than that of waist circumference.

While studies from diverse populations have evaluated the utility of these anthropometric measures in predicting CAD, few have focused on the South Asian context, where the patterns of CAD risk factors may differ from those in Western populations[12, 13]. In particular, the predictive value of neck circumference in CAD severity has not been well studied in Bangladesh or South Asia. Moreover, the relative contribution of neck and waist circumference as predictors of CAD severity in this region has not been directly compared, which creates a significant gap in the existing literature. This study aims to fill this gap by comparing the ability of neck and waist circumference to predict the severity of CAD in a Bangladeshi cohort.

The primary objective of this study is to compare neck and waist circumference as predictors of CAD severity in patients diagnosed with CAD in Bangladesh. By evaluating the relationship between these body measurements and the severity of coronary artery disease, we seek to determine which of the two measurements provides a more reliable and practical tool for assessing CAD severity.

The secondary objective of the study is to analyze the clinical relevance and applicability of using neck and waist circumference as routine diagnostic tools for CAD severity. This involves exploring whether these simple, non-invasive measurements can be integrated into routine clinical practice to aid in risk stratification and early intervention in resource-limited settings, such as Bangladesh. Ultimately, this study aims to contribute to the identification of cost-effective diagnostic approaches that could improve early detection and management of CAD in the Bangladeshi population.

MATERIALS & METHODS

Study Design:

This was an observational, cross-sectional study aimed at evaluating the predictive value of neck and waist circumference as indicators of coronary artery disease (CAD) severity in a cohort of Bangladeshi patients. The study was conducted at the Department of Cardiology, Dhaka Medical College, Dhaka, Bangladesh.

Study Site:

The study was carried out at the Department of Cardiology, Dhaka Medical College, which is a tertiary care hospital located in Dhaka, the capital city of Bangladesh. The hospital provides comprehensive diagnostic and therapeutic services for patients with cardiovascular conditions and serves as a referral center for various cardiac conditions across the region.

Study Duration:

The study was conducted over a period of one year, from May 2013 to April 2014. During this time, eligible patients were enrolled, and data were collected, analyzed, and interpreted.

Study population

The study included adult patients diagnosed with coronary artery disease (CAD) who sought evaluation and treatment at the Department of Cardiology, Dhaka Medical College. Participants had to be 18 years or older and diagnosed with CAD based on clinical symptoms, electrocardiographic findings, and/or imaging techniques such as coronary angiography, allowing for a reliable assessment of the relationship between anthropometric measurements and CAD severity.

Patients with obesity-related disorders or chronic conditions affecting body measurements, such as metabolic syndrome, polycystic ovary syndrome (PCOS), or hypothyroidism, were excluded. Additionally, individuals unable to undergo imaging or diagnostic procedures to assess CAD severity, including coronary angiography, CT scans, or stress tests, were also excluded. This ensured that the study focused on individuals with reliable diagnostic data to evaluate CAD severity.

Anthropometric Measurements:

- **Neck Circumference (NC):** Neck circumference was measured at the level just below the laryngeal prominence (Adam's apple) using a flexible measuring tape. The measurement was taken while the patient was standing in an upright position, with the head in a neutral position, and the tape placed snugly around the neck without compression.
- **Waist Circumference (WC):** Waist circumference was measured at the midpoint between the lower rib and the iliac crest using a flexible measuring tape. Measurements were taken at the end of normal exhalation, ensuring that the tape was parallel to the floor and not compressing the skin.

CAD Severity Assessment:

The severity of CAD was assessed using coronary angiography as the gold standard. Angiographic findings were categorized based on the number of coronary vessels involved (1-vessel, 2-vessel, or 3-vessel disease) and the degree of stenosis in each vessel (mild, moderate, or severe).

If angiography was not performed, other non-invasive diagnostic methods such as computed tomography (CT) coronary angiography or exercise stress testing were utilized to assess CAD severity.

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Other Variables

Demographic Data: Demographic details, including age, gender, and educational status, were recorded to examine their potential influence on CAD severity. Age was categorized to assess its role, while gender differences were considered in relation to anthropometric measurements. Educational status was noted, as it may affect health awareness and lifestyle choices.

Comorbid Conditions: Data on hypertension, diabetes, dyslipidemia, and smoking were collected, as these are significant risk factors for CAD. Their presence was accounted for to control for potential confounding effects on the relationship between neck and waist circumference and CAD severity.

Lifestyle Factors: Lifestyle factors such as smoking status, physical activity levels, and dietary habits were assessed through patient interviews. These factors are known to influence cardiovascular health and were considered in the analysis to evaluate their interaction with CAD severity.

Laboratory Parameters: Blood pressure measurements, lipid profiles (total cholesterol, LDL, HDL, triglycerides), and other relevant biomarkers were collected. These laboratory parameters provided additional insights into the patients' cardiovascular health and were included in the analysis to adjust for their impact on CAD severity.

Sample Size Calculation

The sample size was determined based on the expected correlation between neck circumference, waist circumference, and coronary artery disease (CAD) severity. Using a standard formula for correlation studies and regression analysis, the required sample size was estimated to ensure adequate power for detecting significant associations.

Assuming a moderate correlation (r = 0.30) between anthropometric measures and CAD severity(14), with a 95% confidence level (α = 0.05) and 80% power (β = 0.20), the required sample size was calculated using the formula:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2}{C^2} + 3$$

where:

- $Z_{\alpha/2}$=1.96 (for 95% confidence level)
- Z_{β}=0.84 (for 80% power)
- C=0.5×$ln\frac{(r+1)}{(r-1)}$ (Fisher's Z-transformation for correlation)

To account for potential dropouts or incomplete data (10-15%), the final sample size was adjusted to approximately 100 participants.

This sample size ensured 80% statistical power to detect meaningful associations between neck and waist circumference and CAD severity while allowing for adjustments in multivariable regression analyses.

Statistical Analysis

Data analysis was performed using STATA (Version 17) software. Descriptive statistics were calculated for baseline characteristics, with continuous variables expressed as means and standard deviations, and categorical variables as frequencies and percentages. Correlation analysis was conducted to assess the relationship between neck and waist circumference with CAD severity using Pearson's or Spearman's coefficients, depending on the data distribution. A multivariable logistic regression was performed to evaluate the independent association of anthropometric measures with CAD severity, adjusting for confounding variables like age, gender, comorbidities, and lifestyle factors. Results were presented as odds ratios (ORs) with 95% confidence intervals (CIs).

For group comparisons, chi-square tests were used for categorical variables, while t-tests or ANOVA were applied to continuous variables, such as neck and waist circumference. To assess diagnostic performance, ROC curve analysis was conducted, calculating the area under the curve (AUC) to evaluate the sensitivity, specificity, and accuracy of neck and waist circumference as predictors of CAD severity. All statistical tests were considered significant at $p<0.05$, and confidence intervals were reported to indicate the precision of the estimates. This approach ensured a comprehensive evaluation of the data to identify the predictive value of neck and waist circumference for CAD severity.

RESULTS

Table I presents the baseline characteristics of the study population, stratified by CAD severity. The mean age of participants was 56.4 ± 8.5 years, with a significant increasing trend across CAD severity groups (p = 0.002). Patients with severe CAD were notably older (60.3 ± 7.9 years) compared to those with mild CAD (52.1 ± 7.2 years), suggesting that age plays a key role in disease progression. Sex distribution showed a predominance of males (72%), with a significantly higher proportion in the moderate (77%) and severe (77%) CAD groups compared to the mild group (60%) (p = 0.048). This indicates a greater burden of CAD among men. Conversely, the proportion of females was lower (28% overall), consistent with the known higher prevalence of CAD in males.

Hypertension was more prevalent in patients with severe CAD (69%) compared to those with mild CAD (40%), with a statistically significant difference (p = 0.019). This finding reinforces the well-established link between hypertension and CAD progression. Similarly, diabetes was significantly more frequent in moderate (51%) and severe (51%) CAD groups compared to mild cases (30%) (p = 0.033), highlighting its impact on worsening coronary pathology. Smoking was more common in patients with severe CAD (51%) than in those with mild CAD (30%) (p = 0.042), suggesting that tobacco use is associated with greater disease severity. Additionally, BMI showed a significant increase across CAD severity groups, with the highest mean BMI observed in the severe CAD group (28.1 ± 3.2 kg/m^2) compared to mild CAD (25.5 ± 2.9 kg/m^2) (p = 0.015), further supporting the role of obesity as a contributing factor to CAD progression.

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Table – I: Baseline Characteristics of the Study Population

Variable	Total (n = 100)	Mild CAD (n = 30)	Moderate CAD (n = 35)	Severe CAD (n = 35)	*p*-value
Age (years), Mean ± SD	56.4 ± 8.5	52.1 ± 7.2	57.8 ± 8.1	60.3 ± 7.9	0.002
Male, n (%)	72 (72%)	18 (60%)	27 (77%)	27 (77%)	0.048
Female, n (%)	28 (28%)	12 (40%)	8 (23%)	8 (23%)	0.048
Hypertension, n (%)	58 (58%)	12 (40%)	22 (63%)	24 (69%)	0.019
Diabetes, n (%)	45 (45%)	9 (30%)	18 (51%)	18 (51%)	0.033
Smoking, n (%)	42 (42%)	9 (30%)	15 (43%)	18 (51%)	0.042
BMI (kg/m^2), Mean ± SD	26.7 ± 3.1	25.5 ± 2.9	27.1 ± 3.0	28.1 ± 3.2	0.015

Neck circumference increased progressively across the groups, with the mean NC being 37.2 ± 1.9 cm in mild CAD, 39.1 ± 2.1 cm in moderate CAD, and 40.4 ± 2.3 cm in severe CAD. The highly significant p-value (<0.001) indicates a strong correlation between higher NC and greater CAD severity, suggesting that NC may serve as a reliable indicator of cardiovascular risk. Similarly, waist circumference showed a significant upward trend with disease severity, measuring 92.3 ± 5.8 cm in mild CAD, 98.7 ± 6.2 cm in moderate CAD, and 102.5 ± 6.9 cm in severe CAD (p < 0.001). This finding is consistent with existing evidence linking increased central adiposity to a higher burden of atherosclerosis and cardiovascular complications.

Table – II: Comparison of Anthropometric Measurements across CAD Severity Groups

Variable	Mild CAD (n = 30)	Moderate CAD (n = 35)	Severe CAD (n = 35)	*p*-value
Neck Circumference (cm)	37.2 ± 1.9	39.1 ± 2.1	40.4 ± 2.3	<0.001
Waist Circumference (cm)	92.3 ± 5.8	98.7 ± 6.2	102.5 ± 6.9	<0.001

Table III demonstrates the correlation between anthropometric measurements and CAD severity, indicating a strong positive association for both neck circumference (NC) and waist circumference (WC). The correlation coefficient for NC with CAD severity was 0.62 (p < 0.001), suggesting a moderate to strong relationship, where increasing NC is associated with more severe CAD. This reinforces the growing recognition of NC as a potential marker of cardiovascular risk. Waist circumference showed an even stronger correlation with CAD severity, with a correlation coefficient of 0.68 (p < 0.001), indicating a robust positive association. This finding aligns with existing evidence that central obesity is a key predictor of atherosclerotic burden and cardiovascular complications.

Table – III: Correlation Between Anthropometric Measurements and CAD Severity

Variable	Correlation Coefficient (r)	p-value
Neck Circumference vs CAD Severity	0.62	<0.001
Waist Circumference vs CAD Severity	0.68	<0.001

Table IV presents the results of a multivariable logistic regression analysis assessing the independent predictors of CAD severity. Both neck circumference (NC) and waist circumference (WC) were found to be significant predictors, with each 1 cm increase in NC associated with 45% higher odds of severe CAD (OR: 1.45, 95% CI: 1.22–1.73, p < 0.001) and each 1 cm increase in WC linked to 52% higher odds (OR: 1.52, 95% CI: 1.29–1.81, p < 0.001). These findings suggest that both NC and WC are strong, independent anthropometric markers of CAD severity, with WC showing a slightly stronger association. Age was also a significant predictor, with each additional year increasing the odds of severe CAD by 8% (OR: 1.08, 95% CI: 1.02–1.14, p = 0.007). Among comorbid conditions, hypertension (OR: 1.67, 95% CI: 1.12–2.49, p = 0.013) and diabetes (OR: 1.58, 95% CI: 1.02–2.47, p = 0.041) were both independently associated with greater CAD severity. Additionally, smoking emerged as a significant risk factor, increasing the odds of severe CAD by 72% (OR: 1.72, 95% CI: 1.06–2.81, p = 0.026).

Table – IV: Multivariable Logistic Regression Analysis for CAD Severity

Variable	Adjusted OR (95% CI)	p-value
Neck Circumference (per cm increase)	1.45 (1.22 – 1.73)	<0.001
Waist Circumference (per cm increase)	1.52 (1.29 – 1.81)	<0.001
Age (years)	1.08 (1.02 – 1.14)	0.007
Hypertension	1.67 (1.12 – 2.49)	0.013
Diabetes	1.58 (1.02 – 2.47)	0.041
Smoking	1.72 (1.06 – 2.81)	0.026

Table V presents the ROC curve analysis evaluating the predictive accuracy of neck circumference (NC) and waist circumference (WC) for severe CAD. Both measures demonstrated significant discriminative ability, with WC showing a slightly higher area under the curve (AUC: 0.82, 95% CI: 0.74–0.88, p < 0.001) compared to NC (AUC: 0.76, 95% CI: 0.68–0.83, p < 0.001). The optimal cut-off for NC was identified as ≥39 cm, yielding a sensitivity of 78% and specificity of 72%, while WC had a cut-off of ≥98 cm, with a higher sensitivity (82%) and specificity (75%).

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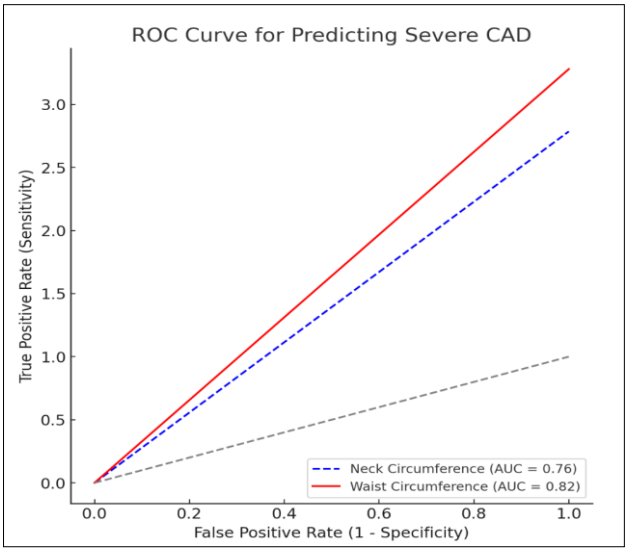

Figure 1: ROC Curve Analysis of Neck and Waist Circumference

Table – V: ROC Curve Analysis of Neck and Waist Circumference for Predicting Severe CAD

Predictor	AUC (95% CI)	Cut-off Value	Sensitivity (%)	Specificity (%)	p-value
Neck Circumference (cm)	0.76 (0.68–0.83)	≥39 cm	78%	72%	<0.001
Waist Circumference (cm)	0.82 (0.74–0.88)	≥98 cm	82%	75%	<0.001

DISCUSSION

This study aimed to compare neck circumference (NC) and waist circumference (WC) as predictors of coronary artery disease (CAD) severity in a Bangladeshi population. Our findings demonstrate that both NC and WC are significantly associated with CAD severity, with WC showing a slightly stronger predictive value. These results underscore the potential utility of anthropometric measurements as simple, non-invasive markers for identifying patients at higher risk of severe CAD.

The baseline characteristics revealed that patients with more severe CAD were generally older and had a higher prevalence of hypertension, diabetes, and smoking, which aligns with established risk factors for CAD[15]. Furthermore, body mass index (BMI) was significantly higher in the severe CAD group, reflecting the well-documented relationship between adiposity and cardiovascular disease[16]. The increasing trend of NC and WC across CAD severity groups suggests that central and upper-body adiposity may contribute to the pathophysiology of atherosclerosis.

The correlation analysis demonstrated a significant positive relationship between NC and WC with CAD severity. WC showed a stronger correlation ($r = 0.68$, $p < 0.001$) compared to NC ($r = 0.62$, $p < 0.001$), indicating that abdominal obesity may be more strongly linked to the progression of CAD. This aligns with previous studies highlighting WC as a reliable indicator of visceral adiposity, a major driver of metabolic and inflammatory processes contributing to atherosclerosis[17]. However, the notable correlation of NC with CAD severity suggests that upper-body adiposity, possibly reflecting deeper metabolic dysfunction, may also play a critical role in cardiovascular risk.

Multivariable logistic regression analysis further supported the predictive value of NC and WC. Each 1 cm increase in NC was associated with 45% higher odds of severe CAD (OR: 1.45, 95% CI: 1.22–1.73, $p < 0.001$), while each 1 cm increase in WC increased the odds by 52% (OR: 1.52, 95% CI: 1.29–1.81, $p < 0.001$). Traditional CAD risk factors, including age, hypertension, diabetes, and smoking, remained independently associated with disease severity, reinforcing their established roles in CAD pathogenesis[18].

The ROC curve analysis indicated that both NC and WC are effective predictors of severe CAD, with WC demonstrating slightly superior predictive ability (AUC = 0.82) compared to NC (AUC = 0.76). The optimal cut-off values identified in this study (≥39 cm for NC and ≥98 cm for WC) showed good sensitivity and specificity, suggesting their potential clinical applicability as screening tools. These findings are consistent with previous research reporting WC as a robust indicator of cardiometabolic risk, while also highlighting NC as an emerging predictor of cardiovascular disease[19]. Our findings suggest that incorporating NC and WC measurements into routine clinical assessment may improve early detection and risk stratification of CAD patients, particularly in resource-limited settings where advanced imaging modalities are not always available. Given the strong predictive performance of WC, it should be prioritized in risk assessment, while NC could serve as a supplementary indicator, especially in cases where WC measurements are less feasible.

Future research should explore the mechanistic pathways linking upper-body and central adiposity with CAD progression, as well as validate these findings in larger, multi-ethnic cohorts. Longitudinal studies are also needed to determine whether changes in NC and WC over time correlate

with CAD progression and outcomes. The primary strength of this study is its focus on a Bangladeshi population, providing region-specific insights into the role of anthropometric markers in CAD severity. Additionally, the use of coronary angiography for CAD severity assessment enhances the robustness of our findings. However, some limitations should be acknowledged. The cross-sectional design prevents causal inference, and residual confounding from unmeasured variables cannot be ruled out. Furthermore, the study was conducted at a single center, which may limit generalizability to broader populations.

CONCLUSION

This study demonstrates that both NC and WC are significant predictors of CAD severity in Bangladeshi patients, with WC exhibiting a slightly stronger association. Given their simplicity, accessibility, and predictive value, these anthropometric measurements could serve as valuable tools for early identification of individuals at risk for severe CAD. Further research is warranted to establish their long-term prognostic utility and integration into routine cardiovascular risk assessment strategies.

Conflict of Interest:

The authors confirm that there are no conflicts of interest associated with this study.

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REFERENCES

1. *Islam AKMM, Majumder A a. S. Coronary artery disease in Bangladesh: a review. Indian Heart J. 2013;65(4):424–35.*
2. *Chowdhury MAB, Islam M, Rahman J, Uddin MT, Haque MR, Uddin MJ. Changes in prevalence and risk factors of hypertension among adults in Bangladesh: An analysis of two waves of nationally representative surveys. PLoS ONE. 2021 Dec 2;16(12):e0259507.*
3. *Chowdhury MZI, Haque MA, Farhana Z, Anik AM, Chowdhury AH, Haque SM, et al. Prevalence of cardiovascular disease among Bangladeshi adult population: a systematic review and meta-analysis of the studies. Vasc Health Risk Manag. 2018 Aug 21;14:165–81.*
4. *Skaria A. The Economic and Societal Burden of Alzheimer Disease: Managed Care Considerations. 2022 Sep 12 [cited 2025 Feb 2];28. Available from: https://www.ajmc.com/view/the-economic-and-societal-burden-of-alzheimer-disease-managed-care-considerations*
5. *Kodeboina M, Piayda K, Jenniskens I, Vyas P, Chen S, Pesigan RJ, et al. Challenges and Burdens in the Coronary Artery Disease Care Pathway for Patients Undergoing Percutaneous Coronary Intervention: A Contemporary Narrative Review. Int J Environ Res Public Health. 2023 Apr 25;20(9):5633.*
6. *Noninvasive Testing for Coronary Artery Disease | Effective Health Care (EHC) Program [Internet]. [cited 2025 Feb 2]. Available from: https://effectivehealthcare.ahrq.gov/products/coronary-artery-disease-testing/research-protocol*
7. *Ross R, Neeland IJ, Yamashita S, Shai I, Seidell J, Magni P, et al. Waist circumference as a vital sign in clinical practice: a Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity. Nat Rev Endocrinol. 2020 Mar;16(3):177–89.*
8. *Kim D. Factors Affecting Obesity and Waist Circumference Among US Adults. Prev Chronic Dis [Internet]. 2019 [cited 2025 Feb 2];16. Available from: https://www.cdc.gov/pcd/issues/2019/18_0220.htm*
9. *Wildman RP, Gu D, Reynolds K, Duan X, Wu X, He J. Are waist circumference and body mass index independently associated with cardiovascular disease risk in Chinese adults?2. Am J Clin Nutr. 2005 Dec 1;82(6):1195–202.*
10. *Darsini D, Hamidah H, Notobroto HB, Cahyono EA. Health risks associated with high waist circumference: A systematic review. J Public Health Res. 2020 Jul 2;9(2):1811.*
11. *Tal S, Litovchik I, Klar MM, Maresky HS, Grysman N, Wiser I, et al. The association between neck adiposity and long-term outcome. PLoS ONE. 2019 Apr 23;14(4):e0215538.*
12. *Latheef SAA, Subramanyam G, Reddy BM. Utility of anthropometric traits and indices in predicting the risk of coronary artery disease in the adult men of southern Andhra Pradesh. Indian Heart J. 2018 Dec;70(Suppl 3):S133–9.*
13. *Gupta M, Brister S, Verma S. Is South Asian ethnicity an independent cardiovascular risk factor? Can J Cardiol. 2006 Mar;22(3):193–7.*
14. *Sabah KMN, Chowdhury AW, Khan HLR, Hasan AH, Haque S, Ali S, et al. Body mass index and waist/height ratio for prediction of severity of coronary artery disease. BMC Res Notes. 2014 Apr 17;7(1):246.*
15. *Yanai H. A Significance of High Prevalence of Diabetes and Hypertension in Severe COVID-19 Patients. J Clin Med Res. 2020 Jun;12(6):389–92.*
16. *Gregory AB, Lester KK, Gregory DM, Twells LK, Midodzi WK, Pearce NJ. The Relationship between Body Mass Index and the Severity of Coronary Artery Disease in Patients Referred for Coronary Angiography. Cardiol Res Pract. 2017;2017:5481671.*
17. *Rashiti P, Behluli I, Bytyqi AR. Assessment of the Correlation between Severity of Coronary Artery Disease and Waist–Hip Ratio. Open Access Maced J Med Sci. 2017 Nov 30;5(7):929–33.*
18. *Vaduganathan M, Mensah GA, Turco JV, Fuster V, Roth GA. The Global Burden of Cardiovascular Diseases and Risk. J Am Coll Cardiol. 2022 Dec 20;80(25):2361–71.*
19. *Optimal Waist Circumference Cutoff Value Based on Insulin Resistance and Visceral Obesity in Koreans with Type 2 Diabetes - PMC [Internet]. [cited 2025 Feb 11]. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4483611/*