

Evaluating Body Mass Index to High-Density Lipoprotein Cholesterol (BMI/HDL-C) Ratio in Predicting Coronary Artery Disease: A Multicenter Study

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Purpose: The purpose of the study is to search for simple, widely available markers that combine adiposity and lipoprotein status to improve coronary artery disease (CAD) risk discrimination. For this, we evaluated whether the body mass index to high-density lipoprotein cholesterol ratio (BMI/HDL-C) discriminates angiographically confirmed CAD better than BMI or HDL-C alone.

Patients and Methods: In this multicenter observational study, we enrolled 834 adults undergoing coronary angiography at three tertiary centers. CAD was defined as $\geq 50\%$ stenosis in ≥ 1 major coronary artery and its branches. BMI and fasting HDL-C were measured on admission; BMI/HDL-C was calculated. We assessed associations using Spearman correlation, logistic regression, receiver operating characteristic (ROC) analysis, and Area under the curve (AUC).

Results: Mean age was 58.5 ± 11.9 years; 53.7% were male; 440 had CAD. BMI/HDL-C correlated most strongly with CAD ($\rho = 0.68$) versus HDL-C ($\rho = -0.65$) and BMI ($\rho = 0.142$). In logistic regression (after adjusting for Diabetes Mellitus, Hypertension, dyslipidemia, and smoking), a one-unit increase in the HDL-C was associated with a 26.2% reduction in the odds of CAD, while a 6.4% and 55.2% increase in the odds of CAD was noted with a one-unit increase in the BMI and BMI/HDL ratio, respectively. ROC analysis showed superior discrimination for BMI/HDL-C (AUC 0.892; 95% CI 0.870–0.913) compared with HDL-C (AUC 0.875; 95% CI 0.849–0.901) and BMI (AUC 0.582; 95% CI 0.543–0.621). An optimal BMI/HDL-C cutoff of 19.7 achieved 100% sensitivity and 83.5% specificity. AUC differences were statistically significant ($p < 0.001$).

Conclusion: In conclusion, the BMI/HDL-C ratio demonstrated superior discriminatory ability for angiographically defined CAD compared to BMI or HDL-C alone, suggesting its potential as a simple and clinically useful marker, although further validation in prospective studies is warranted.

Keywords: body mass index, BMI, high-density lipoprotein cholesterol, HDL-C, BMI/HDL ratio, coronary artery disease, CAD, risk stratification



Introduction

Coronary artery disease (CAD) accounts for the largest proportion of cardiovascular diseases (CVD) globally and is one of the leading causes of CVD mortality worldwide, despite huge capital investment in the field of CVD risk prevention and treatment.¹ According to the Global Burden of Disease Data 2021, between 1990 and 2019, CVD prevalence increased from 271 million to 523 million, while cardiovascular mortality rose from 12.1 million deaths to 18.6 million.² These statistics highlight an early detection of patients at risk of CAD and thus early prevention and prompt treatment of these individuals to mitigate the adverse outcomes.

For decades, several traditional risk factors have been under study, such as age, male sex, smoking, hypertension, diabetes mellitus, and dyslipidemia and explain much of the CAD risk.³ Obesity is one of these important risk factors for CAD, and has gained more attention in an era where it has attained the status of a global epidemic.⁴ Body mass index (BMI) is a simple index for measuring obesity using simple anthropometric values, weight, and height. Obesity, as measured by an elevated BMI, is associated with increased CAD risk both indirectly by affecting the other risk factors like hypertension and insulin resistance, and directly through mechanisms like inflammation and adipokine dysregulation.⁵ Although high BMI is related to elevated CAD risk, there is a current debate going on that high BMI alone may not pose significant CAD risk unless one does not have obesity related morbidities.^{6,7}

Lipid abnormalities or dyslipidemia in the form of high low-density lipoprotein cholesterol (LDL-C), triglycerides, or total cholesterol, and/or low levels of high-density lipoprotein cholesterol (HDL-C), are the key responsible factors in atherogenesis and CAD.⁸ For the past decades, multiple studies have been conducted to compare the strength of solitary lipid profile variables (LDL-C, HDL-C, triglycerides) with their indices and ratios (LDL/HDL-C, non-HDL-C/HDL-C, TG/HDL-C, and the atherogenic index of plasma) as markers of CAD.^{9–12} These indices and ratios have been proposed to improve risk prediction and are potentially superior to individual lipid measures (often outperforming single lipid values in specific contexts). However, none of these ratios and indices has taken into account the anthropometric values like BMI, which play a crucial role in atherosclerosis and CAD. Composite indices that combine measures of adiposity with markers of metabolic health can give valuable insights into the risk detection of CAD since they integrate two complementary dimensions of cardiometabolic risk i.e., the burden of excess adiposity in the form of BMI and the metabolic/lipoprotein problems in the form of dyslipidemia associated with atherogenesis. Such findings support the concept that integrative markers may better capture the complex pathophysiology linking obesity to atherogenesis.¹³

The BMI/HDL-C ratio is a simple, affordable, and readily available index that integrates the anthropometric value of adiposity (BMI) with the anti-atherogenic lipid fraction (HDL-C). There is vast evidence in the literature that high BMI is associated with insulin resistance, atherogenic dyslipidemia (characterized by raised triglycerides, small dense LDL, and low HDL-C), pro-inflammatory states, and endothelial dysfunction, all of which contribute to CAD. Conversely, HDL-C is involved in reverse cholesterol transport and possesses anti-inflammatory and antioxidant properties.^{14,15} Combining BMI and HDL-C into a single ratio and comparing it with the predictive strength of each component when studied alone may give beneficial insights into CAD risk assessment, potentially capturing both the burden of adiposity and impairment of protective lipoprotein mechanisms. Most of the literature has studied the effects of different components of lipid profile and ratios among them on atherosclerosis and CAD, such as the TG/HDL-C ratio, atherogenic index of plasma (AIP), etc.^{16,17} Few of the studies have considered the combination of BMI with lipid profile and other atherogenic variables; the combined effect as a ratio is not studied in detail.¹⁸ Given the rising prevalence of obesity worldwide and the continuing challenge of optimizing CAD risk stratification, an easily obtainable index that improves discrimination (or performs comparably with fewer resources) would be clinically useful. The BMI/HDL-C ratio, which can be calculated from routinely collected clinical information, may serve as such a marker. However, despite the biologic plausibility, the literature specifically evaluating the BMI/HDL-C ratio as a discriminator for CAD remains lacking.

The main objective of this study is to evaluate whether the BMI/HDL-C ratio discriminates angiographically-confirmed CAD from non-CAD. It is also aimed to compare the discriminative ability of the BMI/HDL-C ratio against BMI and HDL-C alone, and to assess its independent association with CAD after adjustment for traditional risk factors.

Materials and Methods

Study Design and Setting

This was a hospital-based, comparative, observational study conducted between June 2022 and December 2024 in the cardiology departments of Hayatabad Medical Complex, Peshawar; Al-Azhar University Hospital, Cairo; and Maiwand Teaching Hospital, Kabul. The study protocol was reviewed and approved by the Hospital Research and Ethics Committee (IREB) of MTI, Hayatabad Medical Complex, Peshawar (approval number: 599/HEC/B&PSC/2021). The study protocol adhered to the principles of the Declaration of Helsinki. Informed consent was obtained from all participants before enrollment. Confidentiality of patient data was strictly maintained, and all analyses were performed on anonymized datasets. The sample size was calculated using a standardized sample size calculator, based on the 50% prevalence of CAD in patients going through angiography (385 participants), keeping 95% confidence interval and 5% margin of error. The patients, 18 years and above, presenting with ischemic heart disease (IHD) features (eg., typical angina, exertional chest pain, or equivalent symptoms such as dyspnea on exertion), were recruited into the study through a non-probability consecutive sampling technique. Written informed consent was obtained from all participants in accordance with the Declaration of Helsinki. Exclusion criteria were patients with a history of prior coronary revascularization (percutaneous coronary intervention or coronary artery bypass graft surgery), known cardiomyopathy, valvular heart disease, or congenital heart disease, severe hepatic or renal dysfunction, and malignancy.

The participants were divided into two groups:

1. CAD group: This group included the patients with angiographically proven $\geq 50\%$ luminal stenosis in at least one major coronary artery.
2. Non-CAD group: This group included the patients with $< 50\%$ stenosis in all major coronary arteries on angiography.

Data Collection

All the participants were subjected to a detailed history and physical examination. Demographic and clinical, including age, gender, CAD risk factors, height, weight, etc., were obtained at admission using structured case history forms. Body mass index (BMI) was calculated by formula as $\text{weight}/\text{height}^2$ (kg/m^2). Fasting blood samples were obtained to measure lipid profile (HDL-C, LDL-C, total cholesterol, triglycerides) using an automated analyzer.

All patients underwent selective coronary angiography using the Judkins technique via radial or femoral access. Angiograms were interpreted by experienced interventional cardiologists without knowing the biochemical test results. CAD was defined as $\geq 50\%$ luminal diameter stenosis in at least one major epicardial coronary artery.

Statistical Analysis

Data were analyzed using MS Excel (Microsoft Corporation, Washington, USA), SPSS version 26 (IBM Corp., Armonk, NY, USA), and R version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were expressed as mean \pm standard deviation (SD) or median (interquartile range, IQR) based on distribution. Categorical variables were presented as frequencies and percentages. Normality of continuous variables (BMI, HDL-C, and BMI/HDL-C ratio) was assessed using the Shapiro–Wilk test. As all variables showed significant deviation from normality ($p < 0.001$), nonparametric tests were applied. The Kruskal–Wallis test was used to compare the distributions of continuous variables across the three participating countries. For variables with significant overall Kruskal–Wallis results, pairwise comparisons were conducted using Mann–Whitney *U*-tests. To control for multiple testing, Bonferroni correction was applied, and a *p*-value threshold of 0.017 ($0.05/3$) was considered statistically significant for the pairwise comparisons. Categorical variables were compared across countries using the Chi-square test or Fisher’s exact test, as appropriate. Multivariable logistic regression analysis was performed to assess the association between study variables and CAD after adjusting for the covariates, including hypertension, diabetes mellitus, smoking status, and dyslipidemia. To avoid multicollinearity, BMI, HDL-C, and the BMI/HDL-C ratio were analyzed in separate models. A *p*-value < 0.05 was considered statistically significant. The results are presented as tables and figures.

Results

The study included 834 patients (394 non-CAD, 440 CAD) with a mean age of 58.5 ± 11.9 years and 53.7% males. CAD patients had a higher prevalence of hypertension (86.7% vs. 13.3%), diabetes (80.1% vs. 19.9%), smoking (83.8% vs. 16.2%), and dyslipidemia (79.2% vs. 20.8%) compared with non-CAD patients. Mean BMI/HDL-C ratio was markedly higher in CAD (30.45 ± 5.4) than in non-CAD (23.07 ± 2.9), with similar distribution across nationalities. The summary is in Table 1.

Normality testing with Shapiro–Wilk test confirmed that BMI, HDL-C, and BMI/HDL-C ratio were not normally distributed (all $p < 0.001$). Therefore, medians (inter-quartile range, IQR) were calculated, and nonparametric methods were applied. The Kruskal–Wallis test showed significant inter-country differences in BMI ($\chi^2 = 7.9$, $df = 2$, $p = 0.019$), while HDL-C ($\chi^2 = 5.6$, $df = 2$, $p = 0.058$) and BMI/HDL-C ratio did not differ significantly among the three countries ($\chi^2 = 4.25$, $df = 2$, $p = 0.120$). These statistics are simplified in Table 2.

Post-hoc pairwise analyses using the Mann–Whitney *U*-test with Bonferroni correction (adjusted $\alpha = 0.017$) demonstrated intra-group difference between Afghanistan and Pakistan in BMI ($p = 0.009$), and between Afghanistan and Egypt in HDL-C ($p = 0.013$), so these variables were also analyzed separately as well.

Table 1 Baseline Demographic, Clinical, and Laboratory Characteristics of Patients with and without CAD

Characteristic	Non-CAD (n = 394)	CAD (n = 440)	Total	P Value
Age, years (mean \pm SD)	58.8 \pm 10.8	58.1 \pm 12.8	58.45 \pm 11.9	0.63
Male sex, n (%)	213 (47.5%)	235 (52.5%)	448 (53.7%)	0.85
Female	181 (46.9%)	205 (53.1%)	386 (46.3%)	0.87
Hypertension, n (%)	12 (13.3%)	78 (86.7%)	90 (10.8%)	0.001
Diabetes mellitus, n (%)	31 (19.9%)	125 (80.1%)	156 (18.7%)	0.001
Current smoking, n (%)	34 (16.2%)	176 (83.8%)	210 (25.2%)	0.001
Dyslipidemia	58 (20.8%)	221 (79.2%)	279 (33.5%)	0.001
BMI, kg/m ² (mean \pm SD)	30.25.56 \pm 4.7	31.73 \pm 5.1	31.03 \pm 4.9	0.001
HDL-Cholesterol, mmol/L (mean \pm SD)	1.31 \pm 0.18	1.05 \pm 0.10	1.17 \pm 0.19	0.001
BMI/HDL-C ratio (mean \pm SD)	23.07 \pm 2.9	30.45 \pm 5.4	26.9 \pm 5.7	0.001
Nationality				
Afghanistan	118 (46.8%)	134 (53.2%)	252 (30.2%)	0.85
Egypt	140 (47.3%)	156 (52.7%)	296 (35.5%)	0.87
Pakistan	136 (47.6%)	150 (52.4%)	286 (34.3%)	0.86

Abbreviations: CAD, coronary artery disease; BMI, body mass index; HDL-C, high-density lipoprotein; LDL, low-density lipoprotein.

Table 2 Comparison of BMI, HDL-C, and BMI/HDL-C Ratio Across the Three Countries

Variable	Median (Inter-Quartile Range IQR)			Kruskal–Wallis χ^2 (df=2)	p-value
	Afghanistan (n= 252)	Egypt (n= 296)	Pakistan (n= 286)		
BMI (kg/m ²)	31.0 (9)	30.0 (8)	30.0 (8)	7.9	0.019
HDL-C (mmol/L)	1.11 (0.28)	1.08 (0.77)	1.12 (0.34)	5.68	0.058
BMI/HDL-C ratio	26.1 (8.9)	26.0 (5.9)	24.9 (7.5)	4.24	0.120

Abbreviations: CAD, coronary artery disease; BMI, body mass index; HDL-C, high-density lipoprotein; LDL, low-density lipoprotein.

Table 3 Correlation of Different Variables with CAD

Variable	Spearman's rho	P-value
BMI	0.142	0.01
HDL-C in mmol/L	- 0.65	0.001
BMI/HDL-C ratio	0.68	0.001

Table 4 Diagnostic Performance of BMI, HDL-C, and BMI/HDL-C Ratio for Detecting CAD

Variable	AUC (95% CI)	Optimal Cutoff	Sensitivity (%)	Specificity (%)	p-value vs BMI/HDL-C
BMI	0.582 (0.543–0.621)	25.5	91.4	18.3	<0.001
HDL-C (mmol/L)	0.875 (0.849–0.901)	0.97	83.2	96.4	<0.001
BMI/HDL-C ratio	0.892 (0.870–0.913)	19.7	100.0	83.5	Reference

Abbreviations: CAD, coronary artery disease; BMI, body mass index; HDL-C, high-density lipoprotein; LDL, low-density lipoprotein.

The Spearman rho showed a strong positive correlation of BMI/HDL-C ratio ($\rho = 0.68$, $p = 0.001$), and a negative correlation of HDL-C ($\rho = - 0.65$, $p = 0.001$), with the occurrence of CAD, however, BMI showed a weaker but significant correlation ($\rho = 0.142$, $p = 0.01$), as summarized in Table 3.

Logistic regression analysis showed that BMI, serum HDL-C level, and BMI/HDL-C ratio were significant independent predictors of CAD. A one-unit increase in the BMI was associated with a 6.4% increase in the odds of CAD (OR = 1.064, CI = 1.034–1.095, $p < 0.001$), that of HDL-C was associated with a 26.2% reduction in the odds of CAD (OR = 0.738, 95% CI = 0.709–0.768, $p < 0.001$), while one-unit increase in the BMI/HDL-C ratio was associated with a 55.2% increase in the odds of CAD (OR = 1.552, 95% CI = 1.460–1.650, $p < 0.001$).

ROC analysis showed that the BMI/HDL-C ratio was the strongest predictor of CAD (AUC 0.892, 95% CI 0.870–0.913), with an optimal cutoff of 19.7 (sensitivity 100%, specificity 83.5%). HDL-C also predicted CAD well (AUC 0.875, 95% CI 0.849–0.901; cutoff 0.97 mmol/L; sensitivity 83.2%, specificity 96.4%), while BMI alone was a poor predictor (AUC 0.582, 95% CI 0.543–0.621; cutoff 25.5; sensitivity 91.4%, specificity 18.3%). Comparisons of ROC curves showed that BMI and HDL-C were significantly less discriminative than BMI/HDL-C ratio ($p < 0.001$). This is shown in Table 4 and Figure 1 below.

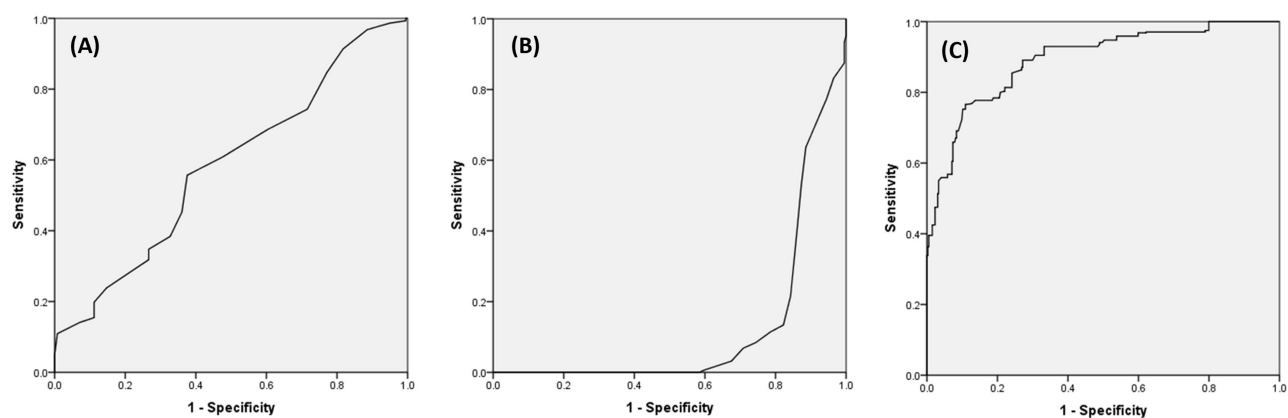


Figure 1 ROC curve of BMI (A), HDL-C (B), and BMI/HDL-C ratio (C) for discriminating CAD Receiver operating characteristic (ROC) curves comparing (A) BMI, (B) HDL-C, and (C) BMI/HDL-C ratio for the detection of coronary artery disease. The BMI/HDL-C ratio demonstrated superior discriminative ability (AUC 0.892, 95% CI 0.870–0.913) compared with BMI (AUC = 0.582, 95% CI 0.543–0.621) and HDL-C (AUC 0.875, 95% CI 0.849–0.901).

Discussion

In this study, we found that while both BMI and HDL-C are independently associated with CAD, the BMI/HDL-C ratio provides the strongest predictive value as a discriminator between CAD and non-CAD patients. Specifically, the BMI/HDL-C ratio showed the highest correlation with CAD ($\rho = 0.68$), the greatest odds ratio in logistic regression (OR 1.552 per unit increase), and the largest area under the ROC curve (AUC 0.892, 95% CI 0.870–0.913). In contrast, BMI alone had limited discriminative ability (AUC 0.582) as compared to HDL-C (AUC 0.875) and BMI/HDL-C ratio (AUC 0.892). Moreover, HDL-C was strongly protective against CAD, but its discriminative value was significantly lower than the ratio. These results may suggest that integrative biomarkers stratify cardiovascular risk in a significantly better way than individual markers. These may also provide valuable insights into the questions that combining anthropometric and biochemical parameters together may outperform any of these parameters if studied individually.

BMI as a CAD Predictor

In our study, we found that BMI, despite its significant correlation with disease, was a weak independent predictor of CAD ($\rho = 0.142$, $p = 0.01$). Our finding is much in line with the current literature that infers that although BMI is a useful measure of body adiposity, it does not fully reflect the obesity related risk of CAD. Antonio García-Hermoso et al in their study inferred that only body mass index does not represent the true adiposity and hence poorly assesses cardiometabolic risk, like CAD risk.¹⁹ Adding further to the evidence, Pei Xiao et al, in their nationwide cross-sectional study, concluded that high BMI with higher lean mass index (LMI) has similar odds of LDL-C, total cholesterol, and non-HDL-C cholesterol as compared to participants with normal BMI.²⁰ On the other extreme, there are studies suggesting a protective role of BMI in CAD and related mortality, especially in the elderly and patients with multiple chronic conditions.^{21,22} Our ROC analysis, however, confirms that BMI, while easy to measure, has limited clinical utility for discriminating CAD in high-risk populations.

HDL-C and CAD Risk

In our study, we found that higher HDL-C was strongly protective against CAD, a conclusion drawn from multiple studies, including the Framingham Heart Study.^{23,24} A one-unit (mmol/L) increase in HDL-C reduced CAD odds by 26.2%, and ROC analysis confirmed its robust discriminative ability (AUC = 0.875). However, in recent years, contrasting evidence has emerged regarding this protective role. In their randomized control trial on cholesteryl ester transfer protein (CETP) inhibitor Torcetrapib in CAD patients, Philip J Barter et al found a 72.1% increase in HDL-C and a decrease of 24.9% in LDL-C, but an increased risk of cardiovascular events (hazard ratio, 1.25; 95% confidence interval [CI], 1.09 to 1.44; $P=0.001$) and death from any cause (hazard ratio, 1.58; 95% CI, 1.14 to 2.19; $P=0.006$).²⁵ This paradox suggests that HDL-C functionality, rather than concentration alone, may be critical since HDL-C exerts anti-atherogenic effects through reverse cholesterol transport, antioxidative activity, and endothelial function modulation. Emerging evidence suggests that very high levels of HDL-C (hyper-HDL-C) may not always confer cardioprotective effects and may exhibit non-linear associations with cardiovascular outcomes. Although such non-linear relationships were not specifically modelled in the present study, this may have influenced the observed associations and should be explored in future research. Our findings nevertheless reinforce the evidence that HDL-C has a strong negative correlation with CAD in real-world South Asian and Middle Eastern cohorts.

BMI/HDL-C Ratio as an Integrative Marker

The most novel aspect of this study is the superior predictive value of the BMI/HDL-C ratio in comparison with its individual components, having an AUC = 0.892 vs 0.875 for HDL-C, and 0.582 for BMI. The ratio demonstrated both high sensitivity (100%) and good specificity (83.5%), with an optimal cutoff of 19.7, outperforming BMI and HDL-C alone. The integrated ratios are a subject of debate in the risk stratification studies in CAD nowadays. In one of such studies, Poochanasri, M. et al conclude that a high triglyceride TG/HDL-C ratio is associated with an increased 10-year risk of CAD in patients with Type 2 Diabetes Mellitus.²⁶ Ting S. et al in their study on 1351 CAD patients deduced that LDL-C/HDL-C ratio is a significantly better predictor of CAD risk as compared to either LDL-C or HDL-C alone.¹⁶ Although these studies have addressed several lipid profile ratios and compared their relative risk in CAD, evidence regarding the integrative value of lipid profile and anthropometric measures like BMI is lacking. Addressing this gap in the literature, Wang L. et al studied the integrated effect

of triglycerides, plasma glucose, and BMI as the triglyceride-glucose-BMI (TyG-BMI) index on the severity of CAD.²⁷ In this study, they concluded that the TyG-BMI index is directly related to the severity of CAD and can be a useful tool for early risk identification. Our study has captured two contrasting aspects of CAD risk, with high BMI representing the adverse adiposity and HDL-C representing the protective anti-atherogenic lipoprotein, combining anthropometric and biochemical dimensions together as BMI/HDL-C ratio, which provides a more balanced and clinically relevant metric. Patients with high BMI and simultaneously low HDL-C are at markedly greater risk than those with either factor alone, which explains the stronger correlations and higher AUC observed in our analysis.

Clinical and Public Health Implications

This study uses two routinely available simple parameters, HDL-C and BMI, which makes it feasible in resource-limited and public health settings. Although current CAD risk calculators, such as the Framingham and atherosclerotic cardiovascular disease (ASCVD) scores, use BMI or HDL-C, they do not study them as a ratio. Incorporating the BMI/HDL-C ratio may improve prediction accuracy, particularly in populations with high obesity and dyslipidemias, as our study population. The BMI/HDL-C ratio may be more productive in certain populations like those in our study, the South Asian and Middle Eastern populations, who have higher visceral adiposity, lower HDL-C levels and high CAD risk compared with Western populations.²⁸ The BMI/HDL-C ratio may therefore be particularly suited for these groups, offering context-specific predictive accuracy.

Strengths and Limitations

One of the major strengths of this study is its large sample size and multicenter nature, enhancing its external validity and generalizability. The study used robust statistical analysis by using multiple complementary statistical methods (correlation, logistic regression, and ROC analysis), thus strengthening the evidence.

The main limitation of the study is its observational nature, thus limiting the causal inference. We did not study the effect of some other possible confounders, such as dietary habits, physical activity, and socioeconomic status of the participants. Another limitation of this study is that the non-CAD group (<50% stenosis) may include a heterogeneous population; however, since all patients were evaluated for suspected CAD, this reflects real-world practice and is unlikely to significantly affect the overall validity of the findings.

Conclusion

In conclusion, this study provides compelling evidence that the BMI/HDL-C ratio is a superior predictor of CAD compared with BMI or HDL-C alone. The ratio combines two routinely available simple measures into a cost-effective and clinically meaningful marker with excellent discriminative ability. Given the rising burden of obesity, the BMI/HDL-C ratio may serve as a practical tool for CAD risk stratification and preventive intervention in certain populations. However, future large-scale studies are needed to establish its role in clinical practice and public health policy.

Abbreviations

BMI, Body Mass Index; HDL-C, High-Density Lipoproteins-Cholesterol; LDL-C, Low-Density Lipoproteins-Cholesterol; TG, Triglycerides; CAD, Coronary Artery Disease; CVD, Cardiovascular Diseases; IHD, Ischemic Heart Disease; ROC, Receiver Operating Characteristic; AUC, Area Under the Curve.

Data Sharing Statement

The datasets used during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

The study protocol adhered to the principles of the Declaration of Helsinki and was reviewed and approved by the Hospital Research and Ethics Committee (IREB) of MTI, Hayatabad Medical Complex, Peshawar (approval number: 599/HEC/B&PSC/2021). Informed consent was obtained from all participants before enrollment.

Acknowledgments

The authors would like to thank the Deanship of Scientific Research at Shaqra University for supporting this work.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

No funding was provided for this article.

Disclosure

The authors declare that they have no competing interests.

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