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Study on the Correlation Between Ultrasonic Myocardial Work Parameters Combined with TyG-BMI and the Degree of Coronary Stenosis

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ABSTRACT

Objective: This study aims to investigate the correlation between ultrasonic myocardial work parameters and triglyceride-glucose-body mass index (TyG-BMI) with the degree of coronary stenosis, and to evaluate the diagnostic value of each parameter individually and in combination for significant coronary stenosis. Methods: Data were collected from 155 patients who underwent coronary angiography for chest pain at the Department of Cardiology of the Affiliated Hospital of Youjiang Medical University for Nationalities between September 2025 and April 2026. Based on angiographic findings, patients were classified into a group with significant coronary stenosis (n=89) and a group without significant stenosis (n=66). Differences between groups were compared using independent-sample t-test or Mann-Whitney U test. Correlation analyses were performed to calculate the coefficients of correlation between coronary stenosis severity and ultrasound parameters as well as clinical indicators. Binary logistic regression was employed to identify independent influencing factors, while the receiver operating characteristic (ROC) curve was used to evaluate the diagnostic performance of individual indicators and combined models. Results: Correlation analysis revealed an extremely strong positive correlation between the degree of coronary stenosis and the global myocardial work index (GCW) (r=0.898), an extremely strong negative correlation between global wasted work (GWW) and global myocardial work efficiency (GWE) (r=-0.904), moderate positive correlations between systolic blood pressure (SBP) and interventricular septal thickness (IVST) (r=0.525) and between total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) (r=0.597), as well as a moderate positive correlation between TyG-BMI. Compared with the group with significant stenosis, the group with non-significant stenosis exhibited significantly reduced IVST, GWW, and TyG-BMI, while GWI, GCW, and GWE were significantly increased (all P<0.05). Multivariate logistic regression demonstrated that GCW was a protective factor for significant coronary stenosis (OR=0.995,95% CI: 0.992–0.998, P=0.004), whereas GWW (OR=1.043,95% CI: 1.025–1.062, P<0.001), GWE (OR=2.602,95% CI: 1.764–3.838, P<0.001), and TyG-BMI (OR=1.050,95% CI: 1.018–1.084, P=0.002) were independent risk factors. The AUC values for diagnosing significant coronary artery stenosis using each individual indicator ranged from 0.648 to 0.745, while the combined diagnostic model achieved an AUC of 0.899 (95% CI: 0.848–0.949), with a sensitivity of 76.4% and specificity of 90.9%, demonstrating significantly superior performance compared to individual indicators (P<0.05). Conclusion: Myocardial work parameters (GCW, GWW, GWE) and TyG-BMI are independent risk factors for significant coronary stenosis. Their combined application significantly enhances diagnostic accuracy, providing a new reference basis for non-invasive assessment of coronary stenosis.

KEYWORDS

Myocardial work parameters; TyG-BMI; Degree of coronary stenosis; Ultrasound; Diagnostic value

1. INTRODUCTION

Coronary artery disease (CAD) is one of the leading causes of death and disability worldwide, posing a significant challenge to public health. The 2026 Heart Disease and Stroke Statistics Report released by the American Heart Association indicates that although the age-standardized mortality rate from cardiovascular diseases has shown a declining trend in some high-income countries, the absolute number of cases and deaths from cardiovascular diseases continues to rise due to global population growth and accelerated aging [1]. A 2026 review by Naeem et al. further predicts that without more effective intervention strategies, global annual cardiovascular disease deaths will reach 35.6 million by 2050, with the total number of cases exceeding 1.14 billion, driven primarily by metabolic, environmental, and behavioral risk factors [2]. China also bears a substantial disease burden, with approximately 5 million deaths annually attributable to cardiovascular diseases, among which CAD predominates. A 2025 report by the Lancet Committee proposed shifting the definition of CAD from late-stage ischemia and acute coronary events to early detection and prevention of coronary atherosclerosis, which could potentially save 8.7 million lives globally each year [3]. In this context, exploring early identification and precision diagnostic strategies for CAD holds significant clinical and public health implications.

Invasive coronary angiography (ICA) remains the "gold standard" for assessing the degree of coronary artery stenosis and guiding revascularization decisions. However, ICA is an invasive procedure with potential risks such as radiation exposure, contrast-induced renal injury, and vascular complications, coupled with relatively high costs, which limit its application in large-scale screening and long-term follow-up. Although non-invasive anatomical evaluation techniques such as coronary computed tomography angiography (CCTA) have made significant advancements in recent years, their diagnostic accuracy remains limited in cases of severe coronary artery calcification, prominent wall calcification artifacts, or irregular heart rates. Additionally, functional assessment methods based on invasive catheter pressure measurements, such as the flow reserve fraction, require advanced technical expertise, and their accessibility in widespread clinical practice still needs improvement. Therefore, the development of accurate and reproducible non-invasive evaluation methods for early warning and risk stratification of coronary artery disease (CAD) has become a critical direction in cardiovascular imaging research.

In recent years, the non-invasive myocardial work (MW) technique, developed from two-dimensional speckle tracking imaging (2D-STI), has provided a novel perspective for the non-invasive assessment of coronary artery disease (CAD). Unlike the global longitudinal strain (GLS) measured by traditional speckle tracking techniques, MW technology constructs a left ventricular pressure-strain loop (PSL) by fitting the myocardial longitudinal strain parameters obtained from 2D-STI with the subject's non-invasive brachial artery blood pressure values, thereby yielding a series of myocardial function parameters with less load dependence than traditional GLS [4]. These parameters include the global work index (GWI), global constructive work (GCW), global wasted work (GWW), and global work efficiency (GWE), which quantitatively evaluate left ventricular function from multiple dimensions such as myocardial contraction efficiency, energy consumption, and work loss. The review published by Hussain et al. in 2025 systematically elaborated on the advancements of echocardiography in CAD diagnosis and prognostic evaluation, particularly highlighting the unique advantages of MW technology in identifying load dependence and subclinical myocardial dysfunction [5]. The systematic review published by Ayciriex et al. in 2026 conducted a comprehensive assessment of changes in non-invasive myocardial work parameters during stress load tests, emphasizing the distinctive value of myocardial work in detecting subclinical myocardial dysfunction [6]. The combination of peak GWE in dobutamine load echocardiography with traditional load test interpretation significantly increased the positive predictive value from 45% to 81% [7]. The study by Zhao et al. (2025) demonstrated that GCW reserve exhibits high sensitivity and incremental diagnostic value in detecting myocardial ischemia in patients with chronic coronary syndrome, with predictive models incorporating GCW and hemoglobin achieving C-index values of 0.844 and 0.822

in the derivation and validation cohorts, respectively [8]. In patients with non-ST-segment elevation acute coronary syndrome, the cohort study by Huang et al. (2025) confirmed that GWI based on left ventricular pressure-strain loops more effectively detects coronary occlusion, and the combined use of GLS and MW parameters further enhances diagnostic efficacy (P=0.016) [9]. Zhao et al. (2025) further investigated the value of non-invasive myocardial work in predicting high-risk and stable CAD patients, finding that both GWI and GCW were independently associated with high-risk CAD and demonstrated independent diagnostic value in high-risk CAD patients with normal ventricular wall motion and left ventricular ejection fraction [10]. In patients with preserved left ventricular function and no resting wall motion abnormalities, Li et al. (2026) developed and externally validated a logistic regression model integrating GWI and multiple biomarkers, achieving AUC values of 0.916 in the training set and 0.911 in the validation set, providing robust evidence for the clinical application of this technique [11].

Meanwhile, the role of metabolic factors in the pathogenesis and progression of coronary artery disease (CAD) has garnered increasing attention. Insulin resistance (IR), as a central pathophysiological component of metabolic syndrome, permeates the entire course of atherosclerosis. The triglyceride-glucose body mass index (TyG-BMI), a novel composite marker comprehensively reflecting both IR and obesity status, has been demonstrated by multiple studies to independently correlate with CAD risk and disease severity. A case-control study by Liu et al. (2025) involving 2,356 participants revealed that TyG-BMI was independently associated with early-onset CAD (OR=1.004,95% CI: 1.002–1.007, P=0.002) and showed positive correlations with the number of affected vessels and the Gensini score. The area under the curve (AUC) for TyG-BMI in predicting early-onset CAD was 0.673, superior to that of the TyG index (AUC=0.625) and BMI alone (AUC=0.656) [12]. A meta-analysis encompassing 10 cohort studies involving 871,728 subjects demonstrated that individuals with the highest TyG-BMI levels had a 69% increased CAD risk compared to those with the lowest levels (HR=1.69,95% CI: 1.23–2.31), providing robust population-based evidence for the association between TyG-BMI and CAD risk [13]. Mahdavi-Roshan et al. (2025) conducted a cross-sectional study involving 930 CAD patients, demonstrating that the risk of severe CAD in the highest quartile group of TyG-BMI was 1.98 times higher than in the lowest quartile group (OR = 1.98; 95% CI: 1.31–2.99), while also revealing a dose-response relationship between high dietary insulin load and insulin index with severe CAD [14]. Song et al. (2025) systematically elucidated the pathophysiological mechanisms and clinical application prospects of TyG-BMI in atherosclerotic cardiovascular diseases in their review, emphasizing its predictive potential across various conditions [15]. Regarding the relationship between TyG-BMI and the severity of coronary stenosis, Wang et al. (2025) found in a study of 1,537 hypertensive patients that the highest third quartile group of TyG-BMI exhibited a 3.836-fold increased risk of multi-vessel CAD compared to the lowest third quartile group in the diabetes subgroup (95% CI: 1.763–8.347; P = 0.001), with a nonlinear dose-response relationship observed between the two variables [16]. These findings indicate that TyG-BMI, as a simple and cost-effective clinical marker, holds significant potential for application in CAD risk screening and risk stratification.

Ultrasound MW parameters reflect the functional consequences of coronary stenosis from the perspectives of myocardial contractile efficiency and energy metabolism, whereas TyG-BMI reveals the progression risk of coronary atherosclerosis at the metabolic level of insulin resistance and obesity. The combined application of these two parameters enables a more comprehensive non-invasive assessment of coronary stenosis risk from both functional and metabolic dimensions. MW technology effectively identifies compensatory changes in myocardial load under ischemic conditions, while TyG-BMI provides additional risk stratification information from the perspective of metabolic reserve, forming a complementary relationship [20]. However, current studies integrating ultrasound MW parameters with TyG-BMI for diagnosing significant coronary stenosis remain limited. This study aims to use coronary angiography as the gold standard to systematically analyze the correlation between ultrasound MW parameters (GWI, GCW, GWW, GWE) and TyG-BMI with the degree of coronary stenosis, evaluating the diagnostic value of each parameter individually and in combination for significant coronary stenosis, thereby providing new reference criteria for non-invasive CAD assessment.

2. MATERIALS AND METHODS

2.1. Study Subjects

This study enrolled 155 patients who underwent coronary angiography in the Department of Cardiovascular Medicine at the Affiliated Hospital of Youjiang Medical University for Ethnicities between September 2025 and April 2026. The cohort included 89 patients with significant coronary artery stenosis and 66 patients with non-significant stenosis. Inclusion criteria were: (1) Patients aged ≥18 years; (2) Patients presenting with chest pain who underwent their first coronary angiography and met internationally recognized criteria—specifically, left main coronary artery stenosis ≥50% or non-left main coronary artery stenosis ≥70%—defining significant stenosis [21]; otherwise, the stenosis was classified as non-significant; (3) Complete clinical data; (4) Voluntary and full cooperation throughout the study. Exclusion criteria included: (1) Prior percutaneous coronary intervention or coronary artery bypass grafting; (2) History of severe valvular heart disease, artificial heart valves, myocarditis, or pericarditis; (3) History of acute cerebrovascular accident, severe infectious diseases, fever of unknown origin, chronic obstructive pulmonary disease, hematologic disorders, autoimmune diseases, or malignancies; (4) Severe hepatic or renal dysfunction; (5) Use of lipid-lowering agents, platelet aggregation inhibitors, or anticoagulants within the preceding 3 months; (6) Incomplete clinical data or suboptimal ultrasound image quality precluding myocardial work analysis. All participants provided informed consent and signed relevant documents, complying with the provisions of the Helsinki Declaration.

2.2. Clinical Data

Collect all clinical data of the enrolled researchers, including basic information, laboratory parameters, coronary angiography results, and ultrasound parameters such as age, gender, height, weight, blood pressure, IVST, GWI, GCW, GWW, GWE, and biochemical indicators obtained after fasting for at least 8 hours, including triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), fasting blood glucose (FBG), and total cholesterol (TC).

Parameter:

BMI (Body Mass Index) = Weight / Height^2 (kg/m^2).

The TyG index (Triglyceride-Glucose Index) = ln[Fasting triglycerides (FPG, mg/dL) × Fasting blood glucose (TG, mg/dL)].

TyG-BMI (Triglyceride-Glucose Body Mass Index) = TyG index × BMI.

Internationally, visual assessment typically defines significant stenosis as a coronary artery stenosis ≥70% in the non-left main coronary artery and ≥50% in the left main coronary artery [21]; conversely, such stenoses are classified as non-significant.

2.3. Statistical Methods

Data analysis was performed using SPSS 26.0 and SPSSAU software. Continuous variables were first tested for normality using the Shapiro-Wilk test. Variables conforming to a normal distribution were expressed as mean ± standard deviation, with comparisons between groups conducted using the independent samples t-test; variables non-conforming to normal distribution were expressed as median (interquartile range), with comparisons between groups performed using the Mann-Whitney U test. Categorical variables were presented as counts (percentage), with intergroup comparisons analyzed using the chi-square test or Fisher's exact probability method. The correlation between each variable and the degree of coronary stenosis was assessed using the Spearman rank correlation coefficient. Variables with statistically significant differences in univariate analysis (IVST, GWI, GCW, GWW, GWE, TyG-BMI) were selected as independent variables, with coronary stenosis severity (0 = non-significant stenosis, 1 = significant stenosis) as the dependent variable. A binary logistic regression analysis was conducted using the forced-entry method. Regression coefficients, Wald chi-square values, odds ratios, and their 95% confidence intervals were calculated for each variable. Model overall significance was evaluated using the likelihood ratio test, model explanatory power was assessed using Nagelkerke's R-squared, and model accuracy was evaluated using predictive classification tables.

Plot the ROC curves for each individual indicator and the combined prediction probability, calculate the area under the curve (AUC) and its 95% confidence interval, determine the optimal cutoff value using the Jordon index, and compute the corresponding sensitivity and specificity. Comparison of AUC values among different indicators was performed using the DeLong test. A two-sided P<0.05 was considered statistically significant.

3. RESEARCH FINDINGS

3.1. Comparison of Baseline Data

Table 1. Comparison of baseline characteristics among patients with different degrees of coronary stenosis

variable	Non-significant stenosis group (<50%, n=66)	Significantly narrowed group (≥50%, n=89)	test statistic	p price
Demographic Characteristics				
Male [n (%)]	40 (60.6)	56 (62.9)	U=2869.0U=2869.0	0.770
Age (years)	54.0(median)	54.0(median)	U=2935.0U=2935.0	0.994
Clinical Biomarkers				
SBP (mmHg)	139.0(median)	131.0(median)	U=2547.5U=2547.5	0.159
ultrasound parameter				
IVST (mm)	9.52 ± 1.56	10.49 ± 1.79	t=−3.506t=−3.506	0.001
GWI	1930.5(median)	1612.0(median)	U=1623.0U=1623.0	<0.001
GCW	2324.5(median)	1982.5(median)	U=1539.0U=1539.0	<0.001
GWW	139.5(median)	208.0(median)	U=1767.5U=1767.5	<0.001
GWE	93.0(median)	92.0(median)	U=2066.0U=2066.0	0.002
Laboratory Parameter				
LDL-C (mmol/L)	2.38 ± 0.83	2.22 ± 0.77	t=1.282t=1.282	0.202
TC (mmol/L)	4.46(median)	4.36(median)	U=2623.5U=2623.5	0.257
TyG-BMI	39.80(median)	53.49(median)	U=1497.0U=1497.0	<0.001

Note: Normally distributed variables (IVST, LDL-C) were expressed as mean ± standard deviation; intergroup comparisons were performed using the independent samples t-test. Non-normally distributed variables were expressed as medians; intergroup comparisons were conducted using the Mann-Whitney U test. Gender differences were analyzed using the Mann-Whitney U test (results consistent with the chi-square test: $\chi^2 = 0.086$, p = 0.769).

Using a 50% coronary artery stenosis degree as the cutoff, the 155 patients were divided into a non-significant stenosis group (<50%, n=66) and a significant stenosis group (≥50%, n=89). The demographic characteristics, clinical parameters, ultrasound findings, and laboratory indicators of the two groups were compared, with results presented in Table 1.

No statistically significant differences were observed between the two groups in terms of age, gender, SBP, LDL-C, or TC (all $p > 0.05$), indicating comparability of baseline characteristics. Compared with the significantly stenosed group, the non-significantly stenosed group exhibited a markedly reduced IVST (9.52 ± 1.56 vs. 10.49 ± 1.79, $t = -3.506$, $p = 0.001$) and a significantly lower TyG-BMI (39.80 vs. 53.49, $U = 1497.0$, $p < 0.001$). Regarding myocardial work parameters, GWI, GCW, and GWE were significantly lower in the significantly stenosed group compared to the non-significantly stenosed group, while GWW was significantly higher (all $p < 0.01$), suggesting reduced myocardial work efficiency in patients with significant coronary stenosis.

3.2. Relevance Analysis

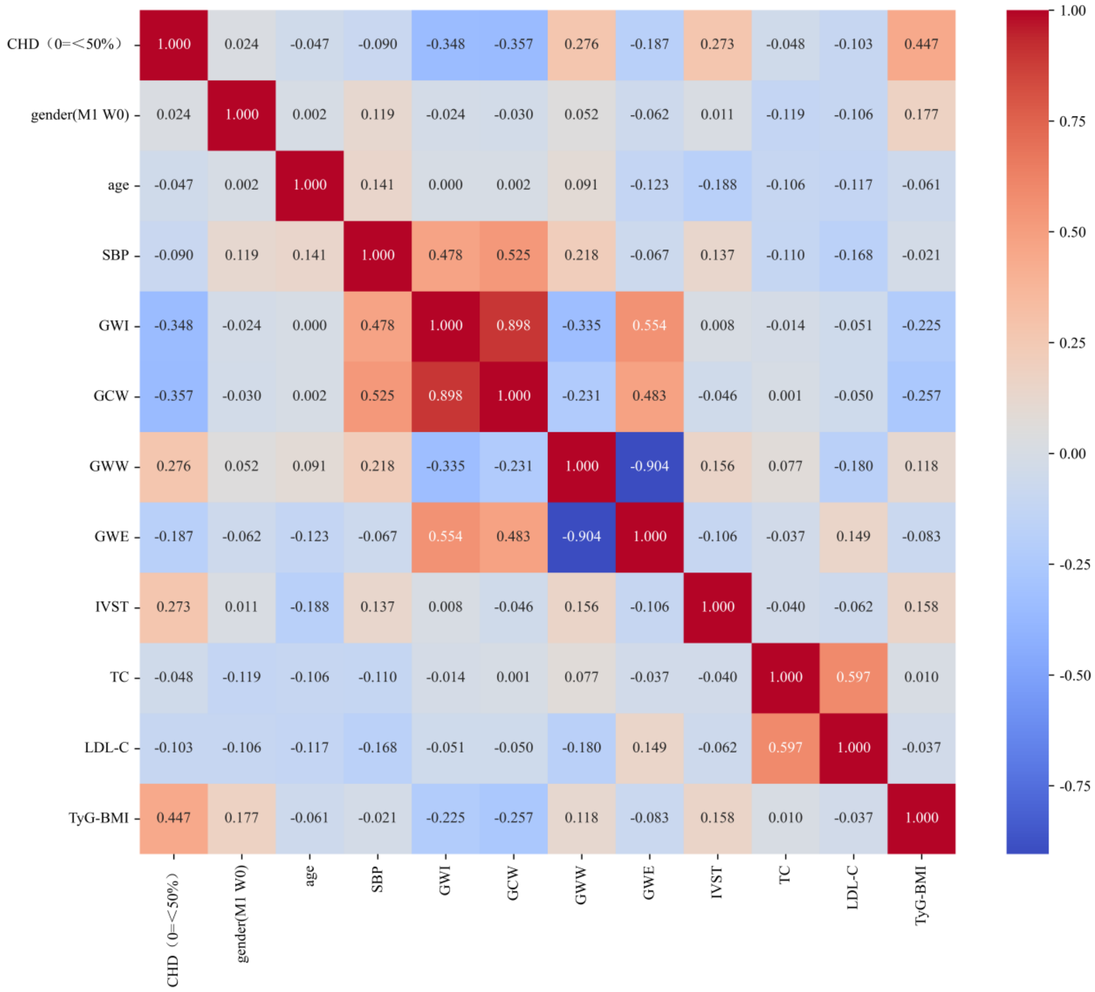

Figure 1. Heatmap showing the correlation between coronary stenosis severity and various indicators

Note: Red indicates positive correlation, blue indicates negative correlation; the darker the color and the larger the absolute value of the number, the stronger the correlation. The diagonal represents perfect correlation between the variables ($r=1.000$).

The Pearson correlation heatmaps incorporating 11 variables (gender, age, systolic blood pressure [SBP], GWI, GCW, GWW, GWE, IVST, TC, LDL-C, TyG-BMI) revealed that coronary stenosis severity (CHD) exhibited a moderately strong positive correlation with TyG-BMI ($r=0.447$), moderately strong negative correlations with GWI ($r=-0.348$) and GCW ($r=-0.357$), a weakly positive correlation with IVST ($r=0.273$), a weakly positive correlation with GWW ($r=0.276$), and a weakly negative correlation with GWE (r=−0.187). These findings suggest that higher TyG-BMI levels correlate with reduced myocardial work efficiency (decreased GWI and GCW) and an increased risk of significant coronary stenosis. Additionally, TyG-BMI showed weak negative correlations with GWI (r=−0.225) and GCW (r=−0.257), indicating a tendency toward decreased myocardial work indices in patients with higher insulin resistance, implying a potential association between metabolic factors and myocardial dysfunction. The correlation coefficients between other variables—age, gender, SBP, TC, and LDL-C—and CHD were all weak ($|r|<0.1$), consistent with the absence of significant intergroup differences in univariate analyses (see Figure 1).

3.3. Binary Logistic Regression Analysis

Using the degree of coronary stenosis as the dependent variable, the statistically significant ultrasound parameters (IVST, GWI, GCW, GWW, GWE) and clinical indicators (TyG-BMI) identified in the univariate analysis were selected as independent variables for binary logistic regression analysis (forced entry method). The results are presented in Table 2.

GCW was a protective factor for significant coronary stenosis (OR=0.995,95% CI: 0.992–0.998, p=0.004), meaning that each one-unit increase in GCW reduced the risk of significant coronary stenosis by approximately 0.5%. GWW was a risk factor for significant coronary stenosis (OR=1.043,95% CI: 1.025–1.062, p<0.001); each one-unit increase in GWW elevated the risk by 4.3%. GWE was a strong risk factor for significant coronary stenosis (OR=2.602,95% CI: 1.764–3.838, p<0.001), with each one-unit increase in GWE raising the risk by approximately 1.6-fold. TyG-BMI was also an independent risk factor for significant coronary stenosis (OR=1.050,95% CI: 1.018–1.084, p=0.002); each one-unit increase in TyG-BMI increased the risk by 5.0%. GWI and IVST showed no independent correlation in the regression model (both p>0.05). In conclusion, myocardial work parameters (GCW, GWW, GWE) and the insulin resistance index (TyG-BMI) are independent determinants of significant coronary stenosis, with GWE exhibiting the strongest effect.

Table 2. Results of binary logistic regression analysis on factors influencing significant coronary stenosis

variable	regression coefficient (BB)	standard error	Wald χ^2	p price	OR price	95% CI of OR
GWI	-0.001	0.002	0.216	0.642	0.999	0.996 ~ 1.002
GCW	-0.005	0.002	8.263	0.004	0.995	0.992 ~ 0.998
GWW	0.043	0.009	21.980	<0.001	1.043	1.025 ~ 1.062
GWE	0.956	0.198	23.253	<0.001	2.602	1.764 ~ 3.838
IVST	0.258	0.143	3.249	0.071	1.295	0.978 ~ 1.715
TyG-BMI	0.049	0.016	9.508	0.002	1.050	1.018 ~ 1.084
constant	-88.161	18.012	23.958	<0.001	0.000	—

Note: TyG-BMI: Triglyceride-glucose body mass index; GCW: Total coronary work; MHR: Monocyte/high-density lipoprotein cholesterol ratio; IVST: Ventricular septal thickness; GWW: Total work waste; β: Regression coefficient; SE: Standard error; OR: Odds ratio; CI: Confidence interval; P<0.05 indicates statistically significant difference.

3.4. Predictive Value of Individual Indicators and Combined Diagnostics for Significant Coronary Stenosis

To further evaluate the predictive value of myocardial work parameters (GCW, GWW, GWE) and TyG-BMI, both individually and in combination, for significant coronary stenosis (stenosis ≥50%), receiver operating characteristic (ROC) curves were plotted. Using coronary stenosis severity as the gold standard (positive defined as significant stenosis group, i.e., CHD=1), the area under the curve

(AUC), optimal cutoff values (determined by the maximum Joden index method), and corresponding sensitivity and specificity were calculated for each parameter. Additionally, the predicted probabilities obtained from incorporating these parameters into a logistic regression model were used as combined diagnostic indicators. The results are presented in Table 3 and Figure 1 (ROC curve plot).

Among the individual indicators, TyG-BMI exhibited the highest AUC (0.745; 95% CI: 0.666–0.824), followed by GCW (0.738; 95% CI: 0.656–0.820), both demonstrating moderate diagnostic value (0.7 <AUC <0.9). In contrast, GWW (AUC = 0.699) and GWE (AUC = 0.648) showed lower diagnostic value.

The AUC of the combined diagnosis was 0.899 (95% CI: 0.848–0.949), significantly higher than that of each individual indicator (all p<0.05), indicating high diagnostic value (approaching 0.9). With the optimal cutoff value of 0.673, the sensitivity was 76.4% and the specificity was 90.9%, demonstrating excellent discriminative ability.

In conclusion, the combined application of myocardial work parameters (GCW, GWW, GWE) and TyG-BMI significantly enhances the predictive accuracy for significant coronary stenosis, outperforming any single indicator.

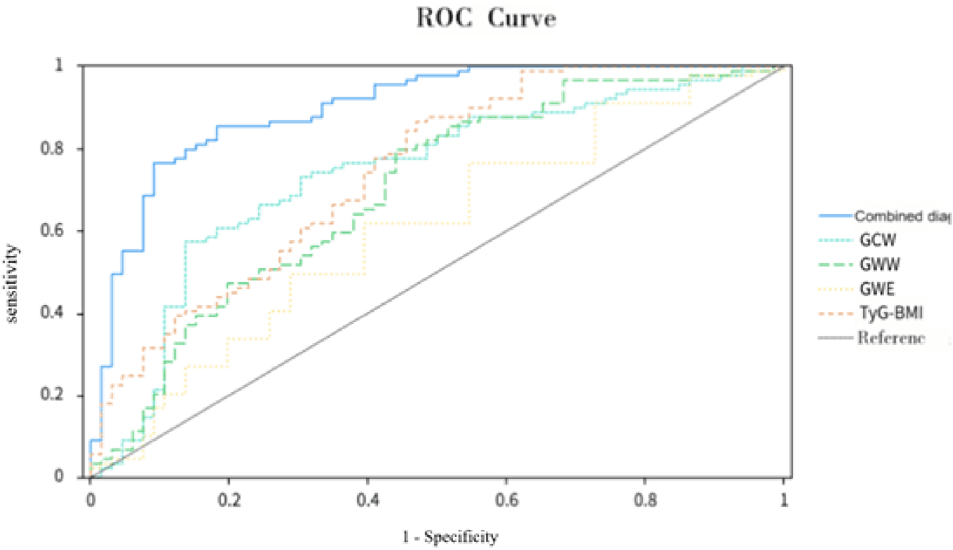

Figure 2. ROC curves of the four models

Note: The optimal cutoff value for joint diagnosis is the predicted probability value from the Logistic regression model, which is dimensionless. AUC: Area under the curve; CI: Confidence interval.

4. DISCUSSION

This study systematically analyzed the relationship between ultrasonic myocardial work parameters and TyG-BMI with the degree of coronary stenosis based on clinical data from 155 patients undergoing coronary angiography. The main findings of the study include:

4.1. Relationship Between Myocardial Work Parameters and Coronary Stenosis

One of the most significant findings of this study is the substantial correlation between myocardial work parameters and the degree of coronary stenosis. The Mann-Whitney U test revealed that GWI, GCW, and GWE were significantly lower in the significantly stenosed group compared to the non-significantly stenosed group, whereas GWW was significantly higher (all p<0.01). Logistic regression analysis further confirmed that GCW was a protective factor for significant coronary stenosis (OR=0.995,95% CI: 0.992–0.998, p=0.004), while GWW (OR=1.043, p<0.001) and GWE

(OR=2.602, p<0.001) were independent risk factors. Among the four myocardial work parameters included, GWE exhibited the highest OR value (2.602), indicating the most pronounced effect.

Myocardial work technology is a novel echocardiographic technique developed in recent years, which combines two-dimensional spot-tracking echocardiography with non-invasive brachial artery blood pressure measurement to construct a left ventricular pressure-strain loop, thereby overcoming the load-dependent limitations of traditional spot-tracking techniques [35]. With the widespread clinical application of this technology, its value in assessing coronary artery lesions has garnered increasing attention. The latest study by Liu Yong and Sun Aitong (2026) found that GLS, GWI, GWE, and GCW were all reduced, while GWW was increased in the coronary artery disease group. Compared with the mild-to-moderate lesion group, these parameters exhibited more pronounced changes in the severe lesion group, with GWE showing the strongest correlation with lesion severity and optimal diagnostic efficacy (AUC=0.84; sensitivity=70%, specificity=87.5% at a cutoff of 89.5%) [36]. The GWE regression OR value in this study reached 2.602, consistent with the findings of that study. Notably, the Meta-analysis by Ajello et al. (2022), which pooled data from five studies involving 501 patients, demonstrated that GCW exhibited the highest diagnostic accuracy, with a SROC area under the curve of 0.86, superior to GWI (0.84), GWE (0.83), GLS (0.79), and GWW (0.74) [37]. This Meta-analysis also reported excellent intra-and interobserver consistency across all myocardial work parameters, ensuring reliability for clinical application [37]. This study demonstrated that GWE exhibited the highest OR value; an increase of one unit in GWE was associated with a approximately 1.6-fold elevated risk of significant coronary stenosis, suggesting that GWE may be particularly sensitive in identifying coronary stenosis. Research combining myocardial work with three-dimensional spot tracking technology also revealed that in the case group, GWE, GWI, and GCW were significantly reduced, while GWW increased, with GWE showing the most significant predictive value for coronary stenosis (AUC = 0.790,95% CI: 0.715–0.874) [38].

4.2. The Relationship Between TyG-BMI and Coronary Stenosis

This study found that the TyG-BMI was significantly higher in the group with significant stenosis (53.49) compared to the group without significant stenosis (39.80), with the Mann-Whitney U test demonstrating an extremely significant difference (U=1497.0, p<0.001). Multivariate logistic regression analysis revealed that TyG-BMI was an independent risk factor for significant coronary artery stenosis (OR=1.050,95% CI: 1.018–1.084, p=0.002). ROC curve analysis showed that the AUC of TyG-BMI as a single indicator was 0.745 (95% CI: 0.666–0.824), indicating its diagnostic value. As a novel comprehensive biomarker for assessing insulin resistance, TyG-BMI has been increasingly studied in the field of cardiovascular diseases in recent years. The triglyceride-glucose mass index (TyG-BMI) is recognized as a reliable and cost-effective surrogate marker for insulin resistance [39]. A cross-sectional study by Mahdavi-Roshan et al. (2025) involving 930 patients with coronary artery disease (CAD) demonstrated that the OR for severe CAD in the highest quartile of TyG-BMI was 1.98 (95% CI: 1.31–2.99, p-for-trend=0.001) [40]. Another case-control study involving 2,356 participants demonstrated that TyG-BMI was independently associated with early-onset coronary artery disease (OR=1.004,95% CI: 1.002–1.007, p=0.002) and showed positive correlations with the number of affected vessels and the Gensini score. The AUC of TyG-BMI for predicting early-onset coronary artery disease was 0.673 [40]. A study by Yang et al. (2026) enrolled 454 patients with coronary artery disease and found that the TyG-BMI levels in the moderate-to-severe lesion group were significantly higher than those in the mild lesion group. Multivariate logistic regression analysis confirmed that TyG-BMI was an independent risk factor for moderate-to-severe coronary artery lesions, with an AUC of 0.708 according to ROC curve analysis. These findings are consistent with the aforementioned studies, further validating the clinical utility of TyG-BMI in assessing coronary stenosis risk. Potential mechanisms by which insulin resistance promotes coronary atherosclerosis progression include: activating inflammatory pathways to exacerbate endothelial dysfunction and macrophage activation; inducing oxidative stress and reducing nitric oxide bioavailability; stimulating vascular smooth muscle cell proliferation and migration; and worsening dyslipidemia [41]. By combining the TyG index with BMI, TyG-BMI simultaneously reflects both insulin resistance levels and obesity status, potentially providing a more comprehensive assessment of the synergistic metabolic damage effects on coronary arteries compared to single indicators. However, since this study was conducted using a cross-sectional design, causal relationships cannot be definitively established, and the association between TyG-BMI and coronary stenosis requires further validation through prospective cohort studies.

4.3. Clinical Significance of the Joint Diagnostic Model

The combined diagnostic model developed in this study (integrating GWI, GCW, GWW, GWE, and TyG-BMI) achieved an AUC of 0.899 (95% CI: 0.848–0.949), demonstrating significantly superior performance compared to each individual indicator. At the optimal cutoff value of 0.673, the model exhibited a sensitivity of 76.4% and a specificity of 90.9%, indicating robust clinical identification capability. The model's overall prediction accuracy was 80.65%, with a higher accuracy rate of 85.39% for patients with significant stenosis versus 74.24% for those without significant stenosis, confirming its reliability in identifying high-risk patients.

The superior diagnostic efficacy of combined biomarkers compared to single indicators can be attributed to multiple factors. Firstly, myocardial work parameters reflect early changes in cardiac contractile function and demonstrate high sensitivity for subclinical myocardial dysfunction caused by coronary artery stenosis. By integrating left ventricular pressure and longitudinal strain, myocardial work techniques overcome the load dependence inherent in traditional spot-tracking methods, enabling earlier detection of myocardial dysfunction [42]. Secondly, TyG-BMI quantifies the metabolic risk of coronary atherosclerosis progression, complementing myocardial work parameters from structural and functional perspectives. Studies combining GWE with 3D-STI for predicting coronary lesions have similarly identified GWE as a significant predictor of coronary pathology in patients with unstable angina [43].

4.4. Limitations and Prospects

This study has the following limitations: ① The cross-sectional design prevents the establishment of causal relationships; ② The sample size is limited (n=155) and no external validation was conducted; the model stability requires confirmation through multicenter, large-sample studies; ③ No additional potential confounding variables such as inflammatory markers were included; ④ Measurement of myocardial work parameters depends on image quality. Although existing studies have demonstrated good reproducibility [37], a unified quality control standard remains necessary.

5. CONCLUSION

This study demonstrates that myocardial work parameters (GCW, GWW, GWE) and TyG-BMI are independent influencing factors for significant coronary stenosis, with GWE exhibiting the strongest effect and TyG-BMI showing the most prominent association at the metabolic level. The diagnostic model combining these indicators achieved an AUC of 0.899, demonstrating excellent discriminative capacity and predictive efficacy. The integrated application of myocardial work techniques and TyG-BMI provides a novel approach for non-invasive assessment of coronary stenosis and holds promise for aiding risk stratification and decision-making in clinical practice prior to coronary angiography.

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