

Prevalence of Significant Coronary Artery Disease in Patients with Severe Aortic Stenosis and the Diagnostic Value of the Coronary Calcium Score and Echocardiographic Parameters: A Cohort Study at a Referral Center in the Ecuadorian Andean Highlands

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Abstract

Background

Severe aortic stenosis is the most prevalent valvular heart disease in high-income countries and shares some common calcification mechanisms with coronary artery disease. The prevalence of both conditions occurring together ranges from 25% to 75%. In Latin America, the characterization of both conditions has been poorly documented. The diagnostic performance of the coronary calcium score or echocardiographic parameters for identifying coronary artery disease in this subgroup has not been described.

Methods

An observational, analytical, retrospective, cross-sectional study. The study included 390 participants diagnosed with severe aortic stenosis who were treated at a national cardiovascular referral center located at an altitude of 2,850 meters between January 2021 and March 2025. Coronary stratification was performed using coronary computed tomography angiography in 65.9% of cases and invasive coronary angiography in 34.1%. Significant coronary stenosis was defined as a $\geq 50\%$ stenosis in the left main coronary artery or $\geq 70\%$ in the major epicardial vessels. Odds ratios with 95% CI and ROC curves with area under the curve were estimated.

Results

The mean age was 69 years. Women (59.7%) and people of racially mixed ethnic predominated (90.5%). A high prevalence of obesity (57.7%), hypertension (59.0%), dyslipidemia (51.3%), and chronic kidney disease (36.9%) was identified. The prevalence of significant CAD was 12.1%. The calcium score demonstrated excellent discriminatory ability (AUC 0.942; Nagelkerke R^2 0.772), while aortic valve calcium was inversely associated with coronary artery disease (AUC 0.796). The low-flow/low-gradient pattern was the strongest phenotypic predictor of CAD (OR 4.59; 95% CI: 2.2–9.5). Obesity (OR 3.52), hypertension (OR 2.21), chronic kidney disease (OR 2.13), and smoking (OR 1.96) were associated with coronary artery disease. Clinical symptoms and altitude of residence did not show significant associations.

Conclusions

The prevalence of concomitant significant coronary artery disease in our cohort was lower than that reported in European and North American registries. The CAC score was the noninvasive marker with the greatest diagnostic utility. The low-flow, low-gradient pattern was the most robust echocardiographic

predictor associated with coronary artery disease. Our findings provide essential local evidence for optimizing diagnostic stratification in Latin American Andean populations.

Background

Severe aortic stenosis (SAS) is the most prevalent valvular heart disease in high-income countries, and its incidence continues to rise due to an aging population ¹. In individuals over 75 years of age, aortic calcification is present in 12.4%, while 3.4% develop SAS ². After the onset of symptoms, survival without intervention deteriorates significantly, falling below 38% at five years³. Surgical aortic valve replacement (SAVR) or transcatheter aortic valve implantation (TAVI) is the definitive treatment for SAH when it is symptomatic or left ventricular dysfunction is evident⁴.

Worldwide, coronary artery disease (CAD) is the leading cause of cardiovascular mortality, accounting for more than nine million deaths annually⁵. Multiple cardiovascular risk factors, as well as a partially shared pathophysiological basis, are common to both EAS and CAD. Depending on the cohort analyzed, the definition, and the diagnostic method used, the prevalence of concomitant CAD in patients with severe AS varies widely between 25% and 75%. The coexistence of both conditions has direct prognostic and therapeutic implications for the planning of valve intervention ^{6,7}.

The 2024 ESC/EACTS guidelines recommend systematic evaluation of coronary anatomy as a Class I indication in all candidates for aortic valve replacement ⁴. Coronary computed tomography angiography (CCTA) emerging as the first-line diagnostic method in patients with a low or intermediate probability of obstructive CAD, while invasive coronary angiography is reserved for those with a high pre-test probability, known as CAD, or when the CCTA is inconclusive ^{4,8}.

The coronary calcium score (CAC score), quantified using non-contrast computed tomography (CT) by the Agatston method, is a robust predictor of cardiovascular events and atherosclerotic burden ⁹. Aortic and coronary valve calcification have been proposed as processes with partially independent pathophysiological pathways, with differences in molecular, genetic, and cellular signaling mechanisms ^{10,11}.

Studies on the association between aortic valve calcification and CAD in Latin American countries are scarce. In Ecuador, there are no published studies characterizing the relationship between these two conditions or evaluating the diagnostic performance of echocardiographic parameters or the CAC score for identifying obstructive CAD. Chronic hypobaric hypoxia, characteristic of the Andean highlands, may differentially modulate the progression of coronary atherosclerosis and valvular calcification ¹². A significant proportion of the Ecuadorian population resides in the Andean region. The objectives of this study were to analyze the relationship between SAS and CAD in an Ecuadorian cohort from a national referral center, characterize its clinical and demographic profile, determine the prevalence of significant CAD, and evaluate the diagnostic ability of the CAC score and echocardiographic parameters.

Methods

Objective

To analyze the relationship between severe aortic stenosis and coronary artery disease in patients treated at the Eugenio Espejo Specialty Hospital from January 2021 to March 2025.

Study Design and Population

A cross-sectional, observational, analytical, retrospective study was conducted. Data were included for patients with a confirmed diagnosis of SAS treated in the Cardiology Department of the Eugenio Espejo Specialty Hospital (HEEE), a tertiary-level cardiovascular referral center located in Quito, Ecuador (2,850 meters above sea level), between January 2021 and March 2025.

Inclusion criteria

patients aged ≥ 18 years with an echocardiographic diagnosis of SAS (aortic valve area ≤ 1.0 cm² and/or mean gradient ≥ 40 mmHg and/or maximum aortic jet velocity ≥ 4.0 m/s), with documented evaluation of coronary anatomy via CT angiography (CTA) or invasive coronary angiography.

Exclusion criteria

incomplete medical records preventing the extraction of essential variables, age < 18 years, rheumatic etiology, significant concomitant valvular heart disease, or a history of prior aortic valve replacement.

Variables and Definitions

Significant CAD was defined as luminal stenosis $\geq 50\%$ of the left main coronary artery or $\geq 70\%$ of the major epicardial coronary arteries (left anterior descending, circumflex, right coronary) or any of their branches, as demonstrated by CT angiography or invasive coronary angiography. The CAC score and aortic valve calcium score were quantified using the Agatston method on non-contrast CT. The hemodynamic phenotypes of AS were classified according to the 2024 ESC/EACTS guidelines: the low-flow–low-gradient phenotype, characterized by reduced LVEF ($< 50\%$), a mean gradient < 40 mmHg, AVA ≤ 1 cm², and iVS ≤ 35 ml/m²; the low-flow, low-gradient phenotype, which shares similar thresholds for gradient, AVA, and iVS but with preserved LVEF ($\geq 50\%$); the normal-flow–low-gradient phenotype with preserved LVEF, in which the iVS is greater than 35 ml/m² with a gradient remaining below 40 mmHg; and the discordant high-gradient phenotype, defined by a mean gradient ≥ 40 mmHg with AVA greater than 1 cm²)⁴.

Data Collection

Data were collected from an anonymized database. This database included electronic medical records of patients from the Cardiology Department at HEEE. Demographic, clinical, biochemical, echocardiographic, CT, and coronary anatomy variables were collected. Altitude of residence was assigned based on the reported place of residence and verified using official geographic coordinates.

Statistical Analysis

Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), depending on their distribution (verified by the Kolmogorov-Smirnov test). Categorical variables were expressed as absolute frequencies and percentages. To compare continuous variables between groups (with and without significant CAD), the Student's t-test for independent samples or the Mann-Whitney U test was used, as appropriate. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test. Associations between risk factors and significant AEC were expressed as odds ratios (OR) with 95% confidence intervals (95% CI), derived from univariate logistic regression models. The discriminatory power of each variable for detecting obstructive AEC was evaluated using ROC curves and the calculation

of the AUC. The Nagelkerke R^2 was reported as an estimate of the individual effect size of each variable on the outcome. It was used as a complementary measure to the AUC to quantify the magnitude of each association. It is recognized that its interpretation may be more robust in multivariate models. A p-value < 0.05 was considered statistically significant. The analysis was performed using the JASP software, version v0.95.4.

Ethical Considerations

This study was approved by the Ethics Committee for Research Involving Human Subjects (CEISH) of the Eugenio Espejo Specialty Hospital, under protocol number CEISH-HEEE-2025-017. Given the retrospective design and the use of anonymized data from institutional clinical records, an exemption from individual informed consent was granted. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki and its subsequent revisions. No human biological samples were analyzed.

Results

Clinical and Demographic Profile

390 participants with AAS were included. The mean age was 69 ± 13 years (range 18–93 years), with a predominance of women (59.7%; $n = 233$) and people of racially mixed ethnic (90.5%; $n = 353$). Patients with significant CAD had a higher mean age than those without CAD (76.06 ± 7.35 years vs. 68.47 ± 14.59 years; mean difference [MD]: 7.59 years, 95% CI: 4.95–10.22; $p < 0.01$). 93.1% resided in urban areas, and the average altitude of residence was $2,453 \pm 861$ meters above sea level (masl). 79.0% of the participants resided at altitudes $\geq 2,500$ masl.

Hypertension (59.0%) was the most common comorbidity, followed by obesity (57.7%), dyslipidemia (51.3%), and chronic kidney disease (CKD) (36.9%). 36.7% were current or former smokers.

Hypertension was associated with an increased risk of significant CKD (OR 2.21, 95% CI 1.1–4.4, $p = 0.032$), with a prevalence of 15.2% among hypertensive patients compared with 7.5% among non-hypertensive patients. CKD also showed a significant association (OR 2.13, 95% CI 1.1–3.9, $p = 0.016$), with a prevalence of 17.4% among patients with kidney disease versus 8.9% among those with preserved kidney function. Current or past smoking was significantly associated with a higher risk of CKD (3.6 times). Obesity showed the strongest association with CAD (OR 3.52, 95% CI 1.65–7.51, $p = 0.001$), with a prevalence of 16.9% in obese patients versus 5.5% in non-obese patients. Dyslipidemia showed a non-statistically significant association. The remaining comorbidities showed no association with CAD. Table 1 shows the demographic characteristics, and Table 2 shows the association between risk factors and significant CAD.

The most common clinical manifestations were symptoms of heart failure (35.4%), palpitations (19.7%), angina (19.5%), and syncope (14.6%). Most patients were in NYHA functional class II (67.9%). No statistically significant differences were observed regarding clinical manifestations and the presence of CAD. Although angina and symptoms of heart failure were associated with a higher prevalence of CAD, these associations did not reach statistical significance. Table 3.

Table 1
Demographic characteristics and altitudinal distribution of patients with severe aortic stenosis treated at the Eugenio Espejo Specialty Hospital from January 2021 to March 2025

Variable	n (%)	EAC (%)
Male	157 (40,3%)	12,1%
Female	233 (59,7%)	12,0%
Racially mixed	353 (90,5%)	—
Afro-Ecuadorian ethnicity	21 (5,4%)	—
Indigenous ethnicity	16 (4,1%)	—
Urban residence	363 (93,1%)	—
Residence altitude (msnm), mean $\pm$ SD	2.453 $\pm$ 861	—
$\geq 2,500$ m.a.s.l (Andean highlands)	308 (79,0%)	13,0%
$< 2,500$ m.a.s.l (coast/valleys)	82 (21,0%)	8,5%

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EAC: significant coronary artery disease; SD: standard deviation; m.a.s.l.: meters above sea level.

Table 2

Prevalence of significant coronary artery disease according to cardiovascular risk factors and comorbidities in patients with severe aortic stenosis treated at the Eugenio Espejo Specialty Hospital from January 2021 to March 2025

Risk Factor/Comorbidity	Total (n = 390)	With CAD, n (%)	Without CAD, n (%)	OR (IC95%)	p Value
Obesity	225	38 (16.9%)	187 (83.1%)	3.52 (1.6–7.5)	0.001*
High blood pressure	230	35 (15.2%)	195 (84.8%)	2.21 (1.1–4.4)	0.032*
Chronic kidney disease	144	25 (17.4%)	119 (82.6%)	2.13 (1.1–3.9)	0.016*
Smoking	143	24 (16.8%)	119 (83.2%)	1.96 (1.0–3.6)	0.0356*
Dyslipidemia	200	29 (14.5%)	171 (85.5%)	1.62 (0.8–3.0)	0.171
Hypothyroidism	69	5 (7.2%)	64 (92.8%)	0.51 (0.1–1.3)	0.251
Diabetes mellitus	92	12 (13.0%)	80 (87.0%)	1.12 (0.5–2.2)	0.880
Uncontrolled dyslipidemia	165	16 (9.7%)	149 (90.3%)	1.48 (0.7–2.8)	0.287

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CAD: Coronary artery disease; OR: Odds ratio; 95% CI: 95% confidence interval

Statistical test: Pearson's chi-square test. *A p-value < 0.05 is considered statistically significant

Table 3

Clinical characteristics of patients with severe aortic stenosis treated at the Eugenio Espejo Specialty Hospital from January 2021 to March 2025.

Symptom	Total (n = 390)	With CAD, n (%)	Without CAD, n (%)	OR (IC95%)	p Value
Angina	76	12 (15.8%)	64 (84.2%)	1.49 (0.7–3.0)	0.358
Syncope	57	6 (10.5%)	51 (89.5%)	0.83 (0.3–2.0)	0.828
Heart failure	138	19 (13.8%)	119 (86.2%)	1.27 (0.6–2.3)	0.543
Palpitations	77	4 (5.2%)	73 (94.8%)	0.34 (0.1–0.9)	0.062

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CAD: Coronary artery disease; OR: Odds ratio; 95% CI: 95% confidence interval

Statistical test: Pearson's chi-square test. A p-value < 0.05 is considered statistically significant

Echocardiographic Parameters and Hemodynamic Phenotypes

The mean aortic jet velocity was 4.49 ± 0.76 m/s, and the mean transvalvular gradient was 50.2 ± 16.7 mmHg. The mean aortic valve area was 0.62 ± 0.20 cm². The tricuspid valve was the predominant morphology (74.1%); the remaining cases were bicuspid. The mean LVEF was $58.2 \pm 7.8\%$ (range 25–76%), with left ventricular hypertrophy in 64.6% of patients.

In patients with significant AAS, hemodynamic parameters were significantly lower: aortic jet velocity (4.01 ± 0.70 vs. 4.55 ± 0.75 m/s; DM – 0.54; 95% CI: –0.76 to –0.32; $p < 0.01$; AUC 0.736), the mean transvalvular gradient (39.6 ± 11.9 vs. 51.6 ± 16.8 mmHg; DM – 12.0; 95% CI: –15.9 to –8.1; $p < 0.01$; AUC 0.742), and LVEF (53.93 ± 9.51 vs. $58.83 \pm 7.30\%$; DM – 4.90; 95% CI: –7.79 to –2.01; $p < 0.01$; AUC 0.722). Table 4 summarizes the association of hemodynamic echocardiographic and tomographic parameters with CAD.

Table 4

Discriminatory ability of parameters for the detection of significant coronary artery disease in patients with severe aortic stenosis treated at the Eugenio Espejo Specialty Hospital from January 2021 to March 2025.

Finding	Media (DE)	DM (IC95%) p Valeu	Nagelkerke R ²	AUC
Coronary calcium score (n = 257)	1122.9 (1236.76)	1095.7 (642.0- 1549.4) < 0.01*	0.772	0.942
Aortic calcium score (n = 257)	2238.2 (1481.0)	-1805.1 (-2408.6 to -1201.5) < 0.01*	0.236	0.796
Mean gradient (mm/Hg) (n = 390)	39.6 (11.9)	-12.0 (-15.9 to -8.1) < 0.01*	0.158	0.742
Aortic jet velocity (m/s) (n = 390)	4.01 (0.70)	-0.54 (-0.76 to -0.32) < 0.01*	0.154	0.736
LVEF (n = 390)**	53.93 (9.51)	-4.90 (-7.79 to -2.01) < 0.01*	0.135	0.722
Global LV longitudinal strain (n = 338)	-13.15 (4.32)	-0.45 (-1.65 to 0.75) 0.957	0.097	0.698
Aortic valve area (cm ²) (n = 390)	0.67 (0.21)	0.06 (-0.01 to 0.13) 0.049*	0.096	0.692
VDI ratio (n = 390)	0.21 (0.05)	0.01 (-0.01 to 0.03) 0.096	0.074	0.659
PASP (n = 390)	34.25 (6.94)	0.18 (-2.12 to 2.48) 0.070	0.073	0.663
Indexed valve area (cm ² /m ²) (n = 217)	0.37 (0.18)	-0.13 (-0.45 to 0.20) 0.555	0.056	0.652

Prepared by: Authors. 2026

* $p < 0.05$. AUC: area under the curve; **LVEF: left ventricular ejection fraction.

The low-flow, low-gradient (LFLG) pattern showed the strongest association with EAC (32.6% vs. 9.5%, OR 4.59, 95% CI 2.2–9.5, $p < 0.01$, AUC 0.725). Conversely, critical AS was associated with a protective effect against significant EAC (4.3% vs. 15.3%, OR 0.24, 95% CI 0.0–0.6, $p = 0.04$, AUC 0.697). Tricuspid morphology was associated with CAD but had low discriminatory power (14.8%, OR 4.23, 95% CI 1.4–12.1, $p < 0.01$, AUC 0.664). The remaining parameters showed no significant associations.

Table 5

Structural echocardiographic parameters according to the presence of significant coronary artery disease in patients with severe aortic stenosis treated at the Eugenio Espejo Specialty Hospital from January 2021 to March 2025

Structural findings (n = 390)	With CAD	Without CAD	OR (IC95%) p Valeu	Nagelkerke R ²	AUC
Low-gradient flow	14 (32.6%)	29 (67.4%)	4.59 (2.2–9.5) < 0.01*	0.125	0.725
Critical stenosis	5 (4.3%)	111 (95.7%)	0.24 (0.0-0.6) 0.04*	0.106	0.697
Tricuspid valve	43 (14.8%)	246 (85.1%)	4.23 (1.4–12.1) < 0.01*	0.081	0.664
Severe LVH**	8 (14.8%)	46 (85.2%)	1.32 (0.5-3.0) 0.501	0.077	0.659
Paradoxical	5 (17.2%)	24 (82.8%)	1.58 (0.5–4.3) 0.373	0.075	0.659
Amyloidosis sings	3 (12.0%)	22 (88.0%)	0.99 (0.2–3.4) 1.00	0.074	0.660
LVH**	33 (13.1%)	219 (86.9%)	1.33 (0.6–2.5) 0.488	0.073	0.660

Prepared by: Authors. 2026

*A p-value < 0.05 is considered statistically significant. AUC: area under the ROC curve.** left ventricular hypertrophy.

Prevalence of Significant CAD and Coronary Risk Stratification

Coronary risk stratification was performed using CT angiography in 65.9% of cases (n = 257) and invasive coronary angiography in 34.1% (n = 133). The overall prevalence of significant CAD was 12.1%

(n = 47/390). No significant differences were observed based on the evaluation method used (CTA: 11.28% vs. invasive coronary angiography: 13.53%). There were no differences in the prevalence of CAD by sex (men 12.1% vs. women 12.0%; OR 1.00; 95% CI: 0.50–1.80; p = 0.980).

Analysis of the CAC score (available in n = 259; 66.4%) showed an absence of coronary calcification in 53.7% of the participants evaluated, minimal calcification (1–99 AU) in 31.7%, moderate calcification (100–399 AU) in 7.3%, and severe calcification (≥ 400 AU) in 7.3%. The aortic valve calcium score had a median of 3,545 AU (range 0–10,180 AU).

Diagnostic ability of the CAC score and valve calcium for detecting CAD

The CAC score was the variable with the greatest discriminatory power for identifying obstructive CAD (AUC 0.942; Nagelkerke R^2 0.772; p < 0.01). The difference in means between groups was + 1,095.7 UA (95% CI: 642.0–1,549.4; p < 0.01), with a median of 449.0 AU (IQR 238.0–1,708.0) in patients with CAD versus 0.0 AU (IQR 0.0–40.0) in those without CAD.

Conversely, the aortic valve calcium score was significantly lower in patients with CAD ($2,238.2 \pm 1,481.0$ AU vs. $4,043.3 \pm 2,235.8$ AU; DM – 1,805.1 AU; 95% CI: –2,408.6 to – 1,201.5; p < 0.01; AUC 0.796). Table 4 presents the discriminatory power of all the variables evaluated.

Residence Altitude and CAD

The prevalence of EAC was 13.0% among residents of the highlands ($\geq 2,500$ m above sea level) compared with 8.5% among residents at lower altitudes (< 2,500 m above sea level), with an OR of 1.60 (95% CI: 0.69–3.71; p = 0.363). Analysis of altitude as a continuous variable showed a non-significant difference in means between groups (142.2 m above sea level; 95% CI: –93.5 to 377.8; p = 0.289).

Discussion

In Latin America, studies characterizing the profile of SAS and CAD, as well as describing their association, have been scarce and methodologically limited. In São Paulo, Brazil, in 2006, a significant prevalence of CAD (40%) was reported in a cohort of 65 patients with severe SAS evaluated by invasive coronary angiography. Age was the only factor significantly associated with CAD in the univariate analysis, and fibrinogen was identified as an independent variable in the multivariate analysis¹³. In the same year (2006), a similar concomitant prevalence of CAD (50%) was reported in 186 patients, who were also evaluated by invasive coronary angiography¹⁴. In 2011 in Lima, Peru, Jáuregui et al. reported a concomitant prevalence of CAD of 16.3% in 92 patients evaluated by invasive coronary angiography¹⁵. The predictive ability of the CAC score or hemodynamic echocardiographic phenotypes for significant CAD has not been described. The available findings were obtained prior to the widespread adoption of TAVI and the recommendations of the 2021 and 2024 ESC/EACTS guidelines. No studies addressing the specific association between these two conditions in Ecuador have been published.

In our cohort, the prevalence of concomitant significant CAD identified was 12.1%. This figure is significantly lower than that reported by large international registries, where it ranges from 30% to 75%^{6,7,16}.

Several factors may explain this difference. First, more than half of the participants were evaluated noninvasively using CT angiography (CTA). The presence of severe coronary calcification may be associated with a rate of inconclusive results and a possible overestimation of stenosis due to blooming artifacts¹⁷. In our cohort, a high aortic valve calcium score (median 3,545 AU) was identified, while 46.3% had some degree of coronary calcification. Second, our cohort was not preselected as high-risk TAVI candidates but rather reflects general clinical practice with a comparatively younger population (mean age 69 years) and less referral bias than large European and North American registries¹⁸. Third, the predominantly mestizo ethnic profile with high Native American ancestry could differentially modulate atherosclerotic susceptibility. According to Cardoso-Saldaña et al., in racially mixed populations, wide differences in allele frequencies, Lp(a) levels, and associations with valvular calcification among ethnic groups have been demonstrated. The Lp(a) gene contains the rs10455872-G allele, which is present in racially mixed populations and is associated with a higher prevalence of aortic valve calcification (29.4% vs. 19.0%). However, the presence of this allele has not been shown to be associated with increased coronary calcium or risk factors¹⁹.

The exceptional discriminatory power of the CAC score in identifying obstructive CAD (AUC 0.942) is one of the study's most significant findings and is consistent with current evidence. The MESA study demonstrated a progressive and significant association between CAC score categories and major adverse cardiovascular events over more than ten years of follow-up⁹. In the context of severe aortic stenosis, this high discriminatory power has direct clinical relevance. The absence of coronary calcium reliably identifies very low-risk patients in whom invasive coronary angiography would be unnecessary and has direct implications for optimizing diagnosis in settings with limited healthcare resources²⁰.

The significant inverse association between the aortic valve calcium score and the presence of obstructive CAD (AUC 0.796; DM – 1,805.1 UA) supports the hypothesis of partial pathophysiological dissociation between these two calcification processes. This finding is consistent with the report by Henein et al., who demonstrated that the CAC score correlates with aortic root calcium but not with valvular calcium per se, suggesting pathogenic pathways with independent mechanisms that go beyond shared risk factors²¹. Patients with a higher aortic valve calcium burden tend to be younger, have EAS on bicuspid valves, and have a shorter cumulative duration of exposure to systemic atherosclerotic risk factors.

The LFLG phenotype was the echocardiographic predictor with the highest discriminatory power for CAD (OR 4.59; AUC 0.725), with a prevalence of CAD of 32.6% in this subgroup compared with 9.5% in patients without this phenotype. This finding is consistent with the report by Clavel et al., who noted that CAD is common in the classic LFLG pattern and that ischemic myocardial dysfunction directly

contributes to the low-flow, low-output state characteristic of this phenotype, compromising transvalvular flow reserve²².

Critical AS was inversely associated with CAD; only 4.3% of participants had obstructive CAD. This finding represents an original result from our cohort. Greater hemodynamic severity tends to be observed more frequently in cases of bicuspid valve morphology, with younger ages at the time of diagnosis. This may imply a shorter cumulative exposure time to systemic atherosclerotic risk factors^{23,24}. The lower prevalence of CAD in this phenotype contrasts sharply with that observed in the LFLG pattern, suggesting that the hemodynamic severity of AS per se does not directly predict the concomitant coronary atherosclerotic burden.

Tricuspid valve morphology was associated with a higher prevalence of CAD compared to bicuspid valve morphology, a finding consistent with the pathophysiology: AS on the tricuspid valve is characteristic of cardiovascular senescence, a context of greater coronary atherosclerotic burden, whereas bicuspid AS occurs in younger patients with a lower systemic atherosclerotic burden²³.

Among the cardiovascular risk factors analyzed, obesity, hypertension, CKD, and smoking showed a statistically significant association with CAD, consistent with international evidence identifying these factors as common to both diseases²⁵. Smoking and renal insufficiency have been identified as independent predictors of greater coronary complexity as assessed by the SYNTAX score²⁶.

Dyslipidemia and diabetes mellitus did not reach statistical significance in this cohort; this result should be interpreted with caution given the small sample size of these subgroups, which does not allow for the exclusion of an underlying biological relationship.

No clinical symptoms, including angina, distinguished the presence of CAD; the direct clinical implication supports the view that systematic evaluation of coronary anatomy should be performed regardless of the patient's symptomatic presentation. This finding is consistent with that reported by Goncalvez et al. in 2006, in which angina did not emerge as a good predictor of CAD in 186 patients with EAS over the age of 50¹⁴.

Residential altitude was not independently and significantly associated with CAD. Although the Swiss National Cohort reported a cardiovascular protective effect at moderate altitudes in a European population¹², the physiological effects of the Andean highlands at altitudes above 2,500 meters above sea level may differ qualitatively, and the high burden of cardiovascular risk factors in our population may counteract the hypothetical cardioprotective effect of chronic hypoxia.

The study has limitations inherent to its retrospective, single-center design. The method of coronary stratification was not uniform (CCTA in 65.9% and invasive coronary angiography in 34.1%), which may have introduced classification bias. The CAC score was available for only 66.4% of participants. The lack of clinical follow-up prevents the assessment of long-term outcomes. These limitations suggest that the

results should be interpreted with caution and validated through prospective, multicenter studies with larger sample sizes and standardized diagnostic methods.

Conclusions

Population characteristics, the diagnostic stratification method, and a probable ethnic influence explain the lower prevalence of concomitant CAD identified in our cohort ^{17–19}.

The CAC score is the noninvasive marker with the greatest diagnostic utility in this population (AUC 0.942), and its systematic incorporation into preprocedural evaluation is supported ⁹. The LFLG pattern is the most robust echocardiographic predictor of concomitant CAD, supporting the indication for coronary evaluation in this subgroup regardless of symptoms ²².

The inverse association between the aortic valve calcium score and obstructive CAD observed in our cohort suggests that, in patients with established severe aortic stenosis, a higher burden of valvular calcification does not predict the presence of significant CAD. Therefore, aortic valve calcium should not be interpreted as a predictor of concomitant coronary atherosclerotic burden ^{10,21}.

Consistent with previous registry reports, certain traditional cardiovascular risk factors, as well as chronic kidney disease (CKD) and smoking, were significantly associated with significant CAD ^{25,26}.

Our findings contribute to the generation of essential local evidence for adapting international recommendations to the clinical, demographic, and environmental context of Latin American Andean populations.

Abbreviations

AUC

Area under the ROC curve

CAC score

Coronary artery calcium score

CCTA

Coronary computed tomography angiography

CAD

Coronary artery disease

SAS

Severe aortic stenosis

ERC

Chronic kidney disease (CKD)

LVEF

Left ventricular ejection fraction

HEEE
Eugenio Espejo Specialty Hospital
95% CI
95% confidence interval
ICA
Invasive coronary angiography
LFLG
Low-flow, low-gradient
msnm
Meters above sea level
OR
Odds ratio
PSAP
Pulmonary artery systolic pressure
SAVR
Surgical aortic valve replacement
SLG
Global longitudinal strain
TAVI
Transcatheter aortic valve implantation
CT
Computed tomography (CT)

Declarations

Ethical Approval and Consent to Participate

This study was approved by the Ethics Committee for Research Involving Human Subjects (CEISH) at the Eugenio Espejo Specialty Hospital, under protocol number CEISH-HEEE-2025-017. Given the retrospective design and the use of anonymized data from institutional clinical records, an exemption from obtaining individual informed consent was granted. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki and its subsequent revisions.

Consent to Publication

Not applicable

Availability of Data and Materials

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Conflict of Interest

The authors declare that they have no competing interests.

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Author Contributions

JDMZ: Design of the work. Acquisition, analysis, **AND** interpretation of data.

MBMA: Analysis **AND** interpretation of data. Substantively revised the work.

GCSN: Acquisition, analysis, **AND** interpretation of data.

LAGR/MSCLR: Conception **AND** design of the work. Substantively revised the work.

All authors have read and approved the final manuscript.

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