





# Relationship between the TIMI risk score and the angiographic severity of atherosclerosis in patients with acute coronary syndrome without ST elevation: a cross-sectional study

*Relação entre o escore de risco TIMI e a gravidade angiográfica da aterosclerose em pacientes com síndrome coronariana aguda sem supradesnível do segmento ST: um estudo transversal*

Bernardo Buitrago de Andrade<sup>1</sup>, Luiz Augusto Castro Ribeiro<sup>1</sup>, Adriana Torres da Silva<sup>2</sup>, Alda Cristina Alves De Azevedo<sup>2</sup>

## ABSTRACT

**Introduction:** Cardiovascular diseases, particularly non-ST-segment elevation acute coronary syndrome (NSTEMI-ACS), are a major concern due to their high morbidity and mortality rates. NSTEMI-ACS results from the instability of atherosclerotic plaques in coronary arteries and can manifest as either acute myocardial infarction or unstable angina, depending on the elevation of cardiac injury markers. The prognosis is evaluated using the thrombolysis in myocardial infarction (TIMI) risk score, which ranges from 0 to 7 based on seven variables. This score is crucial for deciding on coronary angiography (CAG), which assesses the severity of coronary artery disease and informs treatment decisions. **Objective:** To identify a potential association between the TIMI risk score and coronary artery disease severity on CAG in patients with NSTEMI-ACS. **Methods:** This cross-sectional study includes data from 289 patients admitted to a University Hospital in Belo Horizonte (Minas Gerais, Brazil) for NSTEMI-ACS during the years of 2023 and 2024. Participants underwent CAG conducted by the hospital's interventional cardiology team from October 2023 to July 2024. Both male and female patients diagnosed with NSTEMI-ACS and a TIMI score of  $\geq 2$  were eligible for inclusion. Data were collected from the medical records of eligible patients. **Results:** Analysis revealed that 68% of the 289 participants had at least one artery with an obstruction of  $\geq 50\%$  on CAG. These findings correlate with the TIMI groups, as 75% and 76% of participants within the intermediate and high TIMI groups, respectively ( $p^2=0.017$ ). The left anterior descending artery stood out, with approximately 17% of participants showing obstruction exceeding 50%. **Conclusion:** Our findings demonstrated a significant relationship between the TIMI group and the presence of coronary obstructions surpassing 50%. This is clinically significant, as an intermediate TIMI score may suggest that a patient should undergo coronary evaluation and possibly receive treatment for the identified lesion.

**Keywords:** Non-ST-Elevated myocardial infarction; Unstable angina; Cardiac catheterization.

<sup>1</sup> Faculdade Ciências Médicas de Minas Gerais (FCM-MG), Belo Horizonte, Minas Gerais, Brazil.

<sup>2</sup> Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

### Associate Editor Responsible:

Nestor Barbosa de Andrade  
Faculdade de Medicina da  
Universidade Federal de Uberlândia.  
Uberlândia/MG, Brazil.

### Corresponding author:

Bernardo Buitrago de Andrade  
Faculdade Ciências Médicas de Minas  
Gerais (FCM-MG), Minas Gerais.  
Email: bbuitragoandrade@gmail.com

### Supporting sources:

Programa Institucional de Bolsas de Iniciação Científica (PIBIC) da Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) em parceria com a Faculdade Ciências Médicas de Minas Gerais (FCM-MG).

### Conflicts of interest:

None.

### Ethic committee:

Opinion number:  
72485323.6.0000.5134

## RESUMO

**Introdução:** As doenças cardiovasculares, especialmente a síndrome coronariana aguda sem supradesnível do segmento ST (SCASSST), são uma grande preocupação devido à alta taxa de morbimortalidade. A SCASSST resulta da instabilização de placas ateroscleróticas em artérias coronárias e pode se manifestar como infarto agudo do miocárdio ou angina instável, dependendo da elevação dos marcadores de lesão cardíaca. O prognóstico é avaliado pelo escore TIMI (*Thrombolysis In Myocardial Infarction*), que pontua de 0 a 7 com base em sete variáveis. Esse escore é crucial para decidir pela cineangiocoronariografia (CATE), que avalia a gravidade da doença arterial coronariana e orienta o tratamento. **Objetivo:** Identificar a possível associação entre o escore de risco TIMI e a gravidade da DAC ao CATE de pacientes com SCASSST. **Métodos:** Trata-se de um estudo transversal com dados de 289 pacientes admitidos em um Hospital Universitário de Belo Horizonte, Minas Gerais, Brasil por SCASSST nos anos de 2023 e 2024 e submetidos ao CATE pela equipe de cardiologia intervencionista do mesmo Hospital Universitário. Foram elegíveis pacientes do sexo masculino e feminino, com diagnóstico de SCASSST e escore de TIMI maior ou igual a 2, os quais foram submetidos ao CATE pelo departamento de cardiologia intervencionista do mesmo hospital no período de outubro de 2023 a julho de 2024. Os dados foram coletados a partir dos prontuários dos pacientes elegíveis. **Resultados:** Neste trabalho foi possível notar que, dentre os 289 participantes, 68% apresentaram ao CATE pelo menos uma artéria com obstrução  $\geq 50\%$ . Esses dados podem ser relacionados aos Grupos TIMI, uma vez que 75% e 76% dos participantes com grupo TIMI intermediário e alto, respectivamente, apresentaram pelo menos uma artéria com obstrução  $\geq 50\%$  ( $p^2=0,017$ ). Dentre as artérias com obstrução maior que 50%, destaca-se a ADA, em cerca de 17% dos participantes. **Conclusão:** Foi possível compreender que existe uma relação significativa entre o grupo TIMI e a presença de obstruções coronarianas superiores a 50%. Isso é clinicamente relevante, pois um escore TIMI intermediário pode indicar que o paciente deve ser submetido a uma avaliação coronariana e, possivelmente, tratar a lesão identificada.

**Palavras-chave:** Infarto do miocárdio sem supradesnível do segmento ST; Angina instável; Escore de risco TIMI; Cineangiocoronariografia.

Received on: January 20, 2025.

Approved on: October 22, 2025.

Publication Date: March 17, 2026.

DOI: 10.5935/2238-3182.2025e35126

## INTRODUCTION

Cardiovascular diseases have emerged as a major health concern in developing countries, significantly contributing to morbidity and mortality<sup>1</sup>. According to various studies, cardiovascular diseases account for over 17 million deaths worldwide annually, with this figure projected to grow to 23.6 million by 2030<sup>2</sup>. Additionally, cases of non-ST segment elevation myocardial infarction (STEMI) from

heart attacks lead to approximately 2–2.5 million hospital admissions worldwide each year<sup>3</sup>.

Non-ST-segment elevation acute coronary syndrome (NSTEMI-ACS) is characterized by the instability of an atherosclerotic plaque in a coronary artery, resulting in adjacent thrombus formation, which can be categorized as unstable angina or STEMI<sup>1</sup>. The diagnosis is clinical, and NSTEMI-ACS can manifest through chest or retrosternal pain of recent onset, typically less than one month, lasting

at least 20 minutes, and accompanied by a worsening of the functional class. Additionally, there is an elevation in troponin I above the 99th percentile, which may vary according to the laboratory method used for troponin measurements<sup>3</sup>. It is pertinent to highlight that factors such as smoking, dyslipidemia, a positive family history, advanced age, cardiomyopathies, male sex, diabetes mellitus, and chronic kidney disease are prominent risk factors for triggering NSTEMI-ACS<sup>2</sup>.

The prognosis for NSTEMI-ACS patients can be determined through early risk stratification. Numerous risk scores have been developed to predict outcomes in patients with acute coronary syndrome, with the thrombolysis in myocardial infarction (TIMI) score being particularly notable. This score was derived from the TIMI IIB trial<sup>3</sup>. The TIMI score is based on seven variables: age, previous coronary artery disease (CAD), risk factors, history of angina episodes within the past 24 hours, prior use of acetylsalicylic acid (ASA), ST segment deviation on the electrocardiogram, and elevated cardiac biomarkers. The score ranges from 0 to 7, calculating a patient's risk of mortality, though it was not originally designed to predict CAD severity<sup>1</sup>.

Using the TIMI risk score, non-invasive stratification of CAD severity can be performed. Patients with a TIMI score of  $\geq 5$  must undergo coronary cineangiography (CAG) within 24 hours. Those with moderate risk (TIMI score of 2–5) can delay catheterization for up to 72 hours, whereas patients with a TIMI score below 2 do not require an invasive strategy<sup>2</sup>.

Coronary cineangiography is the gold standard for CAD evaluation and one of the most common invasive procedures worldwide. In addition to the aforementioned recommendations for NSTEMI-ACS patients, the European Society of Cardiology advises CAG for cases of STEMI and selected cases of stable CAD, along with specific non-coronary conditions<sup>4</sup>. There are no absolute contraindications for emergency CAG, while elective procedures must always consider the patient's cardiac and non-cardiac clinical stability<sup>5</sup>.

Coronary cineangiography allows one to diagnose and treat heart disease. It enables the assessment of the coronary arteries, identification of potential obstruction sites and their severity, and visualization of coronary blood flow. The procedure involves introducing contrast into the ostium of the coronary arteries through a percutaneous catheter inserted through the radial or femoral artery<sup>5</sup>. The outcomes of CAG, together with clinical data and prognostic assessment of the patient's cardiovascular risk, guide the optimal treatment approach, whether it be clinical management, percutaneous angioplasty, or conventional revascularization surgery<sup>6</sup>.

Given this context, we sought to identify potential associations between TIMI risk scores and the severity of coronary lesions in the CAG of NSTEMI-ACS patients. In addition, we aimed to identify the possible associations between the TIMI risk score and patients' sex, pattern of coronary dominance, number of vessels affected by moderate or severe CAD, and the location of atherosclerotic plaques.

## METHODS

This is a cross-sectional study, employing quantitative and qualitative approaches, carried out on patients with NSTEMI-ACS admitted to the Hospital Universitário Ciências Médicas de Minas Gerais in Belo Horizonte (Minas Gerais, Brazil). Patients underwent CAG by the interventional cardiology department of the hospital between December 2023 and July 2024, spanning a total study duration of 12 months.

The research was approved by the Research and Ethics Committee of Faculdade Ciências Médicas de Minas Gerais (protocol no. 72485323.6.0000.5134) and was conducted as part of the Institutional Program for Scientific Initiation Scholarships supported by the Minas Gerais Research Support Foundation in partnership with the Faculty of Medical Sciences of Minas Gerais.

A total of 289 patients diagnosed with NSTEMI-ACS and submitted to CAG were included. The inclusion criteria comprised being male and female patients diagnosed with NSTEMI-ACS, possessing a TIMI score of  $\geq 2$  and having undergone CAG by the interventional cardiology department of the university hospital. Exclusion criteria included being diagnosed with STEMI and having a TIMI score of  $< 2$ . Data confidentiality and participants' identities were ensured throughout the study; all participants signed the free and informed consent form.

The two main variables analyzed were the TIMI score and coronary lesion severity. Data on patients' medical records, images, and CAG reports were provided by the hospital and the hemodynamic service. If data in the medical record were insufficient for traditional TIMI stratification, additional data were gathered through patient interviews.

Medical records were used to evaluate patients' sex and the need data for traditional TIMI stratification for NSTEMI-ACS, including age, CAD risk factors, known CAD with obstruction  $\geq 50\%$ , use of ASA within 7 days prior to NSTEMI-ACS, elevated biomarkers post-admission, history of resting angina in the 24 hours prior to NSTEMI-ACS, and ST-segment deviation of  $\geq 5$  mm.

Analysis of the images and CAG reports focused on identifying coronary obstruction, degrees of involvement, blood flow, and affected arteries in order to categorize patients based on coronary lesion severity. Additional data on dominance patterns, number of affected vessels, and locations of atherosclerotic plaques were collected for complementary analyses. Data collection and analyses were carried out by the authors.

The TIMI risk scores and coronary lesion severities in the CAG were subsequently analyzed and categorized into two main groups. Subdivision based on the TIMI score formed three groups: Group 1 (2–3 points), Group 2 (4–5 points), and Group 3 (6–7 points). Another classification was made according to CAD severity, dividing patients into Group 1 (severe CAD:  $\geq 70\%$  obstruction in the left circumflex artery [LCx], left anterior descending artery [LAD], or right coronary artery [RCA];  $\geq 50\%$  obstruction in the left main coronary artery [LMCA]), Group 2 (moderate CAD:  $\geq 50\%$  obstruction

in the LCx, LAD, or RCA;  $\geq 30\%$  obstruction in the LMCA), and Group 3 (non-obstructive CAD:  $< 50\%$  obstruction in the LCx, LAD, or RCA;  $< 30\%$  obstruction in the LMCA).

The prevalence of CAD was analyzed according to sex (male or female), coronary dominance pattern (left or right), number of vessels affected by moderate or severe atheromatosis (zero, one, two, or multiple), and site of vessel obstruction (LMCA, LCx, LAD, RCA, posterior descending artery, or other coronary branches). After this classification, the potential associations between these variables and TIMI scores were assessed.

Categorical variables are presented as absolute and relative frequencies, while numerical variables are described using mean  $\pm$  standard deviation and/or median (1<sup>st</sup>–3<sup>rd</sup> quartiles). Numerical variables were subjected to the Shapiro-Wilk normality test, and for mean/median comparisons, the t-test or Mann-Whitney test was used. Associations between categorical variables were evaluated using the chi-square test or Fisher's exact test, and correlations between numerical variables were assessed using Pearson's or Spearman's correlation coefficients. A significance level of 5% was used, and data were analyzed using R software (v. 4.0.3).

## RESULTS

### SAMPLE CHARACTERIZATION AND GROUP ALLOCATION

A total of 289 participants were eligible, being 122 females (42%) and 167 males (58%). The median age of participants was 66 years, with the 1<sup>st</sup> quartile equal to 59 years and the 3<sup>rd</sup> quartile equal to 72 years. Additionally, 160 patients (55%) had a history of CAD, 216 patients (75%) had angina 24 hours prior to admission, and 207 patients (72%) had  $\geq 3$  risk factors for cardiovascular disease.

With respect to CAG, 253 participants (88%) showed right dominance, 92 participants (32%) had no vessel with  $\geq 50\%$  obstruction, whereas 80 participants (28%) had one vessel with  $\geq 50\%$  obstruction. Notably, 197 participants (68%) had at least one vessel with  $\geq 50\%$  obstruction. Among those with  $\geq 50\%$  obstruction in the CAG, 50 participants (17%) had obstruction in the LAD and 51 participants (18%) had simultaneous obstruction in the LAD, LCx, and RCA. Table 1 presents the sample characterization with simple frequencies and percentages for qualitative variables, along with the median and interquartile range for quantitative variables.

Based on the data, the sample was divided into groups based on the variables TIMI group and CAD group. Most patients (46%) were in the intermediate TIMI group. Regarding CAD, most (66%) were classified as severe (Graphic 1).

### ASSOCIATIONS WITH THE TIMI GROUP VARIABLE

In the analysis of quantitative variables (Table 2), significant differences in median age were observed across the TIMI groups ( $p < 0.001$ ). The high TIMI group had a median age of 70 years (interquartile range: 65–72), the intermediate TIMI group had a median age of 67 years (interquartile range: 59–74), and the low TIMI group had a median age of 63 years (interquartile range: 57–70).

**Table 1.** Sample characterization.

Characterization	N = 289 <sup>1</sup>
<b>Age</b>	66 (59, 72)
<b>Sex</b>	
Female	122 (42%)
Male	167 (58%)
<b>Age <math>\geq 65</math> years</b>	
No	132 (46%)
Yes	157 (54%)
<b>Risk factors <math>\geq 3</math></b>	
No	82 (28%)
Yes	207 (72%)
<b>History of CAD</b>	
No	160 (55%)
Yes	129 (45%)
<b>Elevated biomarkers</b>	
No	114 (39%)
Yes	175 (61%)
<b>Use of ASA</b>	
No	122 (42%)
Yes	167 (58%)
<b>Infra ST <math>\geq 0.5</math> mm</b>	
No	237 (82%)
Yes	52 (18%)
<b>Angina in the last 24 hours</b>	
No	73 (25%)
Yes	216 (75%)
<b>TIMI score</b>	
2	55 (18%)
3	68 (24%)
4	79 (27%)
5	54 (19%)
6	25 (8.7%)
7	8 (2.8%)
<b>TIMI Groups</b>	
Low (2–3 points)	122 (42%)
Intermediate (4–5 points)	134 (46%)
High (6–7 points)	33 (11%)
<b>Dominance</b>	
Balanced	20 (6.9%)
Right	253 (88%)
Left	16 (5.5%)

continue...

... continued Table 1

Characterization	N = 289 <sup>1</sup>
<b>CAD location</b>	
RCA	15 (5.2%)
LCx	8 (2.8%)
LCx, RCA	12 (4.2%)
LAD	50 (17%)
LAD, RCA	36 (12%)
LAD, LCx	19 (6.6%)
LAD, LCx, RCA	51 (18%)
Non-obstructive	61 (21%)
LMCA, LCx	1 (0.3%)
LMCA, LCx, RCA	2 (0.7%)
LMCA, LAD	5 (1.7%)
LMCA, LAD, RCA	6 (2.1%)
LMCA, LAD, LCx	7 (2.4%)
LMCA, LAD, LCx, RCA	16 (5.5%)
<b>Arterial vessels <math>\geq 50\%</math> (n)</b>	
0	92 (32%)
1	80 (28%)
2	64 (22%)
3	49 (17%)
4	4 (1.4%)
<b>CAD Groups</b>	
Severe	192 (66%)
Moderate	5 (1.7%)
Non-obstructive	92 (32%)

Data are presented as mean and standard deviation, median and interquartile range, or absolute number and percentage.

**Legend:** CAD = Coronary artery disease; ASA = Acetylsalicylic acid; RCA = Right coronary artery; LCx = Circumflex coronary artery; LAD = Anterior descending coronary artery; LMCA = Left main coronary artery.

<sup>1</sup>Median (Q1, Q3); n (%).

The presence of  $\geq 3$  risk factors was significantly more prevalent in the high-risk group (97%), followed by the intermediate (86%) and low (49%) groups ( $p < 0.001$ ). Similarly, a history of known CAD was more frequent in the high-risk group (88%) compared to 63% and 13% in the intermediate and low-risk groups, respectively ( $p < 0.001$ ).

Regarding elevated cardiac biomarkers, 97% of patients in the high-risk group presented this condition compared to 55% and 57% in the intermediate and low-risk groups, respectively ( $p < 0.001$ ). Furthermore, the use of ASA was universal in the high-risk group (100%), contrasting with the 75% and 28% in the intermediate and low-risk groups, respectively.

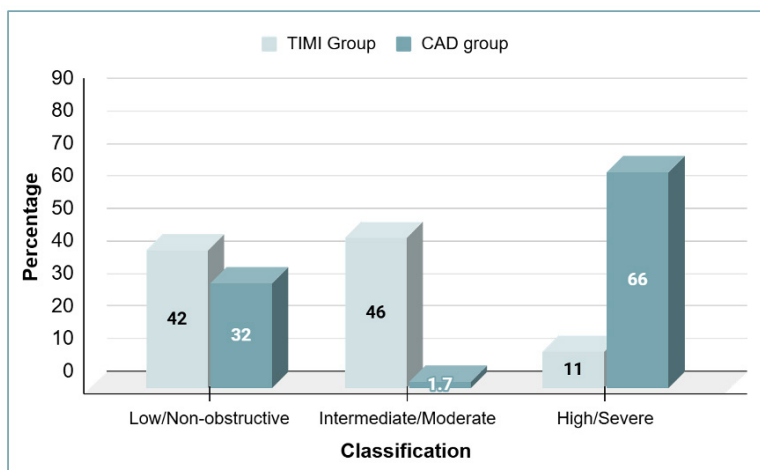
The presence of angina in the last 24 hours was also significantly more frequent in the high-risk group (97%) compared to 85% and 57% in the intermediate and low-risk groups, respectively ( $p < 0.001$ ).

Concerning the CAD group, 76% of patients in the high TIMI group were classified under the severe CAD group; 72% of participants in the intermediate TIMI group also fell within the severe CAD group. The distribution of the TIMI group within the CAD group is provided in Graph 1. Nevertheless, comparing the CAD group with the TIMI risk scores revealed no statistically significant association ( $p^2 = 0.058$ ).

**ASSOCIATIONS WITH THE CAD GROUP VARIABLE**

In the analysis of variables cross-referenced with the CAD group (Table 3), it was evident that obstruction in the LAD was significantly higher in the severe CAD group (86%) than the moderate CAD (80%) and non-obstructive groups (22%) ( $p < 0.001$ ).

Similarly, LCx obstruction was more frequent in the severe CAD group (56%), while it was observed in only 7.6% of non-obstructive CAD cases and 20% of moderate CAD cases ( $p < 0.001$ ). The RCA exhibited a similar pattern, with 65% of cases in the severe CAD group showing obstruction, contrasting only 12% in the non-obstructive CAD group and 40% in the moderate CAD group ( $p < 0.001$ ). The presence of lesions in the LMCA was 18% in the severe CAD group and 3.3% in the non-obstructive CAD group ( $p = 0.001$ ).



**Graphic 1.** Sample distribution (%) according to the groups.

Regarding vessels with  $\geq 50\%$  obstruction, we observed that all cases in the severe and moderate CAD groups presented significant obstruction (100%), while the non-obstructive CAD group, by definition, did not have cases with significant obstruction ( $p < 0.001$ ).

In relation to the TIMI group, as described in section 4.2, when comparing the CAD group with the TIMI risk score, no statistically significant association was observed ( $p^2 = 0.058$ ). However, 75% of patients classified with a high TIMI score had severe injuries in the CAG (Graph 2).

**Table 2.** Associations with the TIMI Group.

Characterization	TIMI Groups				Value $p^2$
	Total N N = 289 <sup>1</sup>	Low N = 122 <sup>1</sup>	Intermediate N = 134 <sup>1</sup>	High N = 33 <sup>1</sup>	
<b>Age</b>	66 (59, 72)	63 (57, 70)	67 (59, 74)	70 (65, 72)	<b>&lt;0.001</b>
<b>Sex</b>					0.8
Female	122 (42%)	54 (44%)	54 (40%)	14 (42%)	
Male	167 (58%)	68 (56%)	80 (60%)	19 (58%)	
<b>Age <math>\geq 65</math> years</b>					<b>&lt;0.001</b>
No	132 (46%)	72 (59%)	55 (41%)	5 (15%)	
Yes	157 (54%)	50 (41%)	79 (59%)	28 (85%)	
<b>Risk factors <math>\geq 3</math></b>					<b>&lt;0.001</b>
No	82 (28%)	62 (51%)	19 (14%)	1 (3.0%)	
Yes	207 (72%)	60 (49%)	115 (86%)	32 (97%)	
<b>History of CAD</b>					<b>&lt;0.001</b>
No	160 (55%)	106 (87%)	50 (37%)	4 (12%)	
Yes	129 (45%)	16 (13%)	84 (63%)	29 (88%)	
<b>Elevated biomarkers</b>					<b>&lt;0.001</b>
No	114 (39%)	53 (43%)	60 (45%)	1 (3.0%)	
Yes	175 (61%)	69 (57%)	74 (55%)	32 (97%)	
<b>Use of ASA</b>					<b>&lt;0.001</b>
No	122 (42%)	88 (72%)	34 (25%)	0 (0%)	
Yes	167 (58%)	34 (28%)	100 (75%)	33 (100%)	
<b>Infra ST <math>\geq 0.5</math> mm</b>					<b>&lt;0.001</b>
No	237 (82%)	112 (92%)	112 (84%)	13 (39%)	
Yes	52 (18%)	10 (8.2%)	22 (16%)	20 (61%)	
<b>Angina in the last 24 hours</b>					<b>&lt;0.001</b>
No	73 (25%)	52 (43%)	20 (15%)	1 (3.0%)	
Yes	216 (75%)	70 (57%)	114 (85%)	32 (97%)	
<b>Score</b>					
1	3 (1.0%)	3 (2.5%)	0 (0%)	0 (0%)	
2	52 (18%)	52 (43%)	0 (0%)	0 (0%)	
3	68 (24%)	66 (54%)	2 (1.5%)	0 (0%)	
4	79 (27%)	1 (0.8%)	78 (58%)	0 (0%)	
5	54 (19%)	0 (0%)	54 (40%)	0 (0%)	
6	25 (8.7%)	0 (0%)	0 (0%)	25 (76%)	
7	8 (2.8%)	0 (0%)	0 (0%)	8 (24%)	
<b>Dominance</b>					0.2
Balanced	20 (6.9%)	10 (8.2%)	10 (7.5%)	0 (0%)	
Right	253 (88%)	108 (89%)	113 (84%)	32 (97%)	
Left	16 (5.5%)	4 (3.3%)	11 (8.2%)	1 (3.0%)	

continue...

... continued Table 2

Characterization	TIMI Groups				Value $p^2$
	Total N N = 289 <sup>1</sup>	Low N = 122 <sup>1</sup>	Intermediate N = 134 <sup>1</sup>	High N = 33 <sup>1</sup>	
<b>CAD location</b>					
RCA	15 (5.2%)	6 (4.9%)	7 (5.2%)	2 (6.1%)	
LCx	8 (2.8%)	1 (0.8%)	6 (4.5%)	1 (3.0%)	
LCx, RCA	12 (4.2%)	5 (4.1%)	4 (3.0%)	3 (9.1%)	
LAD	50 (17%)	25 (20%)	23 (17%)	2 (6.1%)	
LAD, RCA	36 (12%)	14 (11%)	18 (13%)	4 (12%)	
LAD, LCx	19 (6.6%)	4 (3.3%)	10 (7.5%)	5 (15%)	
LAD, LCx, RCA	51 (18%)	20 (16%)	23 (17%)	8 (24%)	
Non-obstructive	61 (21%)	36 (30%)	21 (16%)	4 (12%)	
LMCA, LCx	1 (0.3%)	0 (0%)	1 (0.7%)	0 (0%)	
LMCA, LCx, RCA	2 (0.7%)	1 (0.8%)	0 (0%)	1 (3.0%)	
LMCA, LAD	5 (1.7%)	1 (0.8%)	4 (3.0%)	0 (0%)	
LMCA, LAD, RCA	6 (2.1%)	2 (1.6%)	3 (2.2%)	1 (3.0%)	
LMCA, LAD, LCx	7 (2.4%)	1 (0.8%)	6 (4.5%)	0 (0%)	
LMCA, LAD, LCx, RCA	16 (5.5%)	6 (4.9%)	8 (6.0%)	2 (6.1%)	
<b>LAD</b>					0.2
No	99 (34%)	49 (40%)	39 (29%)	11 (33%)	
Yes	190 (66%)	73 (60%)	95 (71%)	22 (67%)	
<b>LCx</b>					0.005
No	173 (60%)	84 (69%)	76 (57%)	13 (39%)	
Yes	116 (40%)	38 (31%)	58 (43%)	20 (61%)	
<b>RCA</b>					0.14
No	151 (52%)	68 (56%)	71 (53%)	12 (36%)	
Yes	138 (48%)	54 (44%)	63 (47%)	21 (64%)	
<b>LMCA</b>					0.2
No	252 (87%)	111 (91%)	112 (84%)	29 (88%)	
Yes	37 (13%)	11 (9.0%)	22 (16%)	4 (12%)	
<b>Arterial vessels <math>\geq 50\%</math> (n)</b>					
0	92 (32%)	50 (41%)	34 (25%)	8 (24%)	
1	80 (28%)	32 (26%)	44 (33%)	4 (12%)	
2	64 (22%)	21 (17%)	31 (23%)	12 (36%)	
3	49 (17%)	18 (15%)	23 (17%)	8 (24%)	
4	4 (1.4%)	1 (0.8%)	2 (1.5%)	1 (3.0%)	
<b>Arterial vessels <math>\geq 50\%</math> (n)</b>					
No	92 (32%)	50 (41%)	34 (25%)	8 (24%)	0.017
Yes	197 (68%)	72 (59%)	100 (75%)	25 (76%)	
<b>CAD Groups</b>					
Severe	192 (66%)	70 (57%)	97 (72%)	25 (76%)	0.058
Moderate	5 (1.7%)	2 (1.6%)	3 (2.2%)	0 (0%)	
Non-obstructive	92 (32%)	50 (41%)	34 (25%)	8 (24%)	

Data are presented as mean and standard deviation, median and interquartile range, or absolute number and percentage.

**Legend:** CAD = Coronary artery disease; ASA = Acetylsalicylic acid; RCA = Right coronary artery; LCx = Circumflex coronary artery; LAD = Anterior descending coronary artery; LMCA = Left main coronary artery.

<sup>1</sup>Median (Q1, Q3); n (%)

<sup>2</sup>Kruskal-Wallis test; Chi-square test; Fisher's exact test.

**Table 3.** Associations with the CAD group.

Characterization	CAD GROUPS				Value $p^2$
	Overall N = 289 <sup>1</sup>	Severe N = 192 <sup>1</sup>	Moderate N = 5 <sup>1</sup>	Non-obstructive N = 92 <sup>1</sup>	
<b>Age</b>	66 (59, 72)	67 (60, 73)	66 (65, 75)	63 (57, 71)	0.12
<b>Sex</b>					0.8
Female	122 (42%)	78 (41%)	2 (40%)	42 (46%)	
Male	167 (58%)	114 (59%)	3 (60%)	50 (54%)	
<b>Age ≥65 years</b>					0.081
No	132 (46%)	81 (42%)	1 (20%)	50 (54%)	
Yes	157 (54%)	111 (58%)	4 (80%)	42 (46%)	
<b>Risk factors ≥3</b>					0.2
No	82 (28%)	55 (29%)	3 (60%)	24 (26%)	
Yes	207 (72%)	137 (71%)	2 (40%)	68 (74%)	
<b>History of CAD</b>					0.060
No	160 (55%)	97 (51%)	3 (60%)	60 (65%)	
Yes	129 (45%)	95 (49%)	2 (40%)	32 (35%)	
<b>Elevated biomarkers</b>					0.2
No	114 (39%)	69 (36%)	2 (40%)	43 (47%)	
Yes	175 (61%)	123 (64%)	3 (60%)	49 (53%)	
<b>Use of ASA</b>					0.3
No	122 (42%)	75 (39%)	2 (40%)	45 (49%)	
Yes	167 (58%)	117 (61%)	3 (60%)	47 (51%)	
<b>Infra ST ≥0.5 mm</b>					0.13
No	237 (82%)	152 (79%)	4 (80%)	81 (88%)	
Yes	52 (18%)	40 (21%)	1 (20%)	11 (12%)	
<b>Angina in the last 24 hours</b>					0.8
No	73 (25%)	46 (24%)	1 (20%)	26 (28%)	
Yes	216 (75%)	146 (76%)	4 (80%)	66 (72%)	
<b>Score</b>					
1	3 (1.0%)	0 (0%)	0 (0%)	3 (3.3%)	
2	52 (18%)	25 (13%)	2 (40%)	25 (27%)	
3	68 (24%)	45 (23%)	0 (0%)	23 (25%)	
4	79 (27%)	58 (30%)	0 (0%)	21 (23%)	
5	54 (19%)	39 (20%)	3 (60%)	12 (13%)	
6	25 (8.7%)	18 (9.4%)	0 (0%)	7 (7.6%)	
7	8 (2.8%)	7 (3.6%)	0 (0%)	1 (1.1%)	
<b>TIMI Groups</b>					0.058
Low	122 (42%)	70 (36%)	2 (40%)	50 (54%)	
Intermediate	134 (46%)	97 (51%)	3 (60%)	34 (37%)	
High	33 (11%)	25 (13%)	0 (0%)	8 (8.7%)	
<b>Dominance</b>					0.2
Balanced	20 (6.9%)	9 (4.7%)	1 (20%)	10 (11%)	
Right	253 (88%)	172 (90%)	4 (80%)	77 (84%)	
Left	16 (5.5%)	11 (5.7%)	0 (0%)	5 (5.4%)	

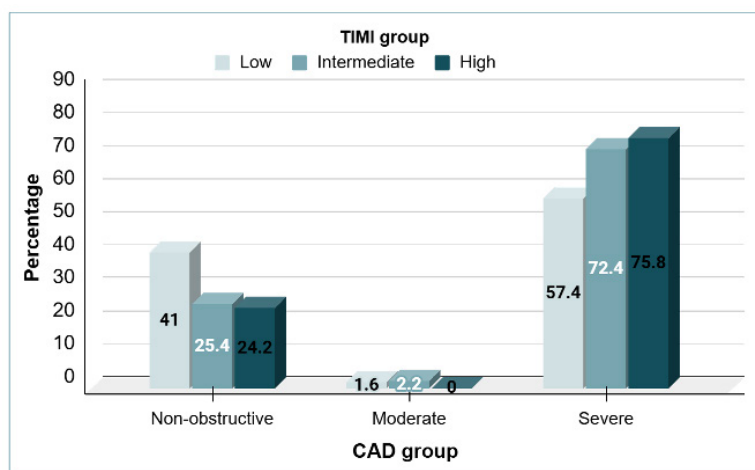
continue...

... continued Table 3

Characterization	CAD GROUPS				Value $p^2$
	Overall N = 289 <sup>1</sup>	Severe N = 192 <sup>1</sup>	Moderate N = 5 <sup>1</sup>	Non-obstructive N = 92 <sup>1</sup>	
<b>CAD Location</b>					
RCA	15 (5.2%)	7 (3.6%)	0 (0%)	8 (8.7%)	
LCx	8 (2.8%)	6 (3.1%)	0 (0%)	2 (2.2%)	
LCx, RCA	12 (4.2%)	11 (5.7%)	1 (20%)	0 (0%)	
LAD	50 (17%)	35 (18%)	3 (60%)	12 (13%)	
LAD, RCA	36 (12%)	33 (17%)	1 (20%)	2 (2.2%)	
LAD, LCx	19 (6.6%)	16 (8.3%)	0 (0%)	3 (3.3%)	
LAD, LCx, RCA	51 (18%)	50 (26%)	0 (0%)	1 (1.1%)	
Non-obstructive	61 (21%)	0 (0%)	0 (0%)	61 (66%)	
LMCA, LCx	1 (0.3%)	0 (0%)	0 (0%)	1 (1.1%)	
LMCA, LCx, RCA	2 (0.7%)	2 (1.0%)	0 (0%)	0 (0%)	
LMCA, LAD	5 (1.7%)	3 (1.6%)	0 (0%)	2 (2.2%)	
LMCA, LAD, RCA	6 (2.1%)	6 (3.1%)	0 (0%)	0 (0%)	
LMCA, LAD, CX	7 (2.4%)	7 (3.6%)	0 (0%)	0 (0%)	
LMCA, LAD, LCx, RCA	16 (5.5%)	16 (8.3%)	0 (0%)	0 (0%)	
<b>LAD</b>					<b>&lt;0.001</b>
No	99 (34%)	26 (14%)	1 (20%)	72 (78%)	
Yes	190 (66%)	166 (86%)	4 (80%)	20 (22%)	
<b>LCx</b>					<b>&lt;0.001</b>
No	173 (60%)	84 (44%)	4 (80%)	85 (92%)	
Yes	116 (40%)	108 (56%)	1 (20%)	7 (7.6%)	
<b>RCA</b>					<b>&lt;0.001</b>
No	151 (52%)	67 (35%)	3 (60%)	81 (88%)	
Yes	138 (48%)	125 (65%)	2 (40%)	11 (12%)	
<b>LMCA</b>					<b>0.001</b>
No	252 (87%)	158 (82%)	5 (100%)	89 (97%)	
Yes	37 (13%)	34 (18%)	0 (0%)	3 (3.3%)	
<b>Vessels <math>\geq 50\%</math> (n)</b>					
0	92 (32%)	0 (0%)	0 (0%)	92 (100%)	
1	80 (28%)	75 (39%)	5 (100%)	0 (0%)	
2	64 (22%)	64 (33%)	0 (0%)	0 (0%)	
3	49 (17%)	49 (26%)	0 (0%)	0 (0%)	
4	4 (1.4%)	4 (2.1%)	0 (0%)	0 (0%)	
<b>Obstructed vessels <math>\geq 50\%</math></b>					<b>&lt;0.001</b>
No	92 (32%)	0 (0%)	0 (0%)	92 (100%)	
Yes	197 (68%)	192 (100%)	5 (100%)	0 (0%)	

Data are presented as mean and standard deviation, median and interquartile range, or absolute number and percentage.

**Legend:** CAD = Coronary artery disease; ASA = Acetylsalicylic acid; RCA = Right coronary artery; LCx = Circumflex coronary artery; LAD = Anterior descending coronary artery; LMCA = Left main coronary artery.<sup>1</sup>Median (Q1, Q3); n (%).<sup>2</sup>Kruskal-Wallis test; Fisher's exact test.



**Graphic 2.** Percentage distribution of TIMI group within the CAD group.

## DISCUSSION

Choosing an ideal risk predictor score for cases of NSTEMI-ACS is a complex task involving multiple variables. Using it to infer the severity of possible coronary obstructions presents an even greater challenge, as evidenced by the lack of similar studies establishing a relationship between clinical and anatomical findings, despite the associations observed.

In this study, among the 289 participants, 68% had at least one artery with  $\geq 50\%$  obstruction on CAG. These data can be related to the TIMI Groups, with 75% and 76% of participants in the intermediate and high TIMI groups, respectively, having at least one artery with  $\geq 50\%$  obstruction ( $p^2=0.017$ ). Among arteries with  $>50\%$  obstruction, the LAD is notably affected in approximately 17% of participants. This observation aligns with a comparative study of 200 patients admitted for acute coronary syndrome, which found that, regardless of the TIMI score group, the LAD had the highest incidence of CAD, showing damage in 66.9% and 79.3% in TIMI  $\leq 4$  and TIMI  $>4$  groups, respectively<sup>7</sup>.

The TIMI group variable presented a statistically significant association with the seven variables that comprise the TIMI risk score, including age  $\geq 65$  years, risk factors  $\geq 3$ , history of CAD, elevated biomarkers, use of ASA, infra ST, and angina in the last 24 hours, which was an expected result<sup>8</sup>. Hence, as the TIMI risk score increases, participants tend to be older, with the high-risk group having the oldest participants. Furthermore, a higher accumulation of risk factors and history of CAD are strongly associated with higher TIMI risk scores.

For instance, the universal use of ASA in the high-risk TIMI group reinforces its importance in risk stratification. Additionally, most of this group experienced angina in the last 24 hours. These data further highlight the importance of clinical and demographic variables in TIMI risk classification and thus therapeutic decision-making.

However, no statistically significant association was observed concerning the CAD Group ( $p^2 < 0.058$ ). Despite this, over 75% of patients with a high TIMI score had serious

injuries in the CAG (Graph 2). This result was not expected, as a retrospective cross-sectional study of 688 patients found multivessel CAD more prevalent in patients with TIMI scores of 5–7 compared to scores of 3–4 ( $p < 0.001$ , odds ratio = 6.34, 95% confidence interval = 3.88–10.36), indicating a significant relationship between CAD severity on CAG and TIMI scores<sup>9</sup>.

An observational study of 188 patients diagnosed with NSTEMI-ACS demonstrated an association between the TIMI risk score and high-risk angiographic findings in NSTEMI-ACS. It revealed that patients with TIMI risk scores of 5–7 were more likely to have severe stenosis (81%) and multivessel disease (80%), with  $p < 0.001$  compared to those with scores of 0–2<sup>8</sup>. Additionally, another study showed that CAD severity increases as TIMI risk scores increase ( $p < 0.0017$ )<sup>10</sup>.

In this study, the intermediate-to-high TIMI score was mostly associated with severe coronary lesions. The relationship between the TIMI group and the presence of  $>50\%$  coronary obstruction, or at least moderate lesions, is notable. An intermediate TIMI score was associated with at least 50% obstruction on the CAG in 75% of patients ( $p^2=0.017$ ). Additionally, 76% of those with a high TIMI score had at least moderate coronary lesions. Another statistically significant relationship was found with the LCx, as 69% of patients with a low TIMI score had no lesion in this vessel ( $p^2=0.005$ ).

This is corroborated by a cross-sectional study involving 406 patients, in which a TIMI score  $>4$  was significantly more associated with trivascular disease or LMCA, while a score of  $\leq 4$  was more associated with non-obstructive CAD ( $p < 0.01$ )<sup>11</sup>. Nonetheless, multicenter studies with larger samples are needed to more accurately verify the interactions and potentially establish a more reliable prediction model for coronary obstruction based on the TIMI score.

Among affected vessels, the strong association between LAD obstruction and CAD severity is essential, as it affected 86% of patients with severe CAD ( $p < 0.001$ ). Similar results were observed with the LMCA, significantly more affected in severe CAD patients than in those with non-obstructive CAD ( $p=0.001$ ). This emphasizes assessing the LMCA in

determining CAD severity, given the impact of its obstruction. Lastly, our findings suggest that the extent of disease in the main coronary arteries strongly correlates with CAD severity.

The main limitation of this study is that data were mostly collected from medical records in a single hospital, which may have limited the number of participants and possibly impacted the results.

## CONCLUSION

Our findings demonstrated a significant relationship between the TIMI group and the presence of coronary arteries with >50% obstruction. This has a crucial clinical impact, as an intermediate TIMI score allows for inferring that the patient will benefit from a coronary evaluation and, possibly, treatment of the culprit lesion.

## AUTHOR'S CONTRIBUTIONS

We describe contributions to the papers using the taxonomy (CRediT) provided above:

*Conceptualization, Investigation, Methodology, Visualization & Writing—review & editing:* BB de Andrade; LAC Ribeiro; AT Torres da Silva; ACA de Azevedo. *Project administration, Supervision & Writing—original draft:* BB de Andrade; LAC Ribeiro; AT da Silva; ACA de Azevedo; *Validation & Software:* BB de Andrade; LAC Ribeiro; AT da Silva; ACA de Azevedo. *Resources & Funding acquisition:* BB de Andrade; LAC Ribeiro; AT da Silva; ACA de Azevedo. *Data curation & Formal Analysis:* BB de Andrade; LAC Ribeiro; AT da Silva; ACA de Azevedo.

## COPYRIGHT

Copyright© 2024 Andrade et al. This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original article is properly cited.

## REFERENCES

1. Abbas S, Siddiqui AH, Cheema A, Abbas A, Jaffri SKA, Khan S, et al. Association of Thrombolysis in Myocardial Infarction (TIMI) Risk Score With Extent of Coronary Artery Disease in Patients With Unstable Angina and NSTEMI. *Pak Armed Forces Med J* [Internet]. 2021 Jan 5; [cited 2024 Sep 11]; 70(Suppl 4):S787-91. Available from: <https://www.pafmj.org/index.php/PAFMJ/article/view/6025>.
2. Roy SS, Abu Azam STM, Khalequzzaman M, Ullah M, Rahman MA. GRACE and TIMI risk scores in predicting the angiographic severity of non-ST elevation acute coronary syndrome. *Indian Heart J* [Internet]. 2018 Dec 1; [cited 2024 Sep 11]; 70(Suppl 3):S250–3. Available from: <https://www.sciencedirect.com/science/article/pii/S0019483217305862?via%3Dihub>.
3. Khandelwal G, Jain A, Rathore M. Prediction of Angiographic Extent of Coronary Artery Disease on the Basis of Clinical Risk Scores in Patients of Unstable Angina. *J Clin Diagn Res* [Internet]. 2015; [cited 2024 Sep 11]; 9(11):OC13-6. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4668449/>.
4. Vrints C, Andreotti F, Koskinas KC, Rossello X, Adamo M, Ainslie J, et al. 2024 ESC Guidelines for the management of chronic coronary syndromes. *Eur Heart J* [Internet]. 2024; [cited 2025 Sep 17]; 45(36):3415–537. Available from: <https://pubmed.ncbi.nlm.nih.gov/39210710/>.
5. Kočka V. The coronary angiography - An old-timer in great shape. *Cor et Vasa* [Internet]. 2015 Dec 1; [cited 2024 Sep 11]; 57(6):e419–24. Available from: <https://www.sciencedirect.com/science/article/pii/S0010865015001009>.
6. Moscarella E, Gragnano F, Cesaro A, Ielasi A, Diana V, Conte M, et al. Coronary Physiology Assessment for the Diagnosis and Treatment of Coronary Artery Disease. *Cardiol Clin* [Internet]. 2020 Nov; [cited 2024 Sep 11]; 38(4):575–88. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S073386512030059X?via%3Dihub>.
7. Lakhani MS, Qadir F, Hanif B, Farooq S, Khan M. Correlation of thrombolysis in myocardial infarction (TIMI) risk score with extent of coronary artery disease in patients with acute coronary syndrome. *JPMA J Pak Med Assoc* [Internet]. 2015; [cited 2024 Sep 11]; 60(3). Available from: <https://pubmed.ncbi.nlm.nih.gov/20225777/>.
8. Cedro AV, Mota DM, Ohe LN, Timerman A, Costa JT, Castro L de S. Associação entre Escores de Risco Clínico (HEART, GRACE e TIMI) e Complexidade Angiográfica na Síndrome Coronária Aguda sem Elevação do Segmento ST. *Arq Bras Cardiol* [Internet]. 2021 Aug; [cited 2024 Sep 11]; 117(2):281–7. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8395810/>.
9. Garcia S, Canoniero M, Peter A, Marchena E de, Ferreira A. Correlation of TIMI risk score with angiographic severity and extent of coronary artery disease in patients with non-ST-elevation acute coronary syndromes. *Am J Cardiol* [Internet]. 2004 Apr 1; [cited 2024 Sep 11]; 93(7):813–6. Available from: [https://www.ajconline.org/article/S0002-9149\(03\)01743-0/fulltext](https://www.ajconline.org/article/S0002-9149(03)01743-0/fulltext).
10. Salem HB, Ouali S, Hammam S, Bougmiza I, Gribaa R, Ghannem K, et al. Corrélation du score TIMI avec l'étendue et la sévérité de l'atteinte coronaire dans les syndromes coronariens aigus sans sus-décalage de ST. *Ann Cardiol Angéiol* [Internet]. 2011 Apr 1; [cited 2024 Sep 11]; 60(2):87–91. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0003392810001873?via%3Dihub>.
11. Mahmood M, Achakzai AS, Akhtar P, Zaman KS. Comparison of the TIMI and the GRACE risk scores with the extent of coronary artery disease in patients with non-ST-elevation acute coronary syndrome. *J Pak Med Assoc* [Internet]. 2013; [cited 2024 Sep 11]; 63(6):691-5. Available from: <https://pubmed.ncbi.nlm.nih.gov/23901666/>.



This is an open access article distributed under the terms of the Creative Commons Attribution License.