

# Diagnosis and risk stratification of coronary artery disease in Yemeni patients using treadmill test

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## ABSTRACT

**Background:** Coronary artery disease (CAD) is a common medical problem that remains a great cause of morbidity and mortality. Based on clinical manifestation, CAD span from chronic stable angina to acute coronary syndrome (ACS), which encompasses (1) unstable angina (UA), (2) non-ST-elevation myocardial infarction (NSTEMI), and (3) ST-elevation myocardial infarction (STEMI). **Objective:** This study was conducted to describe the risk stratification and prognosis of CAD in Yemeni patients undergoing an exercise stress test. **Method:** A retrospective descriptive study involved the records of 302 patients who undergoing exercise stress testing by the Bruce protocol of Treadmill (TMT). **Results:** Out of 302 patients, the mean age was 43.29 years, (range, 22–70 years), and 79.80% were males. The majority of patients (86.75%) were normal. Most of the affected patients (82.50%) were males. All of the affected peoples were more than 30 years old with predominance in more than 50 years old. Results showed that 45% of the positive (+ve) patients were in high-risk group, and 55% were in intermediate and low-risk groups. **Conclusions:** CAD affects males more than females. It affects patients older than 30 years and predominates in elderly patients. Most of the affected patients were in the high, intermediate, and low-risk groups and rarely were in the very high-risk group.

**Keywords:** Coronary artery disease, risk groups, risk stratification, treadmill test, Yemeni patients

## Introduction

Coronary artery disease (CAD) is a common medical problem that remains a great cause of morbidity and mortality around the world.<sup>[1]</sup> Depending on the clinical manifestation, CAD span from chronic stable angina to acute coronary syndrome (ACS), which encompasses (1) unstable angina (UA), (2) non-ST-elevation myocardial infarction (NSTEMI), and (3) ST-elevation

myocardial infarction (STEMI).<sup>[1-2]</sup> Latent risk factors of CAD were identified in 4 classes including: 1) Smoking-drinking, (2) High-risk for dyslipidemia, (3) High-risk for diabetes and malnutrition, and (4) High-risk for metabolic syndrome.<sup>[3]</sup>

The systemic coronary risk estimation (SCORE) system classifies people into 4 categories as the following: (1) Low-risk person (SCORE <1%) should be advised to maintain their low-risk status; (2) Moderate-risk person (SCORE 1 to ≤5) should be advised to maintain their moderate risk; (3) High-risk person (SCORE ≥5 and <10) include subjects with (a) markedly high single risk factor, in particular cholesterol >310 mg/dl, or blood pressure (BP) ≥180/110 mmHg, (b) people with

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diabetes mellitus (DM), (c) patients with marked chronic kidney disease (CKD). High-risk persons should be qualifying for an intensive lifestyle; (4) Very-high-risk persons (SCORE  $\geq 10$ ) include a) documented with cardiovascular disease (CVD) include acute myocardial infarction (AMI), ACS, revascularization procedure of coronary or other arteries, stroke and transient ischemic attacks (TIAs), aortic aneurysm, and peripheral artery disease (PAD), (b) DM with organ damage, and (c) severe CKD. In very-high-risk persons, treatment with drugs is required.<sup>[4]</sup>

The cardiac stress test or treadmill stress test (TMT) is used to detect abnormal cardiac arrhythmias during exercise to diagnose the presence or absence of ischemic heart disease (IHD).<sup>[5]</sup> TMT often forms a part of individual health checks in asymptomatic people to detect early CAD. It has nearly 68% and 77% sensitivity and specificity. respectively.<sup>[6]</sup>

In patients with no obstructive CAD, an exercise testing test (ETT) is insufficient to identify occult coronary abnormalities. A normal TMT does not exclude a non-obstructive cause of angina.<sup>[7]</sup>

Recently, cardiac imaging modalities have higher sensitivities to diagnose and exclude CAD than exercise stress testing. Now, coronary computed tomography angiography (CCTA) is an important imaging modality to exclude CAD with excellent negative predictive value (NPV). The hybrid approach by positron-emission tomography/computed-tomography (PET/CT) provides the highest accuracy in diagnosis and prognosis evaluation of CAD.<sup>[8]</sup>

This study intended, first, to describe the risk stratification and prognosis of CAD in Yemeni patients undergoing exercise stress testing using the TMT, which is the most available test in many developing countries like Yemen. Second, to describe gender and age groups' dominance and differences in results of the exercise test, tertiary, to review detailed changes in positive test results, and finally, to review detailed evidence of myocardial ischemia in positive tests. This was the first study to cover this topic in Yemen.

## Patients and Methods

### Patients selection

This cross-sectional, retrospective study was conducted at the cardiac center in Al-Thawra Modern General Hospital (TMGH), Sana'a city in Yemen. The data of 302 patients who underwent TMT from Jan 1 to Dec 31, 2009, were retrieved from the records of the patients.

### TMT procedure

Each patient with suspected CAD was undergoing exercise stress testing by the Bruce protocol of Treadmill, which is a standard test in cardiology. The treadmill ECG stress testing is a diagnostic test using exercise with electrocardiogram (ECG), heart rate, and BP monitoring. It used to determine the patient's functional capacity of the heart, risk, probability, and extent of CAD, effect and prognosis of treatment. The Bruce protocol consists of 7

stages with a gradual increase in the speed of the patient and the gradient of the treadmill. Each stage lasts for 3 minutes to allow the patient to acclimatize to a specific speed and gradient then advancing to the next stage. During the TMT, the intensity of the exercise is calculated in metabolic equivalents (METs), which reflects the amount of oxygen (O<sub>2</sub>) consumption per minute (1 MET = 3.5 ml/min/kg of O<sub>2</sub> used). Prior to starting TMT, ECG may be performed in standing position with hyperventilation to assess for any changes in ST-segment. Continuous ECG monitoring continues throughout the test and also throughout the recovery period to detect any changes in ST-segment and any arrhythmias. The TMT should stop before completing stage 7 if the patient gets the target heart rate (HR) or positive (+ve) test.<sup>[9,10]</sup>

### Variables assessed

The records of the patients were reviewed and the following parameters were collected.

Demographic data including gender and age, exercise test parameters (including: (a) stage reached (1, 2, 3, or 4), (b) exercise duration in minutes (<6, 6-9, and >9)), peak metabolic equivalents (METs) (<5, 5-10, >10), percent of maximum achieved heart rate >85% (yes, no), exercise test results (positive, negative, or equivocal), evidence of myocardial ischemia (angina chest pain, ST-depression, or both), and prognostic score using Duke TMT score (<5, and >5).

### Statistical analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS). Continuous variables were written as means  $\pm$  standard deviations. Descriptive statistics were expressed as frequencies and percentages.

## Results

In total, this study involved 302 patients who underwent TMT. The mean age at study was 43.29 years, (range, 22-70); 79.80% were men and 20.19% were women. The majority of patients (86.75%) were normal. Sociodemographic data and results of the patients involved in this study [Table 1]. The results showed that most of the affected peoples (82.50%) were males. All of the affected peoples were more than 30 years old and predominantly in more than 50 years old. The results showed that 45% of the +ve patients were at high risk, 47.5% were in intermediate-risk, and 7.5% in low-risk group [Table 2, Figure 1].

## Discussion

CAD is a widespread disease that remains a great medical problem. In this study, we focused on risk stratification of CAD in the Yemeni population who underwent exercise testing test (ETT) using TMT under ECG, BP, and HR monitoring. Bots *et al.*, reported that the mortality rate from coronary heart disease is more in men than in women in adulthood but it becomes nearly similar in old age.<sup>[11]</sup> In our results, males were the most affected patients

**Table 1: Sociodemographic data and test results of all the patients involved in this study**

Variable	Category	No. of patients	Percentage
Gender	Male	241	79.80%
	Female	61	20.19%
	Total	302	100.00%
Age	Less than 30 years	21	6.95%
	30-50 years	176	58.27%
	More than 50 years	105	34.76%
	Total	302	100.00%
Duke TMT score	< 5	37	12.25%
	≥5	265	87.75%
	Total	302	100.00%
Test results	Positive	40	13.25%
	Negative	262	86.75%
	Total	302	100.00%

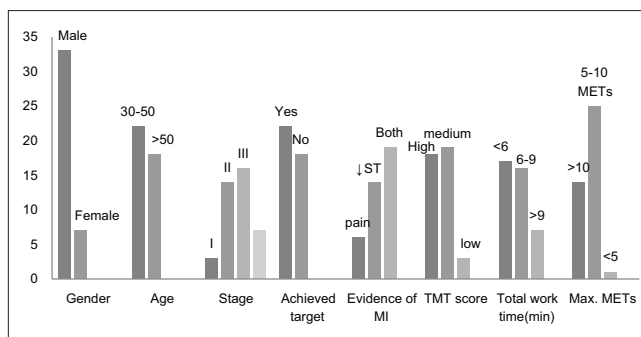
TMT: Treadmill test

**Table 2: Sociodemographic data and test results of the patients with positive (+ve) results after test**

Variable	Category	No. of patients	Percentage
Gender of the +ve patients	Male	33	82.50%
	Female	7	17.50%
	Total	40	100.00%
Age of the +ve patients	<30 years	0	00.00%
	30 - 50 years	18	45.00%
	>50 years	22	55.00%
	Total	40	100.00%
Stage reached by the +ve patients	Stage-1	3	7.50%
	Stage-2	14	35.00%
	Stage-3	16	40.00%
	Stage ≥ 4	7	17.50%
	Total	40	100.00%
Total work time (minutes) in the +ve patients	< 6 minutes	17	42.50%
	6-9 minutes	16	40.00%
	>9 minutes	7	17.50%
	Total	40	100.00%
Maximum reached METs in the +ve patients	<5 METs	1	2.50%
	5-10 METs	25	62.50%
	> 10 METs	14	35.00%
Total	40	100.00%	
Achieved target heart rate > 85% of max. age-predicted	Yes	22	55.00%
	No	18	45.00%
	Total	40	100.00%
Evidence of myocardial ischemia in the +ve patients	Chest pain (Angina)	6	14.30%
	ECG: ST-depression	14	35.00%
	Both	19	49.70%
	Total	40	100.00%
Treadmill score group in the +ve patients	High risk	18	45.00%
	Intermediate	19	47.50%
	Low	3	7.50%
	Total	40	100.00%

METs: Metabolic equivalents; ECG: Electrocardiogram; +ve: Positive

by CAD but the patients in high-risk and intermediate-risk groups were equal in both sexes. This is consistent with the results of Bots *et al.* Our results are consistent with Regitz-Zagrosek *et al.*, who reported that IHD develops in females at a later age in comparison



**Figure 1:** Diagram shows the gender of the positive (+ve) patients, age groups, the stage reached, achieved target heart rate >85%, evidence of MI, and TMT score, Total work time (minutes) and maximum METs reached by the +ve patients. MI: Myocardial infarction; TMT: Treadmill test; MET: metabolic equivalent (1 MET ≈ 3.5 ml of oxygen consumption/min/kg)

to males and females take longer than males to obtain medical care in the setting of ACS.<sup>[12]</sup> The “national health and nutrition examination survey” (NHANES) reported a greater prevalence of CAD in males compared with females in age older than 80 years.<sup>[13]</sup> The results in this study reported that the +ve patients were more than 30 years old and predominate after 50 years old. This result is compatible with the results of Madhavan *et al.*, who reported that the prevalence of symptomatic CAD increases monotonically with increasing age.<sup>[13]</sup> In this study, ST-depression either alone or associated with angina was the predominant indicator of the presence of CAD. This result is consistent with the results of Lim *et al.*<sup>[10]</sup> In this study, most of the patients reached 5-10 or >10 METs, this indicates that the very high-risk patients were few. Most of the patients were intermediate or high risk and only one patient (2.5%) could not reach 5 METs. Garner *et al.* reported that achievement of >10 METs on TMT means a low risk of death. Patients with TMT score >7 METs have 93% 5-year survival rate compared with those <7 METs. Decrease TMT capacity is associated with an increased risk of unstable angina (UA) and MI.<sup>[14]</sup> Kwon *et al.*, reported that maximum METs in exercise myocardial perfusion imaging is a better predictor of life survival.<sup>[15]</sup>

### Limitations of this study

This study was limited by its retrospective nature with no available further diagnostic reference to evaluate the diagnostic accuracy of the TMT and it was a single-center study with a low sample size.

### Conclusions

CAD affects males more than females. It affects patients older than 30 years and predominates in elderly patients. TMT is an effective screening test for IHD and must be a part of individual health checks in asymptomatic people to detect early IHD.

### Ethical approval

Institutional Ethical approval was received for this study. Confidentiality of the patient’s information was assured during data collection and all steps of this study ethics committee on 10 January 2009.

## Declaration of the patient consents

Patient consents were waived due to the retrospective nature of this study.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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