

## ORIGINAL ARTICLE

## Evaluation of Risk Factors Associated with Positive Exercise Tolerance Test

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## ABSTRACT

**Objective:** To determine the potential risk factors in patients aged under 40 years with a positive Exercise Tolerance Test (ETT).

**Study Design:** Prospective study.

**Place and Duration of Study:** The study was carried out at the Department of Cardiology Choudhary Pervaiz Elahi Institute of Cardiology (CPEIC), Multan, Pakistan, from 1<sup>st</sup> January 2021 to 1<sup>st</sup> March 2022.

**Materials and Methods:** The study included 285 patients with positive ETT, selected through non-probability consecutive sampling. Patients were grouped into two age brackets: 20-30 and 31-40. Patients were advised to stop taking nitrates, calcium channel blockers and beta blockers a day before the test. The patients were investigated for potential risk factors that caused the positivity of EET.

**Results:** The study was conducted on 285 patients. The age of the participants was 30.12±5.64 years. There were 185 (64.9%) males and 100 (35.1%) females. The BMI was .32±1.38 kg/m<sup>2</sup>. Obesity was recorded in 38 (13.3%) patients, 85 (29.8%) had a family history, 63 (22.1%) had dyslipidemia, hypertension in 58 (20.4%), 32 (11.2%) had a smoking history, and 56 (19.6%) had diabetes mellitus. Diabetes Mellitus ( $p=0.00$ ) and dyslipidemia ( $p=0.004$ ) were found to be the most significant risk factors in patients aged between 31-40 years with positive EET

**Conclusion:** Diabetes mellitus and dyslipidemia are the most significant causes of positive EET in patients aged between 31-40 years.

**Keywords:** Coronary Artery Disease, Diabetes Mellitus, Exercise Tolerance Test, Hypertension, Risk Factors, Smoking.

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## Introduction

Exercise-induced electrocardiogram (ECG) alterations are used to diagnose coronary artery disease (CAD).<sup>1</sup> CAD is the leading cause of mortality and morbidity globally; common risk factors are family history, obesity, smoking, and dyslipidemia.<sup>2</sup> Patients with CAD commonly present with dyspnea and chest pain. In case of chest pain, coronary angiography is indicated. Dyspnea indicates

undiagnosed CAD if ECG evidence and exertional angina are absent.<sup>3</sup> In clinical cardiology, exercise testing is commonly used for CAD. The standard protocol for Exercise Tolerance Test (ETT) is the Bruce protocol; ETT goes into 6 stages.<sup>4</sup> ECG, heart rate and blood pressure are recorded at the end of each stage. Pain in arms or chest along with ST depression of 1mm after J point indicates positive ETT. Coronary angiography is performed on patients confirming CAD. When the target heart rate is achieved without ECG changes or chest pain, it indicates negative ETT.<sup>5,6</sup> A study conducted on complaints of dyspnea and chest pain among cardiac patients showed that the prevalence of hypertension in ETT- positive patients was 54.6%, while in ETT-negative patients, it was 40.6%.<sup>7</sup> Patients with dyspnea and chest pain undergo coronary angiography, an invasive procedure, and asymptomatic patients cannot be referred for tests. Thus, this study aims to determine

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the frequency of risk factors in patients under 40 years with positive-EET.

## Materials and Methods

The prospective study was conducted at Choudhary Pervaiz Elahi Institute of Cardiology, Multan, from 1<sup>st</sup> January 2021 to 1<sup>st</sup> March 2022. Both male and female patients aged between 20- 40 years who presented with dyspnea and chest pain and were positive for the ETT test were included in this study. Patients who had undergone angioplasty or coronary artery bypass and those diagnosed with CAD were excluded. The study included 285 patients selected through consecutive nonprobability sampling. The informed consent of the patients was recorded. The ethical board of the hospital approved the study.

Data including gender, age, height, and weight were recorded. Detailed history and investigation were performed to recording possible risk factors, including family history, dyslipidemia, hypertension, smoking and diabetes mellitus. Blood samples were collected for a routine investigation. In patients who underwent symptoms, treadmill testing was limited. Patients were advised to stop taking nitrates, calcium channel blockers and beta blockers a d before the test.

SPSS version 23 was used for data analysis. Quantitative variables such as BMI and age were presented as mean and standard deviation. Qualitative variables such as gender and possible risk factors were presented as percentages and frequency. Post-stratification chi-square test was done. *P* value  $\leq 0.05$  was considered statistically significant.

## Results

The study was conducted on 285 patients. The mean age of the participants was  $30.12 \pm 5.64$  years. There were 185 (64.9%) males and 100 (35.1%) females. The mean BMI was  $23.32 \pm 1.38$  kg/m<sup>2</sup>. 38 (13.3%) patients had obesity, 85 (29.8%) had a family history, 63 (22.1%) had dyslipidemia, 58 (20.4%) had hypertension, 32 (11.2%) had smoking history, and 56 (19.6%) had diabetes mellitus. Most patients aged between 31 to 40 years had diabetes mellitus ( $p=0.000$ ) (Table 1) and dyslipidemia ( $p=0.004$ ) (Table 2). Thus, diabetes and dyslipidemia were significant risk factors in patients with positive EET between 31 to 40 years old.

**Table 1: Association of Age with Diabetes Mellitus in Patients with Positive EET**

Diabetes mellitus	Age stratification	
	20-30 years	31-40 years
Yes	6	50
No	144	85
Total	150	135
<i>P</i> -value	0.007	0.000

**Table 2: Association of Age with Dyslipidemia in Patients with Positive EET**

Dyslipidemia	Age stratification		Total
	20-30 years	31-40 years	
Yes	23	40	63
No	127	95	222
Total	150	135	285
<i>P</i> -value	1.3	0.004	

## Discussion

The current study evaluated risk factors in subjects with positive ETT. In this study, a significant association was found between diabetes mellitus and positive EET. Another study reported that in patients aged between 30 to 40, there is a risk of diabetes.<sup>8</sup> Moreover, the association between age and dyslipidemia was also reported, which is in line with the previous study.<sup>2</sup> In the current study, it was also found that the positive predictive value of chronic smokers was higher as compared to nonsmokers. Tobacco smoking and diabetes are risk factors for CAD. Moreover, hypertensive patients had more incidence of false positive results than normotensives. A study showed that the positive predictive value in hypertensive patients was lower (51%) as compared to normotensives (89%).<sup>9</sup> ETT is a durable diagnostic test used for the evaluation of CAD patients. According to the literature, ETT is an early intervention measure used for assessing and ruling out myocardial infarction.<sup>10,11</sup> ETT has a high sensitivity of 98% but low specificity.<sup>12</sup> Low specificity is due to various contributing factors, including digitalis therapy, conduction disturbances, structural heart disease and metabolic diseases. Further evaluation of CAD is based on ETT results, a relatively simple and inexpensive test.<sup>9</sup> A study reported that the positive predictive value of ETT ranged from 75% to 85%.<sup>13</sup> Another study reported that the positive

predictive value of ETT was about 77% (with ST depression of < 2mm) and 96% (with ST depression  $\geq$  2mm).<sup>14</sup> Multiple variables are associated with the improved positive predictive value of ETT.<sup>15</sup> A study reported that male patients are more sensitive to ETT than female patients.<sup>16</sup> Female patients are more prone to false negative results, there is a need for caution and further investigation on these patients.<sup>17</sup> False positive results lead to increased psychological stress and patient load. A previous study found that the positive predictive value of ETT was 77 %, which matches our study results.<sup>18</sup> Due to the limited reliability of ETT in detecting inducible angina, invasive technologies like cardiac magnetic resonance imaging (CMR) and myocardial perfusion scan (MPS) are increasingly used. The limitation of this study is a small sample size; a larger multi centered study is required for further investigation.

## Conclusion

Diabetes mellitus and dyslipidemia are the most significant causes of positive EET in patients aged between 31-40 years.

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