



# Gender differences in bicycle exercise stress echocardiography testing



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## KEYWORDS

Exercise testing;  
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Gender

**Abstract** *Background:* Sex-specific differences for myocardial infarction and coronary artery disease (CAD) have been reported in several studies. The aim of our present study was to identify gender-specific differences regarding bicycle-exercise-stress-echocardiography.

*Methods:* We compared 87 (69.0%) male and 39 (31.0%) female patients with suspected or known stable coronary artery disease (CAD), who underwent bicycle-exercise stress-echocardiography.

*Results:* False-positive exercise-test results were more prevalent in females (21.1% vs. 17.4%) and arterial hypertension was connected with false-positive results in women only. In males, higher peak-exercise heart-rate was accompanied by lower risk of false-positive stress-echocardiography results. Higher systolic peak blood pressure during exercise was related to a higher risk for pending coronary artery interventions in females, whereas higher peak heart-rate during exercise was accompanied by a lower risk for pending coronary artery interventions also in females.

*Conclusions:* Exercise-echocardiography demonstrated significant sex-specific differences. Higher efforts during stress-test lead to better test-accuracy.

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## Introduction

Sex-specific differences for myocardial infarction and coronary artery disease (CAD) have been reported in several studies.<sup>1–4</sup> These differences comprise prevalence,<sup>1,2,5</sup> age at events, cardiovascular risk factors, quality of symptoms, treatment, adverse events and prognosis.<sup>3,4</sup> In general, women were found to outlive men and to develop fewer atherosclerotic cardiovascular events.<sup>6</sup> In average, women are older at cardiovascular events.<sup>4,6</sup> However, this gap in incidence gets closed with advancing age and in the elderly, cardiovascular diseases are the leading cause of death in both genders.<sup>6</sup> CAD is the most common cause of death for American and European men and women.<sup>7,8</sup>

For CAD, several diagnostic procedures are available and in use.<sup>2</sup> The cardio-pulmonary exercise testing is routinely performed to elicit cardiovascular abnormalities that are commonly not present at rest and is a longstanding and powerful tool used to identify suspected CAD or aggravation of CAD.<sup>2</sup> Among the stress testing diagnostic tools, exercise echocardiography was found to be superior over exercise ECGs in terms of diagnostic accuracy and risk stratification for the future.<sup>9–11</sup> Therefore, exercise stress echocardiography testing is the non-invasive method of choice for the assessment of CAD. It is a routine, versatile and reliable non-invasive test in patients with known or suspected CAD in both genders.<sup>9,12,13</sup> However, in approximately 15% of the patients with suspected or known CAD, wall motion abnormalities can be detected in exercise echocardiography suggesting relevant coronary stenosis leading to myocardial ischemia under physical exercise stress, where by significant coronary stenoses could be excluded in coronary angiography (termed as a false positive stress echocardiography result).<sup>2,13</sup> It was reported that especially the comorbidity of arterial hypertension and its treatments can lead to false positive results.<sup>13,14</sup> Data about sex-specific differences are limited.

Thus, we aimed to investigate sex-specific differences in exercise echocardiography especially with regard to factors influencing false positive exercise echocardiography results and coronary interventional treatment.

## Methods

### Patients

We performed a retrospective study of patients with suspected or known stable CAD. The study protocol has been described in detail previously.<sup>13</sup> Briefly summarized, patients were included at the Center of Cardiology, Department of Cardiology I, University Medical Centre Mainz (Germany) between January 2015 and April 2015. All patients were treated in the cardiac polyclinic (outpatient department clinic) during this timeframe and were identified with a search of the hospital information system database. Studies in Germany involving a retrospective analysis of diagnostic standard data do not require an ethics statement.

Patients were eligible for this study, if they were at least 18 years old, presented with suspected or known CAD, and were treated in the cardiac polyclinic (outpatient

department clinic). Clinical reasons for performing the exercise stress echocardiography tests was a suspicion of CAD or a known CAD diagnosis with suspected aggravation due to new stenoses leading to myocardial ischemia under physical stress.

### Exercise stress test protocol

The exercise stress echocardiography tests were conducted using a semi-supine bicycle ergometer with a ramp protocol, which included an increase of 25 or 50 W every 2 min. The bicycle stress echocardiography test was performed using standard techniques and endpoints according to the current guidelines.<sup>15,16</sup> The intended and required heart rate was 80% of 220 minus age, which was utilized as the submaximal load during exercise test.<sup>13</sup>

### Echocardiographical analysis

Echocardiographical images were obtained at baseline (before exercise had started) with two-dimensional transthoracic echocardiography in parasternal long axis, parasternal short axis, apical four chamber view, apical five chamber view, apical two chamber view and apical three chamber view. During exercise stages, peak- and post-exercise images focused on apical four chamber, apical five chamber, apical two chamber and apical three chamber views, which were recorded. During stress test, 12-lead ECG and blood pressure levels were assessed.<sup>15,16</sup> Presence of angina, ST segment changes in ECG and exercise capacity were also noted.<sup>16</sup>

Experienced echocardiographers evaluated the echocardiographic images. An ischemia was defined as a stress-induced new or worsening of pre-existing wall motion abnormalities or a biphasic response.<sup>13,16,17</sup> Inotropic reserve was defined as improvement of any wall motion abnormalities during stress testing in absence of inducible ischemia.<sup>13,17</sup> Necrotic response was defined as akinetic or dyskinetic myocardium without thickening during stress test.<sup>13,16,17</sup> The hypokinetic segments at rest without worsening during stress testing were considered as a rest wall motion abnormality.<sup>17</sup> A test was considered positive for ischemia when at least 2 adjacent segments of the same vascular territory revealed a wall motion abnormality increment.<sup>16,17</sup> A normal test resulted if no new wall motion abnormalities occurred during stress test or even at rest in comparison with pre-examination.<sup>16,17</sup>

### Study groups

Female and male patients with suspected or known stable CAD were compared in accordance to the assessed exercise echocardiography parameters.

### Definitions

According to ESC guidelines,<sup>2</sup> a relevant coronary artery stenosis was defined as causing exercise- and stress-related chest symptoms due to stenosis  $\geq 50\%$  in the left main coronary artery and  $\geq 70\%$  in one or several major coronary arteries and/or fractional flow reserve (FFR)  $\leq 0.80$ .<sup>2</sup>

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