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Erectile dysfunction and quality of life after myocardial infarction: a cross-sectional study with routine point-of-care penile Doppler ultrasonography

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What's new?

This study provides new data on the association between erectile dysfunction and quality of life in men after myocardial infarction treated with percutaneous coronary intervention. Unlike many previous studies based solely on questionnaires, an integrated approach was used, encompassing both the assessment of sexual functioning (IIEF-5) and multidimensional quality of life (SF-36), as well as routine penile hemodynamic assessment using point-of-care Doppler ultrasound. This combination of subjective and objective assessments allowed for a more precise characterization of erectile dysfunction in a clinically homogeneous population of patients after invasive treatment. The results indicate a significant association between erectile

dysfunction and impaired quality of life, highlighting the importance of sexual health—including vascular determinants of erectile function—as an underappreciated component of prognosis and rehabilitation after myocardial infarction.

Abstract

Introduction: Erectile dysfunction (ED) is common in men after myocardial infarction (MI) and is associated with poorer quality of life and systemic vascular disease. Previous studies have primarily relied on questionnaires, rarely including objective assessment of penile hemodynamics.

Objectives: To assess the quality of life in men with ED after MI treated with percutaneous coronary intervention (PCI) including routine assessment of penile hemodynamics using point-of-care resting Doppler ultrasonography.

Patients and methods: This observational, cross-sectional, single-center study included 600 men: 400 after MI treated with PCI and 200 without MI/PCI (controls). ED was assessed using the IIEF-5 questionnaire, and quality of life was assessed using the SF-36. Echocardiography, carotid Doppler ultrasound, and resting penile Doppler ultrasound were performed. Associations were analyzed using Spearman correlation and multivariate linear regression.

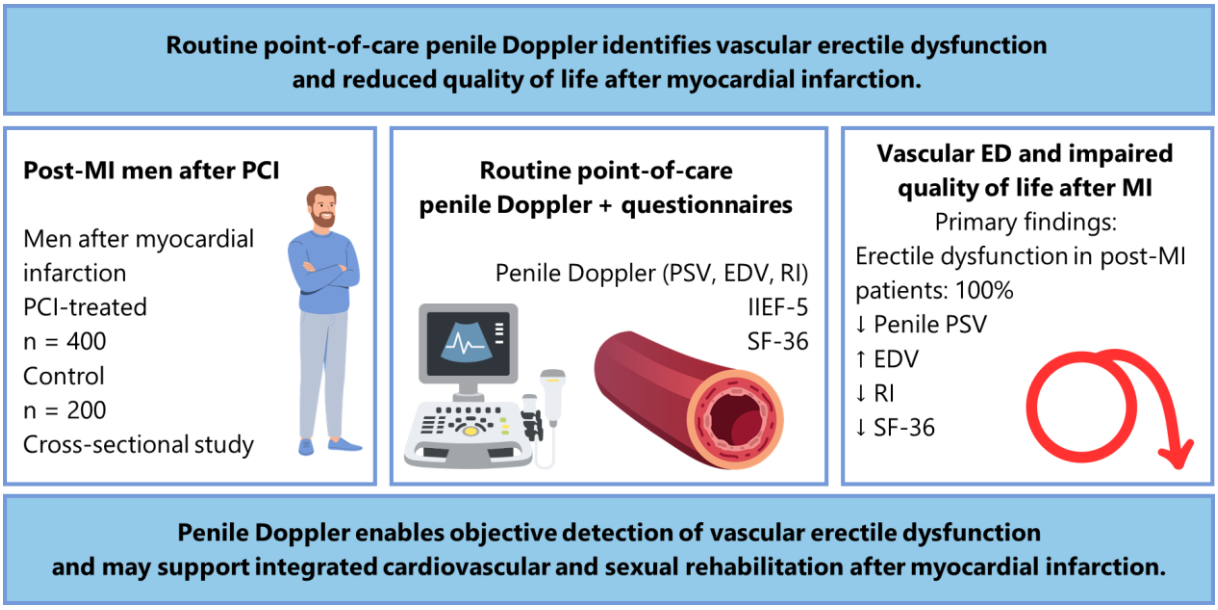
Results: All patients after MI had ED. Quality of life was significantly lower than in controls globally (SF-36: 121.3 (8.9) vs. 134.6 (7.5); P <0.001) and in the physical and mental components. Penile Doppler parameters differed between groups and correlated with IIEF-5. In multivariate analysis, the strongest predictor of quality of life was erectile function (IIEF-5), followed by LVEF, BMI, heart rate, and vascular parameters (IMT, carotid and penile flow).

Conclusions: ED severity is a major independent determinant of quality of life in men after MI/PCI. Penile hemodynamic parameters reflect systemic vascular burden and functional

status. Integrated ED assessment, including IIEF-5 and routine resting penile Doppler ultrasound, can support risk stratification and post-MI care.

Key words

erectile dysfunction, myocardial infarction, PCI, penile Doppler ultrasound, point-of-care ultrasound, quality of life



Graphical abstract

Introduction

In recent decades, the prognosis after myocardial infarction has improved significantly, with mortality rates in developed countries currently around 7–10% in the first year and 15–20% within 5 years [1,2]. Data from large population-based cohorts confirm this trend: in the UK, the annual risk of death after a first myocardial infarction was 8.2% and the 5-year risk was 17.2% [3], while in Australia, in-hospital mortality reached 2.2%, with 15.9% of deaths over a 4.5-year follow-up [4]. However, the decline in cardiovascular mortality is accompanied by an increasing relative share of deaths from non-cardiac causes in long-term follow-up, reflecting the chronic nature of the consequences of myocardial infarction [5,6]. Contemporary registry

data confirm that despite overall improvements in outcomes, important disparities in treatment and prognosis after ST-segment elevation myocardial infarction persist, particularly in relation to delays in care and periprocedural outcomes [7].

In acute myocardial infarction, both with and without ST-segment elevation (STEMI and NSTEMI), percutaneous coronary intervention (PCI) is the preferred invasive treatment, reducing mortality compared with fibrinolysis. In the Danish population, implementation of a primary PCI strategy was associated with a reduction in annual mortality from 10.8% to 7.7%, with a current in-hospital mortality rate of approximately 2.2%. In patients with myocardial infarction and reduced ejection fraction (LVEF ≤40%), PCI reduces the risk of all-cause mortality, cardiovascular death, sudden cardiac death, reinfarction, and hospitalization for heart failure [8,9,10]. In stable coronary artery disease, PCI does not affect mortality or the incidence of myocardial infarction, but effectively relieves symptoms and improves quality of life, especially in patients with severe angina pectoris [11,12]. Recent registry-based studies further emphasize the prognostic importance of coronary disease complexity and completeness of revascularization, as well as patient heterogeneity, including younger populations with distinct clinical characteristics and outcomes after myocardial infarction [13,14].

After myocardial infarction, quality of life (QoL) deteriorates significantly, especially in the first months, with the greatest and more persistent decline observed after spontaneous, rather than periprocedural, infarction [15]. In European studies, reduced QoL is common in the early post-infarction period and persists or worsens in some patients during the first year, especially in the presence of comorbidities [16]. Although revascularization therapy and cardiac rehabilitation may partially improve functioning, long-term QoL after infarction is primarily determined by persistent symptoms, cardiac complications, and psychosocial and behavioral factors, emphasizing the need for a comprehensive therapeutic approach [17,18,19,20]. Moreover, metabolic and inflammatory mechanisms, including lipid-related factors such as

lipoprotein(a), may further contribute to long-term cardiovascular risk and disease progression after acute coronary syndromes [21].

Sexual health is an important component of quality of life for patients after myocardial infarction. According to the American College of Cardiology and the American Heart Association, sexual functioning is an integral component of QoL, and sexual dysfunction is common in patients with coronary artery disease and its risk factors. Sexual activity corresponds to moderate physical activity (3–5 METs) and can be safely resumed usually approximately 3 weeks after an uncomplicated myocardial infarction, provided a negative stress test [22].

Sexual dysfunction, including erectile dysfunction and decreased libido, occurs in approximately 40–60% of post-MI patients and is strongly associated with poorer quality of life, depressive symptoms, and lower acceptance of illness [23]. Interventions such as sexual education, psychological support, and cardiac rehabilitation contribute to improved sexual functioning and QoL after MI [24,25].

The relationship between erectile dysfunction, quality of life, and objective penile hemodynamics assessed by routine point-of-care Doppler examination in men after myocardial infarction treated with PCI has not been studied jointly so far.

Objectives The aim of this study was to assess quality of life in men with erectile dysfunction after myocardial infarction treated with percutaneous coronary intervention, with particular emphasis on the role of routine point-of-care penile Doppler ultrasonography in the evaluation of erectile function.

Patients and methods

Study design The study was an observational and cross-sectional in nature and comprised four stages of data collection and analysis. Stage one involved participant selection based on medical interviews, documentation review, and assessment of inclusion and exclusion criteria. Stage

two involved collecting clinical, anthropometric, and laboratory data during hospitalization. Stage three involved performing imaging and functional cardiovascular tests. Stage four included assessing quality of life, sexual functioning, and psychosocial factors using standardized questionnaires. Integrating data from multiple sources enabled cross-validation and improved reliability of results while reducing potential bias. The study design is presented in Figure 1.

Setting The study was conducted from February 2024 to November 2025 at the Clinical Department of Cardiology, Radom Specialist Hospital named after Dr. Tytus Chałubiński in Radom, Poland. The study protocol was approved by the Bioethics Committee of the Jan Kochanowski University in Kielce (no. 5/2024 of January 19, 2024) and approved by the institutional authorities. The study was conducted in accordance with the principles of the Declaration of Helsinki and its subsequent amendments. All participants provided written informed consent prior to enrollment. The study was covered by mandatory third-party liability insurance for medical research.

Participants The study included men aged 18–59 years who had a myocardial infarction (STEMI or NSTEMI) treated with percutaneous coronary intervention (PCI) within the previous 10 years but no earlier than 12 months before treatment initiation. Patients were recruited during planned hospitalization for cardiological diagnostics. Exclusion criteria included: a diagnosis of cancer (current or history), psychiatric illness (current or history), alcohol dependence syndrome, prior coronary artery bypass grafting, prior stroke, diabetes, use of hormone therapy within the previous 12 months, and anticipated lack of compliance. The control group consisted of individuals without diagnosed cardiovascular disease who were referred for routine cardiological evaluation (e.g., preventive assessment or non-specific symptoms) and represented a metabolically healthy reference population. The control group was recruited at the same institution during the study period. Participants were consecutively

enrolled and met the same general eligibility criteria as the study group, except for the absence of a history of myocardial infarction or prior percutaneous coronary intervention. To ensure full methodological comparability, all participants in the control group underwent an identical standardized study protocol. This included clinical assessment, laboratory testing, echocardiography, carotid Doppler ultrasonography, resting penile Doppler examination, and completion of the same validated questionnaires (IIEF-5 and SF-36), performed under the same conditions and by the same study team.

Variables The primary independent variable was the presence of erectile dysfunction, assessed using the short version of the International Index of Erectile Function (IIEF-5) and classified according to current cutoff scores. The IIEF-5 is a widely used, validated screening tool for erectile dysfunction, with high sensitivity (0.98) and specificity (0.88), available in multiple language and population-based versions, and its questionnaire remains open access [26].

The dependent variable was quality of life assessed using the SF-36 questionnaire (license no. QUO-03978-C0Q3T0), analyzed both as a global score and in individual domains. The SF-36 is widely recommended in clinical trials and practice as a tool for assessing and monitoring quality of life and long-term treatment outcomes in patients after myocardial infarction [27].

Data sources Data regarding erectile dysfunction and quality of life were collected using standardized self-assessment questionnaires completed by participants during hospitalization. Clinical data, including time since myocardial infarction, left ventricular ejection fraction, hemodynamic parameters, body mass index (BMI), laboratory test results, and coronary angiography results, were obtained from medical records. Information regarding lifestyle, sexual activity, and selected psychosocial factors was obtained through a face-to-face interview using a structured questionnaire. Participants underwent point-of-care carotid Doppler ultrasound and resting penile Doppler ultrasound during hospitalization using a LOGIQ S7

XDclear 2.0 ultrasound system (GE Healthcare, Chicago, IL, USA) equipped with a high-frequency linear array transducer (7.5–12 MHz). Penile examination was performed in the supine position, under standardized conditions, with bilateral assessment of the cavernous arteries in longitudinal and transverse projections and recording of flow spectra and basic hemodynamic parameters (PSV, EDV), while maintaining patient privacy. All measurements were performed by the same experienced investigator according to a standardized protocol.

Statistical methods Analyses were performed in R (version 4.3.3; R Core Team, 2024) at a significance level of $\alpha = 0.05$. Normality of distribution was assessed using the Shapiro–Wilk test. Continuous variables were presented as mean (SD) or median (IQR), depending on data distribution. Comparisons between groups were performed using the Welch t-test or Wilcoxon rank-sum test and the χ^2 test or Fisher's exact test. Associations were assessed using the Spearman correlation coefficient. Independent determinants of quality of life were identified using multivariable linear regression with backward stepwise selection based on the Akaike information criterion (AIC) to reduce the risk of model overfitting. Model fit was assessed using R^2 and adjusted R^2, multicollinearity was assessed using variance inflation factors (VIF), and normality of residuals was assessed using the Shapiro–Wilk test. Confidence intervals are reported at the 95% level. As a sensitivity analysis, propensity score matching was performed using nearest-neighbor matching (1:1) with a caliper of 0.2 of the standard deviation of the logit of the propensity score. Covariates included age, body mass index, blood pressure, heart rate, lipid profile, fasting glucose, smoking status, and hypertension. Additional multivariable analyses were performed in the entire study population to assess the consistency of the observed associations.

Results

A total of 600 men meeting the eligibility criteria were included in the study, including 400 patients with a history of myocardial infarction treated with percutaneous coronary intervention (study group) and 200 men without myocardial infarction and without a history of PCI, constituting the control group. As a sensitivity analysis, propensity score matching was performed. In the propensity score–matched cohort (n = 180 pairs), baseline characteristics were well balanced, with all standardized mean differences below 0.1. The differences in quality of life between groups remained statistically significant (SF-36 total score: 122.1 (8.5) in the study group vs. 133.8 (7.6) in the control group; P <0.001). Similarly, the associations between erectile function and quality of life, as well as the direction and magnitude of relationships observed in multivariable analyses, remained consistent with the primary findings.

Characteristics of the study population Baseline clinical, hemodynamic, and biochemical characteristics of the study and control groups are presented in Table 1. As expected, patients after myocardial infarction demonstrated a less favorable cardiovascular risk profile compared with the control group. The median age was 45 years (37; 54) in the study group and 44 years (36; 52) in the control group. The largest group consisted of married men (66%), while the percentages of single and divorced individuals were 23% and 10%, respectively. The vast majority of participants were professionally active (91%). The median time since myocardial infarction was 50 months (26; 80), indicating a stable population in the long-term after coronary revascularization.

Severity of erectile dysfunction In the study group (n = 400), all patients met the IIEF-5 criteria for erectile dysfunction, with the majority classified as having mild-to-moderate forms. Mild to moderate erectile dysfunction predominated (89%), while moderate erectile dysfunction was found in 11% of participants.

The mean (SD) IIEF-5 score in the study group was 13.9 (1.5) points (95% CI, 13.7–14.1), which corresponds to clinically significant mild to moderate erectile dysfunction. The lowest values were observed in the domains of erectile frequency and ability to maintain an erection (2.1 (0.5) and 2.5 (0.6) points, respectively), indicating that insufficient durability of the erectile response was the dominant problem. The sexual satisfaction score was relatively higher (3.3 (0.5) points), suggesting partial preservation of sexual function despite the presence of an organic vascular deficit. In contrast, participants in the control group demonstrated preserved erectile function, with significantly higher IIEF-5 scores compared with the study group, as presented in Table 3. Most individuals in the control group did not meet the criteria for erectile dysfunction.

Quality of life according to SF-36 Quality of life assessed with the SF-36 questionnaire was significantly lower in the study group (n = 400) than in the control group (n = 200) across all domains (Table 2). The largest differences were observed in the physical component (physical functioning, physical role limitations, pain, general health), although significant deterioration was also observed in mental domains, including vitality, social functioning, and emotional role limitations. The SF-36 total score was 121.3 (8.9) in the study group and 134.6 (7.5) in the control group (P <0.001). Summary indicators of physical and mental health were significantly lower in post-myocardial infarction patients with erectile dysfunction.

Clinical and cardiovascular characteristics of patients with erectile dysfunction On echocardiography, patients in the study group demonstrated worse left ventricular structure and function than the control group. The median left ventricular ejection fraction was 42% (38; 46) in the study group and 58% (55; 62) in the control group. Left ventricular diastolic diameter was 5.49 cm (4.99; 6.01) in the study group and 4.92 cm (4.55; 5.28) in the control group, and left atrial diameter was 4.11 cm (3.37; 4.30) in the study group vs. 3.62 cm (3.28; 3.95) in the

control group. The E/A ratio was lower in the study group (1.06 [0.78; 1.25]) than in the control group (1.28 [1.05; 1.46]), indicating more frequent diastolic dysfunction after MI.

On carotid Doppler ultrasound, the intima-media thickness was greater in the study group than in the control group in both the common carotid artery (1.19 mm [1.05; 1.35] vs. 0.84 mm [0.72; 0.96]) and the internal carotid artery (1.13 mm [0.99; 1.29] vs. 0.79 mm [0.68; 0.92]), indicating more severe atherosclerotic changes.

The lipid profile was less favorable in patients after myocardial infarction than in the control group: total cholesterol was 198 mg/dL (172; 224) in the study group and 182 mg/dL (165; 205) in the control group; LDL cholesterol was 122 mg/dL (102; 146) vs. 108 mg/dL (92; 126); HDL cholesterol was 52.4 mg/dL (46.3; 58.3) vs. 58.9 mg/dL (52.1; 66.4); and triglycerides were 140.1 mg/dL (107.7; 179.6) vs. 118.6 mg/dL (92.4; 149.3), respectively.

In resting penile Doppler ultrasound, patients in the study group demonstrated lower PSV and RI values and higher EDV compared with the control group, suggesting impaired cavernous artery hemodynamics in the course of erectile dysfunction. In an analysis stratified by the severity of erectile dysfunction on the IIEF-5 scale, Doppler parameters differed significantly between the control group, patients with mild-moderate ED, and patients with moderate ED, demonstrating a gradual decrease in PSV and RI with increasing ED severity, with an opposite trend for EDV. The IIEF-5 result correlated significantly with PSV and RI, confirming the concordance of the questionnaire assessment with objective hemodynamic parameters (Table 4).

Determinants of quality of life — multivariable analysis Multivariate analysis of the SF-36v2 summary score performed in the post–myocardial infarction group identified several independent determinants of quality of life. The strongest positive predictor, as reflected by the magnitude of the regression coefficient (β), was erectile function assessed by the IIEF-5 scale, while higher body mass index and higher heart rate were independently associated with lower

quality of life. Better left ventricular systolic function remained significantly associated with higher SF-36v2 scores (Table 4).

In an additional analysis including the entire study population (n = 600), erectile function was also significantly associated with quality of life. In multivariable linear regression analysis, higher IIEF-5 score was associated with higher SF-36 total score, as reflected by the regression coefficient (β = 1.42; 95% CI, 1.21–1.63; P <0.001). Other independent determinants included left ventricular ejection fraction, body mass index, and heart rate.

Discussion

Erectile dysfunction and cardiovascular disease are closely linked through a common pathophysiological basis, primarily encompassing generalized endothelial dysfunction and atherosclerosis. Myocardial infarction is a critical clinical event that impacts not only the physical condition but also the psychosocial functioning and perceived quality of life of men. In the population of patients with coronary artery disease, the prevalence of erectile dysfunction is high, and its occurrence can occur even several years before the manifestation of coronary symptoms, suggesting that ED may serve as an early marker of generalized vascular disease [28,29,30]. As expected in a real-world post–myocardial infarction population, patients differed from controls in terms of cardiovascular risk profile and cardiac function. These differences reflect the distinct clinical characteristics of the studied populations and represent a potential source of confounding; however, this was addressed in multivariable analyses and further supported by consistent results in the propensity score–matched analysis. These findings were consistent in both the primary and propensity score–matched analyses, supporting the robustness of the observed associations.

The prevalence of erectile dysfunction in the analyzed cohort, assessed, among others, using the IIEF-5 questionnaire, was 100% and exceeded the values reported in most studies of patients

after myocardial infarction. In the meta-analysis by Sam et al[28], the incidence of de novo ED after a first myocardial infarction was estimated at 64.4%, and in prospective studies of patients with STEMI treated with PCI, the rate of ED increased from approximately 50% immediately after the event to 79% within a few months. In other cohorts after acute myocardial infarction, ED was observed in 76–84% of patients during early follow-up [31]. The 100% prevalence of erectile dysfunction observed in the present study should be interpreted with caution and in the context of the study design and population characteristics. The analyzed cohort consisted of patients in a stable, long-term phase after myocardial infarction, representing a population with established vascular dysfunction. In addition, the use of a sensitive screening tool (IIEF-5) enabled the detection of mild and subclinical forms of erectile dysfunction. Importantly, the majority of cases were classified as mild-to-moderate, suggesting that this finding reflects a high prevalence of vascular impairment rather than severe clinical dysfunction. Therefore, these results should not be directly generalized to the broader population of post–myocardial infarction patients.

The homogeneous distribution of ED severity, including only mild-moderate and moderate forms, with no cases of normal function or severe ED, suggests a clinically consistent cohort of men with persistent, primarily vascular dysfunction typical of PCI-treated coronary artery disease patients. This profile reflects the chronic, stable nature of ED in the long-term post-infarction period. At the same time, interventional data suggest that improvement in sexual function is possible in this population—Palm et al[32] demonstrated a 6.7-point increase in the IIEF score after 12 weeks of sexual rehabilitation compared with standard care.

In the analyzed cohort of men, quality of life was significantly lower than in the control group, both globally (SF-36 total score: 121.3 (8.9) in the study group vs. 134.6 (7.5) in the control group; P <0.001) and in the physical (58.2 (5.4) vs. 67.9 (5.1)) and mental (63.1 (6.0) vs. 69.4 (5.7)) components. The largest differences concerned physical functioning and physical role

limitations, which is consistent with the observations of Brown et al[33] and Huber et al[34] in patients with coronary artery disease. The association between ED severity and poorer quality of life, especially in the physical domain, was also confirmed by Sánchez-Cruz et al[35] and Kriston et al[36], indicating partial mediation by depressive symptoms. A similar profile—greater deterioration of the physical component than of the mental component—was also described in meta-analyses of cardiac rehabilitation [18]. According to Vlachopoulos's concept and the AHA/ESC position statements, ED is an important element of quality of life and a marker of cardiovascular risk, justifying routine assessment of sexual function and quality of life in long-term care after MI/PCI [37].

Objective parameters confirm a close association between erectile dysfunction and generalized vascular disease, consistent with the concept of ED and cardiovascular disease as manifestations of the same atherosclerotic endothelial process. The smaller diameter of penile arteries favors earlier manifestation of flow disturbances than in the coronary circulation [38], and a meta-analysis by Mostafaei et al[39] confirms ED as an independent predictor of CVD and myocardial infarction. The parameters of the studied cohort—moderately reduced LVEF (42%), increased IMT (CCA 1.19 mm; ICA 1.13 mm), and penile Doppler profile (PSV 23.5 cm/s; EDV 6.0 cm/s)—indicate generalized atherosclerosis and a vascular type of ED, which is consistent with the observations of Montorsi, Wehrberger, Baumhäkel, Osondu, and Corona [40,41,42,43,44]. The coexistence of atrial fibrillation (17.3%) and an unfavorable metabolic profile further reflects the common inflammatory-endothelial background of ED and CVD described in population-based studies [45,46]. An important methodological aspect is that penile Doppler ultrasound in the present study was performed under resting (flaccid) conditions without pharmacological stimulation. Therefore, peak systolic velocity (PSV) values should not be directly compared with standard diagnostic thresholds established for post-pharmacological testing. Under resting conditions, cavernosal arterial flow is physiologically low (typically 8–

15 cm/s), and PSV serves primarily as a screening parameter. As demonstrated by Corona et al[44], resting PSV ≥13 cm/s is associated with a high probability of normal dynamic PSV after pharmacological stimulation. Thus, the lower PSV observed in the study group compared with controls likely reflects relative impairment of penile arterial inflow and subclinical vascular dysfunction rather than overt arterial insufficiency. The interpretation of increased end-diastolic velocity (EDV) requires consideration of both vascular and functional factors. Elevated EDV may reflect veno-occlusive dysfunction; however, it can also be influenced by transient functional conditions. Anxiety has been shown to affect penile hemodynamics by impairing smooth muscle relaxation, leading to delayed or incomplete erectile response and higher EDV values. In addition, structural abnormalities such as Peyronie's disease may contribute to increased EDV through intracavernosal fibrosis and impaired veno-occlusive mechanisms. In contrast, current evidence does not support a clear direct relationship between testosterone levels and EDV. Therefore, increased EDV observed in the present study should be interpreted as reflecting a complex interplay of vascular and functional mechanisms rather than a specific indicator of isolated venous insufficiency [47].

Erectile dysfunction was strongly associated with reduced quality of life in men after myocardial infarction treated with PCI, independent of other clinical factors. Lower IIEF-5 scores correlated mainly with a worse physical component of the SF-36v2 and, to a lesser extent, with the psychological component, which is consistent with the observations of Sánchez-Cruz and Huber [34,35]. Worse cardiovascular and vascular parameters (lower LVEF, higher IMT, lower penile PSV) were associated with lower quality of life, which supports the findings of Wehrberger, Bocchio, and El-Sakki indicating that ED is associated with a higher vascular burden and poorer well-being in this population [41,45,46]. Importantly, similar associations were observed in analyses performed in the entire study population; however, these findings should be interpreted with caution, as they were primarily driven by variability within

the study group, while erectile function was largely preserved in the control group. Given the limited variability of erectile function in the control group, this analysis primarily reflects between-group differences rather than within-group associations.

Taken together, the results indicate that the quality of life of men with ED after myocardial infarction is determined mainly by the severity of erectile dysfunction, cardiovascular function and the degree of generalized vascular changes, independently of age and other clinical factors. These findings support the concept of erectile dysfunction as an integrative marker of systemic vascular health rather than an isolated urogenital condition.

Clinical implications Erectile dysfunction should be routinely assessed in men after myocardial infarction treated with PCI because it is common and associated with poorer quality of life and increased vascular burden. Importantly, erectile dysfunction in this population may reflect underlying systemic vascular dysfunction rather than isolated sexual impairment. The diagnosis of erectile dysfunction allows for risk stratification and implementation of targeted interventions, including optimization of cardiac treatment and lifestyle modification, psychosocial support, and structured sexual counseling as part of comprehensive cardiac rehabilitation and standard post-infarction care, as detailed in the supplementary material (Supplementary Table S1).

Limitations The study has several limitations. The single-center, observational, and cross-sectional design, as well as the selective cohort of men after myocardial infarction treated with PCI (without diabetes or CABG), limit the generalizability of the results and causal inferences. The assessment of sexual function based on the IIEF-5, the lack of hormonal and psychological data, and the lack of pre-infarction information may have influenced the observed associations. Given the observational design and baseline differences between groups, residual confounding cannot be fully excluded. Additionally, the relatively large number of variables included in the

multivariable model relative to the number of outcome events may increase the risk of overfitting, despite the use of AIC-based selection.

Conclusions 1) The severity of erectile dysfunction was the strongest independent predictor of quality of life, demonstrating a significant positive association with both the physical and mental components of the SF-36, confirming the central role of sexual health in the overall well-being of men after myocardial infarction. 2) Penile hemodynamic parameters demonstrated an independent positive association with quality of life, indicating that the degree of preserved penile perfusion is a clinically relevant marker of the overall vascular and functional status of patients after myocardial infarction. 3) The use of an integrated ED assessment including IIEF-5 and resting penile Doppler ultrasonography provides complementary information on the vascular and functional status of men after myocardial infarction.

The obtained results indicate the need to routinely include the assessment of sexual function and resting Doppler ultrasound of the penis in comprehensive post-infarction care in men, which may enable early identification of hemodynamic disorders, guide rehabilitation, and improve the quality of life of this population.

Supplementary material

Supplementary material is available at www.mp.pl/paim.

Article information

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Data Availability The datasets generated and analyzed during the study are not publicly available due to data protection regulations. However, anonymized data can be made available by the corresponding author upon reasonable request.

Conflict of interests The authors declare that they have no conflict of interest related to this study.

AI Statement Artificial intelligence was not used in the preparation of this manuscript.

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References

1 Martin SS, Aday AW, Allen NB, et al. 2025 Heart disease and stroke statistics: a report of U.S. and global data from the American Heart Association. Circulation. 2025; 151: e41-e660.

2 Christensen DM, Strange JE, El-Chouli M, et al. Temporal trends in noncardiovascular morbidity and mortality following acute myocardial infarction. J Am Coll Cardiol. 2023; 82: 971-981.

3 Scholfield S, Zghebi SS, Rutter M, et al. Trends in mortality and major adverse cardiovascular events following incident acute myocardial infarction. BMC Cardiovasc Disord. 2026; 26: 125.

4 Nguyen J, Chan N, Hammett C, et al. Survivorship following myocardial infarction in a contemporary Australian cohort: defining cardiac versus non-cardiac mortality. Intern Med J. 2025; 55: 812-821.

5 Abou Hamed A, Gourraud M, Genet T, et al. Prognosis of patients with acute myocardial infarction in the setting of COVID-19: a French nationwide observational study. Arch Cardiovasc Dis. 2025; 118: 312-321.

6 Faridi B, Davies S, Narendrula R, et al. Rural-urban disparities in mortality of patients with acute myocardial infarction and heart failure: a systematic review and meta-analysis. Eur J Prev Cardiol. 2025; 32: 327-335.

7 Doolub G, Mamas MA, Malinowski KP, et al. Closing the sex gap in time delays and mortality in ST-segment elevation myocardial infarction: insights from the National Registry of Invasive Cardiology Procedures (ORPKI). Pol Arch Intern Med. 2025; 135: 17002.

8 Gaudino M, Andreotti F, Kimura T. Current concepts in coronary artery revascularisation. Lancet. 2023; 401: 1611-1628.

9 Thrane PG, Olesen KKW, Thim T, et al. Mortality trends after primary percutaneous coronary intervention for ST-segment elevation myocardial infarction. J Am Coll Cardiol. 2023; 82: 999-1010.

10 Parikh PB, Bhatt DL, Bhasin V, et al. Impact of percutaneous coronary intervention on outcomes in patients with heart failure: JACC State-of-the-Art Review. J Am Coll Cardiol. 2021; 77: 2432-2447.

11 Cartlidge T, Kovacevic M, Navarese EP, et al. Role of percutaneous coronary intervention in the modern-day management of chronic coronary syndrome. Heart. 2023; 109: 1429-1435.

12 Weintraub WS, Mancini GBJ, Boden WE. Percutaneous coronary intervention from COURAGE to ISCHEMIA and beyond. Int J Cardiol. 2023; 373: 39-43.

13 Kwapiszewska-Szybalska A, Zandecki Ł, Sadowski M, et al. Coronary revascularization in patients with ST-segment elevation myocardial infarction and multivessel disease: 2-year follow-up from a large multicenter registry. Pol Arch Intern Med. 2025; 135: 17030.

14 Kampka Z, Szczerba R, Bula K, et al. Clinical characteristics and outcomes of young patients with acute myocardial infarction: the YAMI registry. Pol Arch Intern Med. 2025; 135: 16921.

15 1Gaudino M, Stone GW, Heise RS, et al. Association between myocardial infarction and quality of life in the ISCHEMIA trial. JACC Cardiovasc Interv. 2025; 18: 1263-1272.

16 Wohlfahrt P, Jenča D, Stehlik J, et al. Heart failure-related quality-of-life impairment after myocardial infarction. Clin Res Cardiol. 2023; 112: 39-48.

17 Kaambwa B, Gesesew HA, Horsfall M, et al. Quality of life changes in acute coronary syndromes patients: a systematic review and meta-analysis. Int J Environ Res Public Health. 2020; 17: 6889.

18 Moreira J, Bravo J, Aguiar P, et al. Physical and mental components of quality of life after a cardiac rehabilitation intervention: a systematic review and meta-analysis. J Clin Med. 2024; 13: 5576.

19 Bahall M, Khan K. Quality of life of patients with first-time AMI: a descriptive study. Health Qual Life Outcomes. 2018; 16: 32.

20 Kolarczyk E, Kohanová D, Witkowska A, et al. The factors of quality of life among patients after myocardial infarction in Poland: a cross-sectional study. Sci Rep. 2024; 14: 15925.

21 Satała J, Witkowska A, Pawlos A, et al. Changes in lipoprotein(a) concentrations in patients with acute coronary syndrome. Pol Arch Intern Med. 2025; 135: 16959.

22 Piegza M, Smolarczyk J, Piegza J. Sexual and cardiovascular health. Factors influencing the quality of sexual life of coronary heart disease patients - a narrative review. Vasc Health Risk Manag. 2025; 21: 51-60.

23 Brandis Kepler S, Hasin T, Benyamini Y, et al. Frequency of sexual activity and long-term survival after acute myocardial infarction. Am J Med. 2020; 133: 100-107.

24 Cohen G, Nevo D, Hasin T, et al. Resumption of sexual activity after acute myocardial infarction and long-term survival. Eur J Prev Cardiol. 2022; 29: 304-311.

25 Tokarewicz J, Jankowiak B, Klimaszewska K, et al. Acceptance of illness and health-related quality of life in patients after myocardial infarction: narrative review. J Clin Med. 2025; 14: 729.

26 Lizarraga-Limousin R, Medrano-Sánchez EM, Díaz-Mohedo E, et al. Spanish cross-cultural validation of the electronic version of the International Index of Erectile Function-5 (IIEF-5). Int J Environ Res Public Health. 2022; 19: 3115.

27 García-Sánchez E, Santamaría-Peláez M, Benito Figuerola E, et al. Comparison of SF-36 and RAND-36 in cardiovascular diseases: a reliability study. J Clin Med. 2024; 13: 6106.

28 Sama C, Ajibade A, Al-Saed M, et al. De novo erectile dysfunction after first myocardial infarction: systematic review and meta-analysis. J Sex Med. 2026; 23: 338.

29 Wróblewski O, Skwirczyńska E, Michalczyk K, et al. The relationship between erectile dysfunction, self-esteem, and depression in post-myocardial infarction patients. J Clin Med. 2024; 13: 6134.

30 Tkaczyk F, Chudzik M, Piotrowska AM, et al. Prescription trends and the role of cardiologists in the diagnosis and treatment of erectile dysfunction. J Cardiovasc Dev Dis. 2025; 12: 414.

31 Karabay E, Karsiyakali N, Cinier G, et al. Change in frequency and predictors of erectile dysfunction with changes in the International Index of Erectile Function-erectile function domain score in patients with ST-elevation myocardial infarction: a prospective, longitudinal study. J Sex Med. 2020; 17: 1101-1108.

32 Palm P, Zwisler AO, Svendsen JH, et al. Sexual rehabilitation for cardiac patients with erectile dysfunction: a randomised clinical trial. Heart. 2019; 105: 775-782.

33 Brown N, Melville M, Gray D, et al. Quality of life four years after acute myocardial infarction: short form 36 scores compared with a normal population. Heart. 1999; 81: 352-358.

34 Huber A, Oldridge N, Höfer S. International SF-36 reference values in patients with ischemic heart disease. Qual Life Res. 2016; 25: 2787-2798.

35 Sánchez-Cruz JJ, Cabrera-León A, Martín-Morales A, et al. Male erectile dysfunction and health-related quality of life. Eur Urol. 2003; 44: 245-253.

36 Kriston L, Günzler C, Agyemang A, et al. Effect of sexual function on health-related quality of life mediated by depressive symptoms in cardiac rehabilitation. Findings of the SPARK project in 493 patients. J Sex Med. 2010; 7: 2044-2055.

37 Steinke EE, Jaarsma T, Barnason SA, et al. Sexual counselling for individuals with cardiovascular disease and their partners: a consensus document from the American Heart Association and the ESC Council on Cardiovascular Nursing and Allied Professions (CCNAP). Eur Heart J. 2013; 34: 3217-3235.

38 Gandaglia G, Briganti A, Jackson G, et al. A systematic review of the association between erectile dysfunction and cardiovascular disease. Eur Urol. 2014; 65: 968-978.

39 Mostafaei H, Mori K, Hajebrahimi S, et al. Association of erectile dysfunction and cardiovascular disease: an umbrella review of systematic reviews and meta-analyses. BJU Int. 2021; 128: 3-11.

40 Montorsi P, Ravagnani PM, Galli S, et al. Association between erectile dysfunction and coronary artery disease. Role of coronary clinical presentation and extent of coronary vessels involvement: the COBRA trial. Eur Heart J. 2006; 27: 2632-2639.

41 Wehrberger C, Rauchenwald M, Spinka R, et al. Is left ventricular systolic dysfunction a risk factor for erectile dysfunction? Urology. 2010; 75: 1104-1107.

42 Baumhäkel M, Böhm M. Erectile dysfunction correlates with left ventricular function and precedes cardiovascular events in cardiovascular high-risk patients. Int J Clin Pract. 2007; 61: 361-366.

43 Osondu CU, Vo B, Oni ET, et al. The relationship of erectile dysfunction and subclinical cardiovascular disease: a systematic review and meta-analysis. Vasc Med. 2018; 23: 9-20.

44 Corona G, Fagioli G, Mannucci E, et al. Penile doppler ultrasound in patients with erectile dysfunction (ED): role of peak systolic velocity measured in the flaccid state in predicting arteriogenic ED and silent coronary artery disease. J Sex Med. 2008; 5: 2623-2634.

45 Bocchio M, Scarpelli P, Necozione S, et al. Intima-media thickening of common carotid arteries is a risk factor for severe erectile dysfunction in men with vascular risk factors but no clinical evidence of atherosclerosis. J Urol. 2005; 173: 526-529.

46 El-Sakka AI, Morsy AM. Screening for ischemic heart disease in patients with erectile dysfunction: role of penile Doppler ultrasonography. Urology. 2004; 64: 346-350.

47 Cannarella R, Calogero AE, Aversa A, et al. Differences in penile hemodynamic profiles in patients with erectile dysfunction and anxiety. J Clin Med. 2021; 10: 402.

Table 1 Baseline clinical and biochemical characteristics of the study and control groups			
Variable	Study group (n = 400)	Control group (n = 200)f	*P* value
Age, years	45 (37–54)	44 (36–52)	0.27
Height, cm	178.5 (6.6)	178.0 (6.9)	0.40
Body weight, kg	85.1 (11.0)	80.3 (10.7)	<0.001
BMI, kg/m²	26.8 (3.0)	25.2 (2.7)	<0.001
Systolic BP, mm Hg	133 (12)	122 (10)	<0.001
Diastolic BP, mm Hg	83 (8)	78 (7)	<0.001
Heart rate, bpm	74 (9)	67 (7)	<0.001
LVEF, %	42 (38–46)	60 (57–63)	<0.001
CCA-IMT, mm	1.19 (1.05–1.35)	0.78 (0.68–0.88)	<0.001
Total cholesterol, mg/dL	198 (172–224)	176 (160–194)	<0.001
LDL cholesterol, mg/dL	122 (102–146)	102 (88–118)	<0.001
HDL cholesterol, mg/dL	52 (46–58)	62 (56–70)	<0.001
Triglycerides, mg/dL	140 (108–180)	110 (88–132)	<0.001
Fasting glucose, mg/dL	96 (90–101)	90 (85–95)	<0.001

Smoking (current), n (%)	170 (42.5)	40 (20.0)	<0.001
Hypertension, n (%)	200 (50.0)	10 (5.0)	<0.001

Data are presented as mean (SD) or median (interquartile range), depending on distribution assessed using the Shapiro–Wilk test

Abbreviations: BMI, body mass index; BP, blood pressure; CCA-IMT, common carotid artery intima–media thickness; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction

Table 2 Quality of life assessed by the SF-36 questionnaire in the study and control groups

Characteristic	Study (n = 400)	Control (n = 200)	*P* value
Global SF-36 score	121.3 (8.9)	134.6 (7.5)	<0.001
Physical component (PCS)	58.2 (5.4)	67.9 (5.1)	<0.001
Physical functioning (PF)	55.6 (7.2)	70.8 (6.3)	<0.001
Role physical (RP)	56.3 (8.1)	69.5 (6.8)	<0.001
Bodily pain (BP)	59.8 (7.0)	68.7 (6.1)	<0.001
General health (GH)	57.9 (6.8)	69.2 (5.9)	<0.001
Mental component (MCS)	63.1 (6.0)	69.4 (5.7)	<0.001
Social functioning (SF)	66.8 (7.5)	73.9 (6.2)	<0.001
Vitality (VT)	62.7 (6.9)	70.1 (6.0)	<0.001
Mental health (MH)	64.9 (6.4)	71.0 (5.6)	<0.001
Role emotional (RE)	61.5 (7.3)	68.3 (6.5)	<0.001

Data are presented as mean (SD). Between-group comparisons were performed using the Welch t-test

Abbreviations: BP, bodily pain; GH, general health; MCS, mental component summary; MH, mental health; PCS, physical component summary; PF, physical functioning; RE, role

emotional; RP, role physical; SF, social functioning; SF-36, Short Form-36 Health Survey; VT, vitality

Table 3 Resting (flaccid) penile Doppler ultrasonography parameters in the study and control groups

Characteristic	Study (n = 400)	Control (n = 200)	*P* value
IIEF-5 score, points	15.0 (12–18)	24.0 (23–25)	<0.001
PSV, cm/s	23.0 (17.0–27.0)	28.5 (26.0–31.0)	<0.001
EDV, cm/s	6.0 (5.0–9.0)	5.0 (4.0–6.0)	<0.001
RI	0.74 (0.65–0.82)	0.82 (0.78–0.90)	<0.001

Data are presented as median (interquartile range). Between-group comparisons were performed using the Wilcoxon rank-sum test

Abbreviations: EDV, end-diastolic velocity; IIEF-5, International Index of Erectile Function-5; PSV, peak systolic velocity; RI, resistive index

Table 4 Multivariable linear regression analysis of factors associated with quality of life (SF-36 total score)

Explanatory variable	Quality of life (SF-36 total score) — post–myocardial infarction group		
	β	95% CI	*P* value
Constant	120.96	119.05–122.87	<0.001[a]
Age, years	-0.04	-0.10–0.01	0.15
BMI, kg/m²	-0.36	-0.62–-0.11	0.006[a]
IIEF-5	1.42	1.16–1.68	<0.001[a]
Heart rate, bpm	-0.05	-0.09–-0.00	0.04[a]

LVEF, %	0.18	0.10–0.25	<0.001[a]
LA, cm	-0.51	-1.73–0.72	0.42
AVV, m/s	1.49	0.07–2.92	0.04[a]
ICA-PSV, cm/s	-0.03	-0.04–-0.01	<0.001[a]
ICA-EDV, cm/s	0.07	0.04–0.10	<0.001[a]
ICA Flow: Turbulent vs. Laminar	-8.03	-10.16–-5.90	<0.001[a]
CCA-IMT, mm	-5.46	-7.90–-3.03	<0.001[a]
Penile PSV, cm/s	0.12	0.01–0.24	0.03[a]
Penile EDV, cm/s	-0.14	-0.31–0.04	0.12
WBC, $\times 10^3/\mu L$	-0.52	-0.78–-0.27	<0.001[a]
RBC, $\times 10^6/\mu L$	-0.47	-0.75–-0.19	<0.001[a]
Neutrophils, %	0.24	0.16–0.31	<0.001[a]
Total cholesterol, mg/dL	0.03	0.01–0.04	0.004[a]
HDL, mg/dL	0.05	-0.02–0.11	0.17
LDL, mg/dL	0.01	0.00–0.02	0.03[a]
Chlorides, mmol/L	0.28	0.07–0.49	0.01[a]

Model $R^2 = 0.62$; adjusted $R^2 = 0.60$; n = 400. The model was fitted in the post–myocardial infarction group

a Statistically significant results ($P < 0.05$)

The final model was derived using backward stepwise selection based on the Akaike information criterion (AIC). Variables included in the initial model were selected based on clinical relevance and prior literature.

Abbreviations: AVV, aortic valve velocity; BMI, body mass index; CCA-IMT, common carotid artery intima–media thickness; CI, confidence interval; EDV, end-diastolic velocity; HDL, high-density lipoprotein cholesterol; ICA, internal carotid artery; IIEF-5, International

Index of Erectile Function-5; LA, left atrial diameter; LDL, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; PSV, peak systolic velocity; WBC, white blood cells; β, regression coefficient

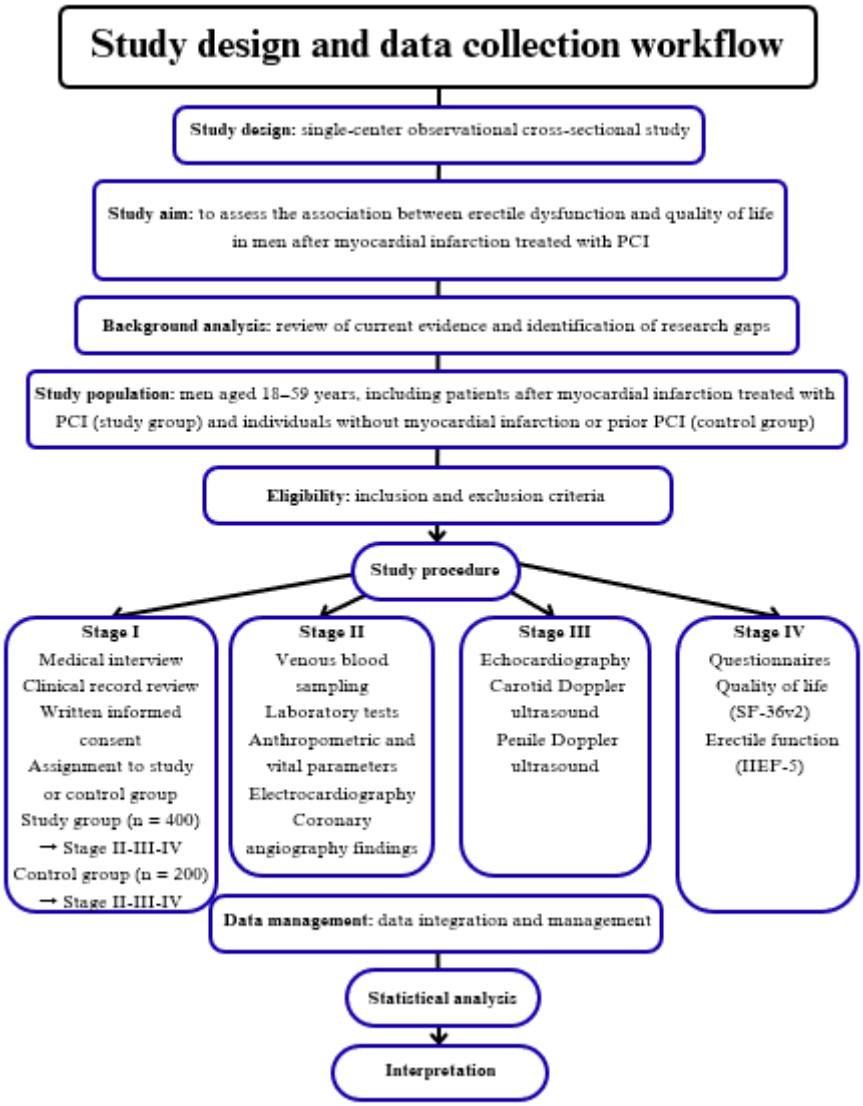

Figure 1 The study design

Short title: ED and quality of life post-MI: POC penile Doppler study