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Resilience is strongly associated with health-related quality of life but does not buffer work-related stress in employed persons 1 year after acute myocardial infarction

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Abstract

Purpose Resilience may facilitate the adaptation after experiencing a severe disease such as acute myocardial infarction (AMI) and attenuate the negative effects of stress on health-related quality of life (HRQOL). However, it is unclear so far whether resilience moderates a negative association between work-related stress and HRQOL in employed patients after AMI.

Methods Patients with confirmed AMI and regular paid employment admitted to a hospital in the study region of the MONICA/KORA Myocardial Infarction Registry, Germany (04/2014–06/2017) were included and completed questionnaires during their hospital stay and 6 and 12 months after discharge. The Resilience Questionnaire (RS-11) and the Effort–Reward Imbalance (ERI) Questionnaire were used to assess trait resilience and ERI, respectively. HRQOL was measured by the Short Form 36 Health Survey (SF-36) mental and physical component summary scales. Generalized estimating equations (GEE) adjusted for relevant potential confounding variables (demographic, social, stress-related, and clinical) were used to determine the association between resilience and HRQOL in the study course.

Results From the 346 patients enrolled in the study, 270 patients (78.0%) had completed all surveys. High baseline trait resilience was significantly and independently associated with high physical HRQOL ($\beta = 0.15$, $p < 0.0001$) and high mental HRQOL ($\beta = 0.37$, $p < 0.0001$) 1 year post AMI. No significant interaction effects between trait resilience and ERI were found in the physical HRQOL GEE model ($\beta = 0.05$, $p = 0.7241$) and in the mental HRQOL model ($\beta = 0.05$, $p = 0.3478$).

Conclusions The results demonstrated that trait resilience is independently and strongly related with post-AMI HRQOL but does not moderate the association between ERI and HRQOL.

Keywords Myocardial infarction · Psychological resilience · Job-related stress · Health-related quality of life

Introduction

Acute myocardial infarction (AMI) is a life-threatening event leading to considerable distress in many patients. 18% and 16% of the patients develop clinically relevant symptoms of acute stress disorder and post-traumatic stress disorder [1]. Besides functional changes of the heart muscle, insufficient adaptation to stress and required life changes (e.g., medication intake, behavioral changes, risk factor control) is the major contributor to impairments of functioning and health-related quality of life (HRQOL) post AMI [2]. In employed patients with AMI, work-related stress is an additional factor which may contribute to adverse HRQOL outcomes [3, 4]. In contrast to already retired individuals, employed patients with AMI have to manage their return to work after AMI and consider changes of the working situation in order to reduce work-related stress in addition to further life changes.

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About 25% of the patients with AMI are in the working age younger than 65 years. Given an incidence rate of 166 per 100,000 inhabitants in persons with AMI younger than 65 years, it can be expected that in Germany about 138,000 persons each year who are in employment are affected by an AMI [5]. Thus, employed patients with AMI are a relevant and vulnerable group which may need additional support or health care interventions in order to successfully manage the post-AMI situation.

A number of personal and environmental factors are suspected to influence the process of adaptation to living with an AMI [6]. One factor which may play a key role in coping with AMI is resilience. A generally accepted definition refers to resilience as "successful adaptation and swift recovery after experiencing severe adversity during life" [7]. However, resilience is a complex construct and the usage of the term resilience varies in the literature. Some researchers consider resilience as a positive outcome after a traumatic event or as a factor describing the process of positive adaptation after a traumatic event [8]. A third approach regards resilience as a personality characteristic (trait) that moderates the negative effects of stress and promotes adaptation [9]. Over the past years, the concept of resilience has increasingly changed from a trait-oriented to an outcome- or process-oriented approach, but it is still open to debate. In addition, psychometrically sound questionnaires to assess resilience as outcome or process are only recently available in different languages [10]. Therefore, the decision to examine trait resilience in the present study was mainly driven by the unavailability of validated German translations of questionnaires such as the Brief Resilience Scale [11] or the Resilience Scale for Adults [12] in the year 2013, when the study was planned. In contrast, a widely used and psychometrically tested questionnaire to measure trait resilience, the Resilience Scale (RS-11), [9] was available.

Since physical illness is a common adversity throughout life, resilience is increasingly addressed in studies on adults with various health conditions. However, according to a systematic review of 52 studies which have examined resilience and related concepts in physically ill persons, only six studied patients with cardiovascular disease [13]. Although a few studies are available so far, which indicate that concepts related with resilience are associated with the HRQOL of persons with AMI [14, 15], there is an apparent lack of studies on the effects of resilience on HRQOL in patients with AMI which provide a direct assessment of resilience [10].

Work-related stress can be assessed with the Effort–Reward Imbalance (ERI) model developed by Siegrist [16]. The ERI model emphasizes that a perceived imbalance between high effort spent at work and low reward is associated with adverse effects on health. In contrast to other models, it includes both extrinsic efforts (situational factors which make work more demanding) and intrinsic efforts (e.g., motivation and commitment to work), and a combination of both sources. Thus, it may be a more comprehensive indicator of stress at work than for instance the job-demand model by Karasek [17, 18].

Although persons who are employed before experiencing an AMI are a particularly vulnerable group, studies investigating the association between work-related stress, resilience, and HRQOL in employees after AMI are completely lacking. So far, it is unclear whether resilience serves as a protective factor to compensate the adverse effects of work-related stress on HRQOL in this group.

Accordingly, the objective of this study was to examine the association between resilience and HRQOL in employed patients after AMI using a direct assessment of resilience in a longitudinal study design and considering a potential interaction effect between resilience and ERI at work.

Methods

Ethical approval was obtained from the ethics committee of the Bavarian Medical Association (No. 14007) in March 2014. A pilot phase with ten patients was started thereafter in order to test the study processes and the feasibility of the baseline questionnaire. The first patient was enrolled in April 2014, the last one-year follow-up took place in June 2017.

Study design

A longitudinal observation study was conducted. After the AMI-patient´s inclusion in the study with informed consent, a baseline survey was performed during the hospital stay. Follow-up data were collected using postal surveys 6 months and 1 year after the AMI.

Study population

The study population consisted of patients with AMI who were admitted to a hospital in the study region of the MONICA/KORA Myocardial Infarction Registry. This population-based AMI registry was initiated in 1984 as part of the World Health Organization MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) project [19]. After the termination of the MONICA project in 1995, the registry became part of the framework of KORA (Cooperative Health Research in the Region of Augsburg). Data on hospitalized patients are obtained from eight hospitals within the study region and two in the adjacent areas.

For the identification of eligible patients, records of all patients admitted to the participating hospitals in the study region are screened to identify patients with AMI. Identified patients are visited routinely by the registry's study nurses and if possible enrolled. Inclusion criteria for the current

study were confirmed AMI, regular paid employment of at least 10 h per week before the AMI, sufficient knowledge of the German language, and informed written consent.

Data collection

The study nurses initially contacted eligible patients at the ward, provided information on the study, obtained informed consent, distributed the baseline questionnaire, and collected the completed questionnaire during the following days. Follow-up questionnaires were administered by postal delivery. If patients did not respond, the nurse called them by telephone and reminded or asked for any problems with completing the questionnaires. For patients who did not provide a telephone number or could not be reached, a postal reminder was sent.

Survey data

The survey consisted of a questionnaire which includes a number of self-administered instruments in order to assess independent variable, outcome, and confounding variables (see Table 1).

The Resilience Scale (RS-11) contains 11 questions on self-esteem, optimism and internal locus of control and is a short form of the 25-item questionnaire developed by Wagnild and Young [9]. The purpose of the Resilience Scale is to measure the degree of individual resilience, considered a personality trait [9]. Schumacher et al. [20] reported on the psychometric evaluation of the German version in a large population sample and developed a unidimensional, short form comprising 11 items. The RS-11 short form showed good internal consistency and a high correlation ($r = 0.95$) with the 25-item version. It has been applied in persons with AMI [21, 22] and has shown similar reliability coefficients (Cronbach's Alpha = 0.93) as in the original sample of the German population (Cronbach's Alpha = 0.91) [20].

The primary outcome of this study was HRQOL. Lacking a validated AMI-specific questionnaire in German language, we have chosen a generic measure, namely the German version of the Short Form 36 Health Survey (SF-36) [23]. It is a 36-item generic questionnaire assessing eight single domains of HRQOL and two summary component scales on physical and mental HRQOL. It is frequently used and validated worldwide; demonstrates good reliability, validity, and responsiveness; and has already been applied in studies with AMI patients [24]. For the present analysis, the physical and the mental component summary scales were used.

Furthermore, a number of other potential confounders were assessed. Work-related stress was measured using the Effort–Reward Imbalance Questionnaire (ERI) [16]. The short form of the ERI questionnaire includes 16 questions about effort, reward, and overcommitment at work. This questionnaire has its focus on the relation between commitment to work and received reward. The aspect of reward is regarded in different dimensions such as material and immaterial gratification: appreciation, payment/upgrading, and job security. The questionnaire was validated in Germany by Siegrist et al. [16] and was applied in European cohorts, including patients with coronary heart disease [25]. Besides

Table 1 Overview on concepts and instruments

Concept	Instrument	Scoring
Independent variable		
Resilience	Resilience questionnaire (RS-11)	Summary score, range 11–77, higher score indicates more resilience
Outcomes		
Physical health-related quality of life	Short Form 36 Health Survey (SF-36), physical summary component scale	Weighted score, German reference population, range −0.33 to 77.31, higher score indicates better physical HRQOL
Mental health-related quality of life	Short Form 36 Health Survey (SF-36), physical summary component scale	Weighted score, German reference population, range −0.60 to 78.17, higher score indicates better physical HRQOL
Confounder		
Effort–Reward Imbalance at work	Effort–Reward Imbalance Questionnaire (ERI)	Weighted summary score, range 0.25–3.99, higher score indicates more effort for less reward
Private strain	Self-developed question according to the INTER-HEART study	Likert scale, range 1–4, higher score indicates more strain
Financial strain	Self-developed question according to the INTER-HEART study	Likert scale, range 1–3, higher score indicates more strain
Perceived stress	Perceived Stress Scale (PSS4)	Summary score, range 0–16, higher score indicates more stress

Instruments were administered at baseline, 6 and 12 months after acute myocardial infarction

work-related stress, financial and private strain were considered by self-developed questions about stressors related to finances, partner, or family according to the INTERHEART study [26]. Additionally, overall perceived stress was assessed using the Perceived Stress Scale (PSS4) [27]. The PSS4 comprises four questions on the perception of stress in general and provides a useful and economic measure of perceived stress.

Clinical data

For patients who are registered at the MONICA/KORA Myocardial Infarction Registry ($n=301$, 87%), information on clinical characteristics, such AMI risk factors, AMI type, recurrent infarction, and in-hospital treatment, was extracted from this database. For not-registered patients ($n=45$, 13%), the corresponding information was extracted from their medical records.

Statistical analysis

Sample size estimation was performed using G*Power 3.1 [28]. Given an effect size of 0.3 and a power of 80% at a two-sided type I error level of 5%, at least 240 patients were required. Based on the experiences from previous studies conducted within the KORA MI Registry framework, it was expected that not more than 30% of the included patients would be lost to follow-up or die. Consequently, 343 patients were needed to be enrolled in the study.

Besides descriptive statistics, changes of scores over time were tested with repeated measures ANOVA or paired t tests, if appropriate. Cohen's D was calculated as a measure of effect size. Generalized estimating equations (GEE) with exchangeable correlation matrix were used to determine the association between resilience and mental as well as physical HRQOL in the study course. In contrast to linear regression models, GEE provides estimates of the regression coefficients without completely specifying the response distribution. Instead, GEE uses the correlation between a subject's repeated measurements. Physical and mental HRQOL served as outcome variables, and resilience was the independent variable. GEE models were adjusted for relevant potential confounding variables (gender, age, marital status, ERI, perceived stress, private and financial strain, obesity, diabetes, smoking, AMI type, reinfarction, recanalization therapy, left ventricular ejection fraction). ERI, perceived stress, as well as private and financial strain were time-varying variables, all others were time-invariant. Potential confounders were selected according to the disjunctive cause criterion, i.e., variables which may be related with the independent variable, the dependent variable or both, were included in the statistical model [29]. Interaction effects of age and gender, as well as resilience and ERI, were tested. The level of significance was set to 0.05. Statistical analyses were performed with SAS version 9.4.

Results

In the study period, 1735 persons with AMI were admitted to the recruiting hospitals and were contacted by the study nurse. 1230 were not eligible, because they had no regular paid employment of at least 10 h per week before the AMI and 30 were lacking sufficient knowledge of the German language. Of the 475 eligible persons, 127 (26.7%) refused participation. From the 348 patients enrolled in the study, 296 (85.1%) completed the survey at 6 months and 288 (82.8%) at 1 year post AMI. All three surveys were available for 272 patients (78.2%). Seven patients died within 1 year. For the data analysis, two patients were excluded because the AMI diagnosis was withdrawn or the resilience questionnaire was not completed at baseline, leaving 346, 294 and 287 patients, respectively, to be analyzed for the three measure points, and 270 patients (78.0%) who had completed all surveys.

Sample characteristics

The characteristics of the analysis sample ($n=270$) are shown in Table 2. The sample mainly consisted of men (83.7%) with a mean age of 54.3 ± 7.5 years. Most persons were married (75.8%) and fully employed (84.0%) before the AMI event. White-collar workers were slightly more frequent than blue-collar workers (41.6% and 33.1%, respectively). The sample had a risk factor profile typical for AMI with a high percentage of current smokers (47.0%), history of hypertension (58.6%), or hyperlipidemia (49.1%). AMIs with and without ST-segment elevation were almost equally represented (43.8% and 48.0%, respectively), and 12.3% of the participants had a recurrent AMI. AMI treatment consisted of recanalization therapy in 94.0% of the patients, most of them (88.8%) had a percutaneous coronary intervention and 9.3% had a coronary artery bypass graft surgery. The majority of participants (63.5%) showed normal (> 50%) left ventricular ejection fractions.

In terms of most characteristics, patients who completed all surveys did not differ significantly from those who had not completed all surveys. However, patients with incomplete study participation were significantly more likely to be unmarried (41.9% vs. 24.1%, $p=0.0027$), blue-collar workers (48.7% vs. 33.0%, $p=0.0224$), and current smokers (66.2% vs. 47.2%, $p=0.0140$) and had a significantly lower mean resilience score at the baseline survey (59.3 ± 10.4 vs. 62.0 ± 9.7, $p=0.0352$).

Table 2 Characteristics of the analysis sample of 270 patients

	Mean	SD
Age (years)	54.3	7.5
	n	%
Gender		
Male	226	83.7
Female	44	16.3
Marital status		
Married	194	75.8
Unmarried	62	24.2
Work time		
≥ 35 h/week	226	84.0
15–34 h/week	36	13.4
10–15 h/week	7	2.6
Type of occupation		
Blue-collar worker	89	33.1
White-collar worker	112	41.6
Public officer	17	6.3
Self-employed	51	19.0
Smoking		
Current smoker	125	47.0
Ex-smoker	91	34.2
Never smoker	50	18.8
Disease history		
Stroke	6	2.2
Hypertension	157	58.6
Angina pectoris	18	6.8
Hyperlipidemia	131	49.1
Diabetes	50	18.7
Coronary heart disease	41	15.3
Obesity	78	29.2
AMI characteristics		
First AMI	235	87.7
Reinfarction	33	12.3
AMI type		
STEMI	117	43.8
NSTEMI	128	48.0
Bundle branch block	15	5.6
Undefined	7	2.6
LVEF		
> 50%	169	63.5
41–50%	57	21.4
31–40%	28	10.5
≤ 30%	10	3.8
n/a	2	0.8
AMI treatment		
Any recanalization therapy	252	94.0
PCI yes	238	88.8
CABG yes	25	9.3

n/a not available, *AMI* acute myocardial infarction, *STEMI* ST-segment elevation myocardial infarction, *NSTEMI* non-ST-segment elevation myocardial infarction, *LVEF* left ventricular ejection fraction, *PCI* percutaneous coronary intervention, *CABG* coronary artery bypass graft

Changes of scores over time

A number of measures changed over the observation period of 1 year in the sample of $n = 270$ patients who completed all surveys (see Table 3). While physical HRQOL and ERI significantly improved, a deterioration was found in terms of mental HRQOL and resilience. Effect sizes of most variables that changed significantly were small (< 0.24), only the improvement in physical HRQOL with an effect size of 0.65 can be considered as a moderate change.

Association between resilience, ERI, and HRQOL

The inter-correlations of all continuous variables at baseline, 6, and 12 months of follow-up are shown in Table 4.

Tables 5 and 6 illustrate the findings from the GEE analyses. High baseline resilience was found to be independently and significantly ($p < 0.0001$) associated with high physical HRQOL 1 year post AMI in the complete cases sample (n = 270) (see Table 5). A high level of ERI was negatively associated ($p = 0.0077$) with physical HRQOL, whereas other measures of stress showed no significant associations. In addition, higher age ($p < 0.0001$), obesity ($p = 0.0007$), and diabetes ($p \leq 0.0005$) had an adverse association with physical HRQOL, whereas male gender ($p = 0.0205$) and married status ($p \leq 0.0001$) were significantly related with good physical HRQOL 1 year post AMI.

In terms of mental HRQOL 1 year post AMI, baseline resilience had the strongest independent association ($p < 0.0001$) (see Table 6). ERI ($p = 0.0302$) as well as other stress measures such as perceived stress ($p < 0.0001$), permanent private strain ($p = 0.0375$), and moderate financial strain ($p = 0.0293$) showed negative associations with mental HRQOL. Again, men had significantly ($p = 0.0034$) better post-AMI mental HRQOL scores than women.

Interaction effects

No significant interaction effects were found for resilience and ERI in the physical HRQOL GEE model ($p = 0.7241$) or in the mental HRQOL model ($p = 0.3478$). Furthermore, the interaction between age and gender was not significant (Physical HRQOL: $p = 0.8808$, mental HRQOL: $p = 0.7137$).

Discussion

This study indicates that the level of resilience plays a crucial role for both the mental and the physical dimension of HRQOL 1 year after AMI in younger, employed persons. It was shown that the association between resilience and HRQOL was independent from other demographic, social, and clinical factors. Moreover, resilience was found to have the strongest relation with mental HRQOL and the second strongest relation with physical HRQOL 1 year after AMI. The hypotheses that resilience interacts with ERI could not be confirmed.

The finding that resilience is independently associated with HRQOL confirms other studies on populations with cancer, diabetes, nephrectomy, Parkinson's disease, and coronary heart disease [13, 30]. Particularly, mental HRQOL components were found to be positively related with resilience [30, 31]. Contrary to the results from the present study, no significant association between resilience and HRQOL was found in some previous studies on chronic heart failure and digestive cancer [32, 33]. It was, however, surprising that resilience emerged as the variable with the strongest association with mental HRQOL and the second strongest association (following age) with physical HRQOL in the current study, despite the adjustment for a number of clinically relevant variables. This result highlights the role of personal and social factors in the adjustment and coping process after AMI. There are two studies which investigated the association of sense of coherence (which is a concept

Table 3 Change of scores over 1 year ($n = 270$)

Concept	Instrument	Baseline		6 months		12 months		p value[a]	Effect size[b]
		Mean	SD	Mean	SD	Mean	SD		
Resilience	Resilience questionnaire (RS-11)	61.98	9.71	59.07	11.42	59.70	11.15	< 0.0001	0.23
Mental HRQOL	Short Form 36 Health Survey (SF-36)	49.35	11.88	47.07	10.79	47.91	10.17	0.0046	0.13
Physical HRQOL	Short Form 36 Health Survey (SF-36)	41.53	10.56	47.95	9.60	48.57	9.04	< 0.0001	0.65
Effort–reward imbalance	Effort–Reward Imbalance Questionnaire (ERI)	1.27	0.45	1.11	0.38	1.20	0.47	0.0045	0.15
Perceived stress	Perceived Stress Scale (PSS4)	6.03	3.06	5.83	3.02	5.88	2.96	0.6349	0.05
Private strain	Modified item from INTERHEART	2.33	0.77	2.30	0.78	2.31	0.72	0.8911	0.03
Financial strain	Modified item from INTERHEART	1.72	0.77	1.68	0.76	1.69	0.73	0.6381	0.06

[a]Repeated measures ANOVA

[b](Mean 12 months – mean baseline)/SD of (mean 12 months – mean baseline)

Table 4 Inter-correlations of continuous variables: Spearman correlation coefficients and *p* value

	Effort–reward imbalance	Mental HRQOL	Physical HRQOL	Perceived stress	Age
Resilience					
Baseline	−0.12 0.0322	0.38 <0.0001	0.04 0.4735	−0.41 <0.0001	0.09 0.0971
6 months	−0.07 0.3532	0.53 <0.0001	0.33 <0.0001	−0.13 0.0237	0.06 0.2759
12 months	−0.10 0.1316	0.63 <0.0001	0.45 <0.0001	−0.62 <0.0001	0.06 0.3159
Effort–reward imbalance					
Baseline		−0.34 <0.0001	−0.12 0.0345	0.34 <0.0001	−0.02 0.7531
6 months		−0.06 0.3911	0.02 0.7843	0.36 <0.0001	0.05 0.4627
12 months		−0.23 0.0007	−0.01 0.8517	0.27 0.0007	−0.14 0.0373
Mental HRQOL					
Baseline			0.07 0.1970	−0.57 <0.0001	−0.01 0.9149
6 months			0.18 0.0020	−0.13 0.0244	0.06 0.3173
12 months			0.35 <0.0001	−0.71 <0.0001	0.14 0.0191
Physical HRQOL					
Baseline				−0.17 0.0456	−0.11 0.0456
6 months				−0.06 0.3256	−0.19 0.0009
12 months				−0.37 <0.0001	−0.15 0.0105
Perceived stress					
Baseline					−0.07 0.1872
6 months					0.03 0.6264
12 months					−0.15 0.0121

HRQOL health-related quality of life

closely related with resilience) and HRQOL in patients with AMI and showed partly comparable results. Bergman et al. [14] found a significant association between sense of coherence and physical limitation (as assessed by the Seattle Angina Questionnaire) more than 4 years after incident AMI in 78 patients. However, clinical factors were not considered as potential confounders. Wrześniewski et al. [15] also investigated the association between sense of coherence and HRQOL (as assessed by the McNew questionnaire) 1 year after AMI in 83 patients. They found that high sense of coherence was positively related with all dimensions of HRQOL, including physical HRQOL. Adjustment for clinical factors was limited to the use of beta-blockers. In contrast, Chan et al. [30] demonstrated that a composite measure of resilience (covering optimism, perceived control and self-esteem) was significantly associated with the mental summary scale of the SF36, but not with the physical summary scale. This study included 67 patients with coronary artery disease and analyzed scores before and after an 8-week rehabilitation program without adjustment for potential confounders. Comparability of these trials with the present study may be, however, limited by differences regarding study design, instruments to measure resilience and HRQOL, and statistical analysis.

Besides level of resilience, baseline ERI was found to be significantly and independently associated with both mental and physical HRQOL post AMI. Cross-sectional studies which also used the SF-36 as an indicator of HRQOL confirmed that high ERI scores were associated with low SF-36 scores in the general population [18], psychiatrists [31], and

Table 5 General equation estimation model ($n = 270$): dependent variable physical health-related quality of life (SF-36 physical component summary scale)

	Estimate	Standard error	95% confidence interval		Z	*p*
Resilience	0.15	0.04	0.08	0.22	4.12	< 0.0001
Effort–reward imbalance	− 1.59	0.60	− 2.76	− 0.42	− 2.67	0.0077
Perceived stress	− 0.08	0.14	− 0.35	0.19	− 0.59	0.5540
Private strain[a]						
Always	− 1.31	2.06	− 5.34	2.72	− 0.64	0.5244
Sometimes	− 0.82	1.11	− 2.99	1.35	− 0.74	0.4570
Rarely	− 0.18	0.99	− 2.12	1.76	− 0.18	0.8561
Financial strain[b]						
Severely	− 0.89	0.97	− 2.79	1.01	− 0.92	0.3584
Moderately	− 0.49	0.73	− 1.92	0.95	− 0.66	0.5064
Age	− 0.25	0.06	− 0.36	− 0.13	− 4.32	< 0.0001
Gender[c]						
Male	3.20	1.38	0.49	5.91	2.32	0.0205
Marital status[d]						
Married	3.96	1.02	1.97	5.95	3.89	< 0.0001
Reinfarction[e]						
Yes	− 0.35	1.32	− 2.93	2.24	− 0.26	0.7935
Recanalization therapy[f]						
Yes	1.83	1.59	− 1.29	4.95	1.15	0.2500
LVEF[g]						
≤ 50%	0.68	0.94	− 1.16	2.53	0.73	0.4678
Not determined	− 1.35	2.72	− 6.68	3.97	− 0.50	0.6184
Obesity[e]						
Yes	− 3.02	0.90	− 4.78	− 1.27	− 3.37	< 0.0001
Diabetes[e]						
Yes	− 4.29	1.23	− 6.70	− 1.89	− 3.50	< 0.0001
Smoking[g]						
Current smoker	0.14	1.17	− 2.17	2.45	0.12	0.9051
Ex-smoker	− 0.77	1.20	− 3.11	1.58	− 0.64	0.5215
AMI type[h]						
NSTEMI	0.50	0.88	− 1.22	2.22	0.57	0.5706
Bundle branch block	− 2.60	2.05	− 6.62	1.42	− 1.27	0.2042
Undefined	2.87	2.03	− 1.10	6.84	1.42	0.1569

LVEF left ventricular ejection fraction, *AMI* acute myocardial infarction, *NSTEMI* non-ST-segment elevation myocardial infarction

[a]Reference category.: never; [b] Ref. Not at all/little; [c] Ref.: female; [d] Ref.: unmarried; [e] Ref.: No; [f] Ref.: > 50%; [g] Ref.: Never; [h] Ref.: ST-segment elevation myocardial infarction

copper–nickel miners [34]. However, to our knowledge, the present study was the first which confirmed this association in persons with AMI in a longitudinal study. The finding that the mean ERI score significantly (but with a small effect size) improved over 1 year may reflect the patients' efforts to improve a stressful job situation or to cope with the existing situation in order to prevent a recurrent AMI event. Indeed, intervention studies have shown that stress management interventions can reduce ERI and improve mental health [35]. Consequently, the findings from the present study suggest interventions for persons with AMI and high ERI in order to improve post-AMI HRQOL.

In the current study, resilience did not moderate the negative consequences of ERI on HRQOL in employed persons with AMI. This finding is not consistent with findings from other studies with different diseases. For instance, in persons with spinal cord injury, Catalano et al. [36] found that the relation between perceived stress and depressive symptoms was mediated by resilience and Wu et al. [37] showed that resilience mediates the relation between cancer symptom distress and HRQOL. However, in contrast to these study, the current study investigated the effects of stress from a very specific source, namely the workplace. Managing work-related stress may require specific strategies that go beyond

Table 6 General equation estimation model ($n = 270$): dependent variable mental health-related quality of life (SF-36 mental component summary scale)

	Estimate	Standard error	95% confidence interval		Z	p
Resilience	0.37	0.04	0.30	0.44	9.76	< 0.0001
Effort–reward imbalance	− 1.33	0.64	− 2.53	− 0.13	− 2.17	0.0302
Perceived stress	− 0.70	0.14	− 0.98	− 0.42	− 4.91	< 0.0001
Private strain[a]						
Always	− 4.13	1.98	− 8.02	− 0.24	− 2.08	0.0375
Sometimes	− 1.44	0.98	− 3.37	0.49	− 1.47	0.1428
Rarely	0.05	0.86	− 1.64	1.74	0.06	0.9504
Financial strain[b]						
Severely	0.71	0.92	− 1.09	2.51	0.77	0.4402
Moderately	1.50	0.69	0.15	2.85	2.18	0.0293
Age	− 0.00	0.05	− 0.10	0.09	− 0.01	0.9893
Gender[c]						
Male	3.66	1.25	1.21	6.12	2.93	0.0034
Marital status[d]						
Married	− 0.71	0.88	− 2.43	1.01	− 0.81	0.4158
Reinfarction[e]						
Yes	− 1.06	1.17	− 3.36	1.24	− 0.90	0.3678
Recanalization therapy[e]						
Yes	2.28	1.34	− 0.35	4.91	1.70	0.0888
LVEF[f]						
≤ 50%	1.24	0.85	− 0.42	2.90	1.47	0.1429
Not determined	7.52	3.76	0.16	14.88	2.00	0.0453
Obesity[e]						
Yes	− 0.04	0.88	− 1.76	1.68	− 0.04	0.9663
Diabetes[e]						
Yes	0.07	1.08	− 2.04	2.19	0.07	0.9455
Smoking[g]						
Current smoker	− 0.61	1.11	− 2.79	1.57	− 0.55	0.5833
Ex-smoker	0.31	1.11	− 1.88	2.49	0.27	0.7835
AMI type[h]						
NSTEMI	0.60	0.80	− 0.97	2.16	0.75	0.4554
Bundle branch block	− 0.04	1.55	− 3.07	2.99	− 0.03	0.9788
Undefined	− 3.75	2.78	− 9.20	1.70	− 1.35	0.1774

LVEF left ventricular ejection fraction, *AMI* acute myocardial infarction, *NSTEMI* non-ST-segment elevation myocardial infarction

[a]Reference category.: never; [b] Ref. Not at all/little; [c] Ref.: female; [d] Ref.: unmarried; [e] Ref.: No; [f] Ref.: > 50%; [g] Ref.: Never; [h] Ref.: ST-segment elevation myocardial infarction

the resources of trait resilience. To sum up, since no similar studies exist, further research is needed in order to provide an appropriate explanation of these results.

To our knowledge, this is the first study which examined the association between resilience and HRQOL in the subgroup of employed persons after AMI taking ERI into account. The long-term study design and appropriate sample size are major strengths of the current study. In addition, standardized assessment of resilience and adjustment for a number of demographic, stress-related, and clinical variables in elaborate statistical GEE models have contributed to the quality of this study.

Limitations

Unfortunately, statistical analyses have to be restricted to the study participants with complete follow-up information since missing data were not at random and therefore the assumption that GEE models can deal with missing cases was not fulfilled. Particularly, the finding that participants who did not complete all surveys had a lower baseline level of resilience than those who were analyzed indicates a selection bias and limits external validity of the results. In addition, there may be also some overlap in the operationalization of the predictor resilience and the outcome mental HRQOL,

e.g., both the RS-11 and the SF-36 include an item addressing the persons' perceived energy level. Thus, it cannot be excluded that a certain proportion of the association between resilience and mental HRQOL was explained by this overlap. Finally, we cannot exclude residual confounding.

Future directions

This study adds important knowledge on the role of resilience and ERI as factors contributing to post-AMI HRQOL. The utility of the resilience inquiry lies in its potential to identify persons with low resilience who are at risk of HRQOL impairments post AMI and to offer appropriate interventions. The strong association between trait resilience and post-AMI HRQOL detected in the present study suggests interventions to strengthen various resilience-promoting resources such as self-efficacy, social support, and coping strategies [38]. Such interventions are commonly part of multi-modal cardiac rehabilitation programs; however, a routine identification of patients with low trait resilience is currently missing. Since screening for depression and anxiety is increasingly being performed at the start of cardiac rehabilitation, a screening for resilience could be easily added [39].

A high level of trait resilience, however, did not buffer the negative effects of ERI on HRQOL in the present study. It implies that patients with high levels of ERI may need specific additional support to help them manage ERI and improve their vocational situation. Although vocational counseling is commonly offered in post-AMI rehabilitation settings, studies identified the need to strengthen and revise vocational interventions in cardiac rehabilitation [40]. In addition, since in Germany only about 50% of the patients utilize cardiac rehabilitation, new approaches of post-AMI care shall be developed in order to reach more patients [41]. Identification and support of patients with AMI with low trait resilience or high ERI may be implemented in future post-AMI care and contribute to a better HRQOL after AMI.

Conclusions

This study demonstrated that trait resilience is independently and strongly related with HRQOL in employed person 1 year after AMI. However, resilience did not moderate the negative consequences of ERI on HRQOL. Further studies are needed to confirm the results of the present trial.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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