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# Relationships between positive psychological constructs and health outcomes in patients with cardiovascular disease: a systematic review

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## Abstract

Depression and anxiety are well-known to be associated with adverse health outcomes in cardiac patients. However, there has been less work synthesizing the effects of positive psychological constructs (e.g., optimism) on health-related outcomes in cardiac patients. We completed a systematic review of prospective observational studies using established guidelines. A search of PubMed and PsycINFO databases from inception to January 2014 was used to identify articles. To be eligible, studies were required to assess effects of a positive psychological construct on subsequent health-related outcomes (including mortality, rehospitalizations, self-reported health status) in patients with established heart disease. Exploratory random effects meta-analyses were performed on the subset of studies examining mortality or rehospitalizations. Seventy-seven analyses from 30 eligible studies ($N$=14,624) were identified. Among studies with 100 or more participants, 65.0% of all analyses and 64.7% of analyses adjusting for one or more covariates reported a significant ($p$<.05) association between positive psychological constructs and subsequent health outcomes. An exploratory meta-analysis of 11 studies showed that positive constructs were associated with reduced rates of rehospitalization or mortality in unadjusted (odds ratio=.87; 95% confidence interval [.83, .92]; $p$<.001) and adjusted analyses (odds ratio=.89; 95% confidence interval [.84, .91]; $p$<.001); there was little suggestion of publication bias. Among cardiac patients, positive psychological constructs appear to be prospectively associated with health outcomes in most but not all studies. Additional work is needed to identify which constructs

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are most important to cardiac health, and whether interventions can cultivate positive attributes and improve clinical outcomes.

**Keywords**

Optimism; positive affect; well-being; cardiovascular disease; coronary artery disease; systematic review

## 1. Introduction

Although there have been numerous advances in the care of cardiac conditions over the last 20 years, rates of hospitalization and mortality from heart disease remain high [1]. Detecting factors that may reduce the risk of adverse cardiac outcomes therefore remains vital, especially among patients who have known cardiovascular disease, as this population is at the highest risk of acute cardiac events and mortality [2].

Psychological factors appear to play a substantial role in cardiac outcomes. For example, depression and anxiety are prospectively associated with the development of cardiovascular illness [3, 4]. Among those with known heart disease, depression and anxiety are linked to major cardiac events, readmissions, and death, independent of traditional risk factors [5–8]. Indeed, the American Heart Association recently declared depression an independent risk factor for poor prognosis following an acute coronary syndrome (ACS) [5].

In contrast, there is some suggestion that positive psychological constructs – cognitive and emotional states or traits that indicate positive psychological functioning, such as optimism, positive affect, and well-being – may have a beneficial impact on health. For example, several studies have found positive psychological constructs to be associated with superior cardiac outcomes and reduced risk of cardiovascular-related mortality [9–11], independent of medical illness severity.

Importantly, positive psychological constructs are not simply the flipside of negative states. Positive and negative constructs, such as optimism and depression, are only somewhat inversely correlated (e.g., $r = -.3$ [12]). Furthermore, the relationships between positive psychological well-being and health outcomes have often been independent of the effects of depression [13]. This suggests that it is not simply an absence of depression that confers the health benefit associated with positive emotions and cognitions.

Given increased attention about relationships between positive psychological constructs and health, some summaries of the literature have been published [12–15]. However, there are still unanswered questions in this field, as these reviews have largely focused on a single positive construct (e.g., optimism) [12], had limited focus on patients with cardiac disease [13], or have been solely descriptive [14]. There is some suggestion that different positive constructs may have greater or lesser effects on health outcomes [14, 16], making it important to examine the literature on a wide range of positive states and traits. Furthermore, the lack of comprehensive reviews and quantitative analyses of positive constructs in

patients with existing heart disease is an important gap, given the need to identify protective factors in this highest-risk population [14, 17].

An analysis that included multiple positive psychological constructs would allow the survey of a much broader literature, with more studies and participants, to more powerfully examine whether there are associations between positive constructs and clinical outcomes. In addition, this approach could explore questions about whether different constructs (e.g., positive affect vs. optimism) have different effects on outcomes in patients with heart disease. By examining these relationships (and their magnitude, via quantitative analysis) in patients with known heart disease, a descriptive and quantitative review could provide useful information for a potential intervention by identifying specific positive constructs that could be targeted to improve clinical outcomes in patients at risk of adverse cardiac outcomes.

Accordingly, we completed a broad systematic review of prospective studies that have analyzed the relationship between a positive psychological construct and subsequent health-related outcomes among patients with existing cardiac illness. We also completed an exploratory meta-analysis on the subset of studies that examined mortality or rehospitalizations as outcomes, allowing us to gather adjunctive quantitative data about relationships between positive states and these major outcomes.

## 2. Methods

The guidelines and criteria outlined in Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) and Meta-analysis Of Observational Studies in Epidemiology (MOOSE) were followed and applied to ensure proper reporting of the data [18, 19]; see eTable 1 for the completed PRISMA guideline template.

### 2.1. Search strategy

A systematic literature search was conducted using keyword-based queries in the PubMed and PsycINFO electronic databases. Keywords related to the population of interest (patients with known cardiac illness) were combined with keywords related to positive psychological constructs, as outlined in Table 1. Each search consisted of two keywords, such as “optimism AND angina.” The search was conducted in January 2014 and included articles from the electronic database inception to January 1, 2014. Articles identified in this systematic search were imported into a standard reference manager, EndNote X7 (Thomson Reuters, 2014).

### 2.2. Selection procedure

English and Spanish language manuscripts published in peer reviewed journals were eligible for this review. Eligible studies were assessed with criteria in line with the PICOS (Participants, Interventions, Comparators, Outcomes, and Study design) search strategy [20]. To be included, studies had to (a) study a cardiac population, with comorbidities permissible as long as cardiac illness was the primary diagnosis, (b) assess effects of positive psychological constructs on health-related cardiac outcomes, such as mortality, rehospitalizations, cardiac events, or health status, and (c) use a prospective, observational study design, such that a baseline measurement of a positive construct was followed by a

subsequent measurement of a health outcome at a later timepoint. To avoid studies likely to represent cross-sectional findings, we required at least a 12 week interval between initial assessment of a positive psychological construct and a subsequent health outcome, and excluded studies that completed baseline assessments of patients in the hospital and then assessed outcomes occurring within the same hospitalization. Of note, we did include secondary observational analyses of intervention studies, provided the analyses reported results across all participants, not only members of an intervention group.

We aimed to include studies that measured both positive psychological states (i.e., typically dynamic and transient cognitive/emotional experiences) and traits (i.e., more enduring characteristics) [21]. In addition, we aimed to include measures of both hedonic well-being (i.e., pleasure-based constructs) and eudaimonic well-being (i.e., characterized by personal growth, positive relations, environmental mastery, and autonomy) [22]. Consistent with these goals, and consistent with the inclusion of constructs in prior analyses of positive psychological well-being [14], we included studies that measured positive affect, optimism/hope, subjective well-being, gratitude, life satisfaction, or life purpose. We combined the related but non-identical concepts of optimism and hope into a single construct in this review, and included articles that assessed either optimism or hope. For consistency with prior work and to maintain a boundary on the review, we did not include other related constructs such as religiosity, spirituality, self-esteem, or self-efficacy.

Regarding cardiovascular disease, we required that study populations contained patients with: (a) coronary artery disease, (b) congestive heart failure, (c) cardiac arrhythmia, or (d) following cardiac surgery (e.g., coronary artery bypass graft) or heart transplant. We did not search for or include illnesses that represent cardiovascular risk factors, such as hypertension, diabetes mellitus, or hyperlipidemia.

We also included a wide range of health-related outcomes. These included mortality (cardiac or all-cause), rehospitalizations (cardiac or all-cause), adverse cardiovascular events (myocardial infarction [MI], unstable angina, stroke), and other medical outcomes relating to cardiovascular health (e.g., lipid levels, inflammatory biomarkers, exercise tolerance, and healthcare utilization). In addition, given an increased focus on patient-reported outcomes [23], we also included self-reported health outcomes, including health-related quality of life (HRQoL), function/disability, health behaviors, pain, and other physical/cardiac symptoms.

In the first round of assessment, two study team members (CD and EB) performed automated searches of the databases as discussed above, removed duplicate articles, and screened titles and abstracts of the remaining articles to rule out excluded studies. During the second round of review, full texts were read and reviewed for eligibility criteria by a third team member, OVL, with clarification by the senior investigator (JH) as needed. Reviewers also searched the reference lists of eligible manuscripts, as well as the reference lists of prior reviews regarding positive psychological constructs and medical illness, to identify other possible articles; none were identified (Figure 1). Once all eligible studies were identified, relevant data was extracted independently by two staff members (CD, EB, and/or OVL) and entered into a study database.

To identify potential sources of bias and study limitations, we reviewed each study using a modified checklist from the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies [24] examining selection bias, confounders, blinding, data collection methods, withdrawals/dropouts, and statistical analyses. We chose not to assign specific quantitative scores to each study given that generating numerical study quality scores for observational studies is problematic [25], and their use in quantitative analyses to calculate effect size can induce bias [26]. Finally, the search was repeated for articles published in Chinese language journals; after removal of duplicates, 20 articles were identified, none of which met all eligibility criteria for this review.

### 2.3. Syntheses of reviewed articles

Following identification and review of included articles, we then descriptively synthesized the results of the systematic review as per the methods of prior systematic reviews [27–29]. Specifically, we calculated the overall proportion of statistically significant associations between positive constructs and outcomes across all identified analyses, and separately calculated this proportion in adjusted analyses (i.e., those that controlled for one or more relevant covariate; for studies with more than one adjusted model, we used the most-adjusted model). We did not include studies with fewer than 100 participants to avoid including studies likely to be underpowered for statistical significance [30]; we also did not include analyses that contained covariates that were explicitly described as potential mediators (e.g., exercise).

To describe effects across different subgroups, we also examined rates of significant associations by positive construct type (optimism, positive affect, well-being, or other positive construct), outcome measure (mortality, rehospitalization, acute medical event, other medical outcome, or self-reported health outcome), and medical population (coronary artery disease [CAD], cardiac surgery, heart failure, or other cardiac cohort). To avoid over-weighting studies with many similar analyses, 5 or more analyses of the same outcome variable were collapsed into a single analysis, and the analysis was considered to be significant when half or more of the total analyses had significant associations; this was done for four studies [31–34] that performed a total of 60 analyses. If we had not collapsed these analyses, these four studies (composed of n=860 participants) would have accounted for nearly half of all analyses across the 30 total examined studies (N=14,624).

### 2.4. Exploratory meta-analysis

Given the breadth of positive psychological constructs and medical outcomes examined in studies of patients with heart disease, a systematic review was the most appropriate approach to synthesize the full literature in this field. However, we conducted meta-analyses of selected outcomes to allow some quantitative assessment of the examined relationships. For these meta-analyses, we included the subset of articles ($n$=11) that utilized either mortality or rehospitalization as the dependent variable because these represent critical outcomes in heart disease. We first completed separate meta-analyses of studies examining rates of rehospitalizations and mortality, and then combined the analyses to generate estimated effects across all studies. This allowed us to optimize specificity in the initial analyses, while increasing power via a greater number of studies in the combined analysis.

Data was abstracted from articles to gather sufficient information (e.g., patient/study characteristics, measures of positive constructs, outcome measures, adjusted and unadjusted effect estimates with 95% confidence interval [CI] and *p* values) to assess quantitative relationships between positive states and the composite outcome variable. When data was unavailable, authors were contacted for additional information.

Following data abstraction, studies were standardized to assess the odds ratio (OR) of a 1 standard deviation (*SD*) change in the continuous predictor (positive psychological) variable. If a study used a psychological construct as both a continuous variable and a dichotomous variable, we used the analysis using the continuous data. In one study (Hoogwegt [35]), the *SD* of the psychological construct (Global Mood Scale; GMS [36]) was not provided, but population norm data for the measure was available in the same (cardiac) population [36], and this value was used instead. For an additional study (Middleton [37]), between-group differences in happiness scores were compared by readmission status using *t* tests; these were converted to an OR for readmissions associated with baseline happiness scores.

A random effects model was used to combine information across studies in all analyses [38]. To obtain a global assessment of effect size, the ORs in individual studies were weighted by the magnitude of the standard error to account for the precision of the OR estimate in each study. Separate analyses were performed to examine adjusted and unadjusted analyses (i.e., those that did or did not control for relevant covariates). Additional sensitivity/moderator analyses were not performed given the small number of studies in this exploratory aim. Study heterogeneity was explored using chi-square analysis of heterogeneity (*Q*) and the $I^2$ statistic derived from *Q* and the degrees of freedom. $I^2$ estimates the degree of variance in a pooled ES that can be accounted for by heterogeneity. Values of 25%, 50%, and 75% are considered low, moderate, and high, respectively [39]. Publication bias was assessed with the Egger test [40]. Stata (StataCorp, College Station, TX) was used for quantitative analyses, with $p<.05$ considered significant and all tests two-tailed.

## 3. Results

The article selection process with reasons for exclusion is outlined in the PRISMA flow diagram in Figure 1. Overall, 9221 non-duplicate articles were identified and screened for inclusion and exclusion criteria. Fifty-eight articles potentially met study criteria based on abstract review, and the full text of each article was reviewed. Thirty articles, with a total of 77 distinct relevant analyses, met all criteria for the systematic review.

### 3.1. Study characteristics

Table 2 provides an overview of study samples by positive construct, study population, and outcome variable. Table 3 lists all eligible studies, their characteristics, and the most relevant analyses; eTable 2 lists additional analyses for the five studies that had more than three relevant analyses completed within the same article. The 30 included studies examined outcomes in a total of 14,624 patients (range: 22–2,317), and 23 of the studies had one or more analysis involving 100 or more participants with heart disease. The largest number of studies assessed patients with stable or unstable CAD (*n*=17) and coronary artery bypass grafts (CABG; *n*=7). Common health-related study outcomes included mortality (*n*=9),

rehospitalizations (*n*=5), and adverse cardiac events (*n*=5). The average follow-up period was 31.75 months (range: 12 weeks [41] to 15.2 years [42]). All studies (except for 2, [43, 44]) controlled for at least one relevant confounding variable, such as age, sex, health status, or negative affect.

## 3.2. Effects of positive psychological constructs on objective medical outcomes

Below we summarize studies by outcome measure and positive psychological construct; covariates in analyses are summarized, except for psychological covariates, which are specifically described for each study. Analyses were unadjusted if no covariates are noted. Full detail for each study is listed in Table 3 and eTable 2. Although listing studies solely as statistically significant or nonsignificant is insufficient [45], we indicate the statistical significance of findings, and full details regarding study results, including effect sizes, confidence intervals, and exact *p* values where available, are listed in Table 3 and eTable 2.

### 3.2.1. Mortality

**3.2.1.1. Optimism:** One study assessing optimism in 68 heart transplant patients approximately 1 year pre-procedure found no association between optimism and all-cause mortality over a mean 3.8 years post-transplant [46]. Grunberg and colleagues [43] examined 108 patients receiving percutaneous cardiac intervention (PCI; e.g., stent) following ACS. Hope was assessed at enrollment, and again—approximately 30 minutes later—immediately before PCI. There were no between-group differences between survivors and non-survivors on baseline or pre-PCI levels of hope.

**3.2.1.2. Well-being:** Three studies in patients with stable or unstable CAD examined connections between well-being and mortality. A study of 1250 patients with CAD undergoing coronary angiography found that higher baseline well-being was associated with lower mortality (median 15.2 years) controlling for medical and demographic characteristics, but not when somatic symptoms and negative affect were added to the model [42]. In 1554 persons with hypertension and CAD, those reporting poor/fair baseline subjective well-being (versus excellent/good well-being) had elevated risk of subsequent one-year adverse outcomes (MI, stroke, or mortality) after adjusting for sociodemographic characteristics and baseline medical health [47]. In contrast, in 567 MI patients, there was no association between well-being and all-cause mortality over an 8 year follow-up period [48].

**3.2.1.3. Positive affect:** Six studies (five in CAD patients) explored connections between positive affect and mortality. First, in 874 patients who had undergone PCI, reduced baseline positive affect was associated with higher risk of subsequent MI or all-cause mortality, controlling for age, gender, and medical covariates [49]. In the Heart and Soul Study (1,018 stable CAD patients), baseline positive affect was associated with reduced risk of all-cause mortality (mean 7.1 year follow-up), after adjusting for age, medical variables, and depression [50]. Similarly, a study of 607 outpatients with CAD found an association between higher baseline positive affect and reduced all-cause mortality at 5 years on unadjusted analysis, but not when analyses controlled for potential mediators (e.g., exercise) [35].

In the aforementioned study of Grunberg and colleagues [43], happiness was also assessed at enrollment, and immediately before PCI. There were no between-group differences between survivors and non-survivors on baseline or pre-PCI levels of hope or happiness, but participants who survived at 6 months exhibited significantly greater improvement in happiness between baseline and pre-PCI.

Among 866 CAD patients, baseline positive affect was significantly associated with all-cause mortality (mean 11.4 year follow-up) when controlling for demographic and medical factors; when trait depression was entered into the model, positive affect did not remain significant [51]. Finally, in 591 patients with an implantable cardioverter defibrillator (ICD) for the prevention or treatment of ventricular arrhythmia, positive affect was not associated with cardiac or all-cause mortality (median 3.2 year follow-up), controlling for sociodemographic and medical factors [52].

**3.2.1.4. Other psychological variables:** Baseline purpose in life significantly predicted subsequent 6 year survival in 95 heart transplant recipients in unadjusted but not adjusted (age, medical factors, hostility, and depression) analyses [53].

### 3.2.2 Rehospitalizations

**3.2.2.1. Optimism:** Four studies examined associations between optimism and rehospitalizations. In surgical cohorts, lower pre-CABG optimism was a significant predictor of surgery- and CAD-related rehospitalizations (*n*=240 participants) as well as all-cause rehospitalizations (*n*=247) at 6 months post-CABG, adjusting for sex, cholesterol, and psychological variables (self-esteem, depression, and neuroticism) [54]. Similarly, lower optimism was associated with greater all-cause rehospitalization rates over 8 months following CABG (*n*=430), controlling for numerous sociodemographic, medical, and psychological (depression and anxiety) variables [55].

In 248 ACS patients undergoing PCI, baseline optimism was associated with reduced cardiac rehospitalizations at 4 years after adjusting for number of diseased vessels and extent of residual stenosis [56]. However, in the Middleton et al. [37] study of 121 patients hospitalized for cardiovascular disease, there was no relationship between baseline optimism/hope and 90-day all-cause readmissions.

**3.2.2.2. Positive affect:** The Hoogwegt [35] study of 607 CAD outpatients also found an association between higher baseline positive affect and reduced all-cause mortality at 5 years. Moreover, in the Middleton [37] study of hospitalized cardiac patients (*n*=121), baseline positive affect/happiness was associated with fewer 90-day all-cause rehospitalizations on multivariate analysis controlling for physical and mental health (personal adjustment) variables.

### 3.2.3. Adverse cardiovascular events

**3.2.3.1. Optimism:** Four studies examined associations between optimism and adverse cardiac events. “Comparative optimism” (patients’ perceived risk of having another cardiac event in comparison to others) was associated with lower rates of cardiac events in 164

patients in the 12 months following cardiac rehabilitation, independent of demographics, medical comorbidities, depression, and distress [57]. In the Grunberg study of 108 PCI patients who had hope and happiness measured prior to PCI, patients who had no subsequent adverse cardiac events reported higher pre-PCI hope than those who later suffered an event [43]. In Kim and colleagues' [58] analysis of 1,546 stable CAD patients, optimism was associated with reduced risk of MI over 2 years, controlling for demographics and medical health. Finally, in Scheier and colleagues' 1989 [59] examination of 48 patients, baseline optimism was marginally associated ($p<.06$) with probable MI but not angina 6 months post-CABG.

**3.2.3.2. Well-being:** In a study by Ried and associates [47] of 2,517 CAD and hypertension patients, persons reporting poor/fair baseline well-being had greater odds of suffering a stroke, but not a nonfatal MI, in the following year.

**3.2.3.3. Positive affect:** Three studies assessed links between positive affect and adverse events, all in CAD patients. In the previously noted Heart and Soul analysis ($n=1,081$), baseline positive affect was not significantly associated with cardiac events (CHF, MI, or, stroke/transient ischemic attack) over a mean follow-up of 7.1 years [50]. In Grunberg [36], pre-PCI hope was greater in those who had no adverse cardiac event post-PCI than those suffering an adverse event. In addition, positive affect was associated with reduced MI risk in the Kim [58] study of 1,546 CAD patients, controlling for demographic and medical variables.

**3.2.3.4. Other positive psychological constructs:** In the same study by Kim et al [58], greater baseline ratings of purpose in life were associated with a reduced risk of MI after 2 years, controlling for demographic, medical variables, and psychological dysfunction (cynical hostility, anxiety, and depression).

### 3.2.4. Other medical outcomes (inflammation, length of hospital stay, $VO_2$ max)

**3.2.4.1. Optimism:** Five studies examined the association of optimism with a variety of health metrics and health services in CABG or cardiac rehabilitation patients. Among 22 subjects with CAD participating in 18 weeks of cardiac rehabilitation, optimism at program outset was associated with subsequent reductions in body fat, global coronary risk, and improvement in aerobic capacity, but not changes in weight or lipid levels, controlling for age and magnitude of the initial health behavior goal [33]. In addition, Glazer et al [41] studied 46 CAD patients in cardiac rehabilitation and found no relationship between baseline optimism and 12-week change in maximum oxygen consumption, controlling for age and gender.

In 45 CABG patients, baseline optimism predicted a positive progression through stages of risk reduction 8 months later, adjusting for multiple cardiac variables and perceived control [60]. In contrast, in 138 CABG patients, optimism assessed prior to cardiac surgery was not associated with length of hospitalization or post-surgical complications in extensively adjusted analyses (including medical variables and depression) [61].

**3.2.4.2. Other positive psychological constructs:** Two studies assessed relationships between positive constructs and measures of physical health. Among 210 CHF patients, Brouwers and colleagues [31] examined baseline connections between positive affect, measured using three distinct instruments, and 18-month changes in tumor necrosis factor alpha [TNFα], soluble TNFα receptors- 1 and 2, C-reactive protein, and interleukin-6 (IL-6), after adjustment for sociodemographic factors, medical variables, lifestyle factors, and depression. Positive affect derived from the Global Mood Scale [36] was significantly associated with reductions in TNFα, soluble TNFα receptor-2, and IL-6 in the fully adjusted model; positive affect scores derived from the Positive And Negative Affect Schedule [62] and Hospital Anxiety and Depression Scale [63] were associated with fewer inflammatory markers.

## 3.3. Effects of positive states on patient-reported health outcomes

### 3.3.1. Functional/health status

**3.3.1.1. Optimism:** Two studies in CABG or cardiac rehabilitation patients explored the prospective connection of optimism to subsequent reports of function. Scheier and associates' 1989 study [59] found that pre-CABG optimism was not associated with post-surgical complications 6 weeks after CABG ($n$=51), controlling for baseline cardiac variables. However, 6 months after CABG ($n$=48), optimists were more likely to have resumed vigorous physical exercise, although rate of return to exercise was only marginally faster ($p$<.09). In addition, at 6 months, optimists reported having greater rates of return to normal function across five functional domains. A second study in 212 CABG patients found no association between baseline optimism and functional status one year later [44].

**3.3.1.2. Positive affect:** Two studies examined positive affect and functional status in CAD patients. Baseline positive affect was associated with a superior trajectory of physical functioning over 3 years in 948 CAD patients, controlling for numerous sociodemographic, medical, behavioral, and psychological variables, including negative affect [64]. Similarly, high levels of positive affect 30 days after PCI ($n$=562) were independently associated with superior health status, self-care, and function at a 12-month follow-up, adjusting for demographic and clinical factors (including negative affect); there was no association of positive affect with pain/discomfort or mobility [34].

### 3.3.2. Health related quality of life (HRQoL)

**3.3.2.1. Optimism:** Four studies examined links between optimism and HRQoL. In 68 heart transplant patients, pre-surgical optimism was significantly associated with both mental and physical HRQoL a median of 3.8 years later, controlling for covariates including depression [46]. In addition, optimism assessed 2 months post-transplant in 66 heart transplant patients was significantly associated with mental HRQoL, vitality, and social function (but not general HRQoL, physical functioning, physical/emotional role, or pain) one year post-transplant, controlling for demographic and medical variables, social support, and coping strategies [32]. Similarly, Scheier (1989) [59] found that dispositional optimism was associated with HRQoL 6 months post-CABG, controlling for multiple cardiac variables. However, in 158 PCI patients, there was no association between in-hospital pre-PCI disease-

specific optimism and subsequent disease-specific HRQoL approximately 3 months post-procedure [65].

**3.3.2.2. Other positive psychological constructs:** Among 220 HF patients without type D personality, baseline positive affect was associated with higher mental HRQoL at one year, controlling for numerous sociodemographic and medical variables; positive affect was also associated with subsequent physical HRQoL on univariate but not multivariate analysis [66].

### 3.3.3. Other patient-reported outcomes (e.g., symptoms of illness)

**3.3.3.1. Optimism:** Three articles (spanning two study cohorts) explored optimism's prospective links to physical symptoms in surgical patients. Among 63 cardiac surgery patients, surgery-specific optimism was associated with significantly fewer 6 month post-surgery cardiac symptoms [67], and subsequent analysis of this study found that optimism/hope was associated with fewer days of cardiac symptoms at six months, adjusting for demographics, medical variables, and depression [68]. In the aforementioned Mahler study of 212 CABG patients [44], baseline optimism interacted with time to predict less pain over the subsequent 12 months; there was no direct effect of optimism.

**3.3.3.2. Other positive psychological constructs:** Among 607 patients with CAD, baseline positive affect was associated with physical activity over a mean 4.7 year follow-up period after adjusting for demographics, medical variables, and negative affect [35]. Furthermore, in the Pelle [66] analysis of HF outpatients without Type D personality, high positive affect was prospectively associated with fewer cardiac symptoms on unadjusted but not adjusted analyses; high positive affect was associated with lesser disability controlling for demographic and medical variables. In Jenkins' study [67] of cardiac surgery patients, well-being was associated with fewer cardiac symptoms at six months.

## 3.4. Summarizing findings across studies (Table 4)

After consolidating multiple analyses of the same outcome variable, a total of 77 analyses from 30 studies met criteria for this systematic review. Of these, 60 analyses (from 23 studies) included at least 100 participants. Across all such analyses, 39 (65.0%) found a significant ($p<.05$) association between a positive psychological construct and a health outcome. When the 34 analyses that adjusted for covariates were considered, 22 analyses (64.7%) were statistically significant. Finally, when including only analyses from 15 studies that controlled for negative affect or depression, 11 out of 18 analyses (61.1%) found statistically significant associations between the positive psychological construct and the health outcome, and independent of additional psychological factors. Table 4 shows synthesized results of analyses (all analyses and adjusted analyses) among study subpopulations divided by positive psychological construct, cardiac population, and study outcome variable.

## 3.5. Meta-analysis (Figures 2 and 3)

Eleven articles [35, 37, 42, 49–52, 54–56, 58] utilized mortality or rehospitalizations as a study outcome and had sufficient data to be included in the exploratory meta-analysis. Nine

of the studies utilized mortality or rehospitalizations as an outcome, and two [49, 58] used composite measures (which were included in the mortality analyses).

**3.5.1. Mortality—**Five studies (eFigure 1) examined unadjusted associations between positive psychological constructs and mortality. The studies showed little heterogeneity ($Q$=1.64; $p$=.65; $I^2$=0.0%), and there was no evidence of small study effects suggesting publication bias seen on the Egger test ($b$=−1.04; $p$=.35). Across the studies, positive psychological constructs were associated with reduced risk of mortality (OR=.87; 95% confidence interval [CI; .82, .92]; $z$=4.74; $p$<.001).

Six studies (eFigure 2) examined adjusted associations between positive psychological constructs and mortality; all studies included one or more medical covariates. These studies did not show significant heterogeneity ($Q$=5.70; $p$=.34; $I^2$=12.3%), and there was no evidence of small study effects (Egger: $b$=.35; $p$=.79). In these studies, positive psychological constructs were again prospectively linked with reduced risk of mortality (OR=.89; CI [.85, .93]; $z$=4.99; $p$<.001).

**3.5.2. Rehospitalizations—**eFigures 3 and 4 display forest plots related to rehospitalization (unadjusted and adjusted analyses). Three studies examined the association between positive psychological constructs and rehospitalizations in unadjusted models (eFigure 3; OR=.86; CI [.79, .93]; $z$=3.52; $p$<.001). These three studies did not show significant heterogeneity ($Q$=.41; $p$=.82; $I^2$=0.0%) and there was no evidence of small-study effects (Egger; $b$=−.44; $p$=.70). Three studies examined adjusted associations between positive psychological constructs and hospitalizations, controlling for at least one medical covariate. There was a significant link between positive psychological constructs and reduced risk of rehospitalization (eFigure 4; OR=.81; CI [.73, .90]; $z$=3.91; $p$<.001). These studies had minimal heterogeneity ($Q$=.65; $p$=.73; $I^2$=0.0%), although there was some suggestion of potential small-study effects (Egger; $b$=−2.41; $p$=.044).

**3.5.3. Combined analyses—**Figures 2 and 3 display forest plots for the combined meta-analysis examining all studies with either mortality or rehospitalization as an outcome, split by adjusted and unadjusted analyses. Six studies examined unadjusted associations between positive psychological constructs and mortality or rehospitalization. The studies were not heterogeneous ($Q$=1.91; $p$=.86; $I^2$=0.0%), with no significant evidence of small study effects ($b$=.82; $p$=.17). Positive psychological constructs were associated with reduced rates of mortality or hospital readmission (Figure 2; OR=.87; CI [.83, .92]; $z$=5.17; $p$<.001).

Nine studies examined adjusted associations. These studies did not show significant heterogeneity ($Q$=8.90; $p$=.35; $I^2$=10.1%) with no significant evidence of small-study effects ($b$=−.72; $p$=.43). Positive psychological constructs were associated with reduced risk of mortality or rehospitalization (Figure 3; OR=.88; CI [.84, .91]; $z$=6.08; $p$<.001).

## 4. Discussion

The current review adds to the literature by examining multiple positive psychological constructs in relation to health outcomes in studies of over 14,000 cardiac patients identified

across the medical and psychological literature. Furthermore, it adds descriptive syntheses and quantitative analyses to consolidate findings across studies. This analysis is the first to focus solely on patients with known heart disease, a cohort of patients who are at greatest risk of mortality and adverse cardiac outcomes [69, 70], and these findings come at a time of increased attention to the benefits of positive emotional factors in cardiac patients [71]. Indeed, focusing on psychological factors that not only bolster mental health but may also foster better cardiovascular outcomes could help to reduce the large number of deaths attributable to heart disease each year [1].

Overall, the majority of studies in this systematic review found prospective relationships between positive psychological constructs and superior medical outcomes among patients with known cardiovascular disease. Such relationships were seen in the majority of analyses (approximately two-thirds), and these connections appeared to exist for a number of different psychological constructs (e.g., optimism, positive affect) and multiple forms of heart disease. Findings were similar in the exploratory meta-analyses involving 11 of the included studies, with significant relationships between positive constructs and mortality or rehospitalization on all individual and combined analyses. Importantly, in numerous studies, the observed associations between positive states and reduced risk of outcomes were independent of key medical, psychological, and sociodemographic variables. Furthermore, in the meta-analyses, the effect size for adjusted analyses was similar to that for unadjusted analyses. However, these associations were by no means universal, as there were null findings, inconsistent control for covariates, and variability in study procedures, samples, outcome measures, and sample size.

Importantly, in over 60% of studies, positive psychological constructs were significantly associated with health outcomes even when controlling for depression or negative affect. This suggests that—in addition to the established adverse effects of ill-being in cardiac patients [5, 7]—positive constructs might have additional, unique, and beneficial effects on health outcomes in this population.

These findings are consistent with a meta-analysis of positive psychological well-being in patients with a variety of medical illnesses. Chida and colleagues [13] found that positive psychological well-being was associated with reduced mortality (HR=.98; CI [.95, 1.00]; $p$=.03), although the meta-analysis examined only mortality as an outcome and included just five studies of patients with heart disease (sensitivity analysis: HR=.93; CI [.86, 1.01]; $p$=.065). Another meta-analysis of optimism and physical health outcomes in 83 studies of patients with medical illness [72] found that optimism was linked to improved health outcomes ($r$=.19; CI [.16, .23]; $p$<.001). This analysis examined only optimism and did not focus specifically on cardiac patients. Finally, Boehm and Kubzansky [14] completed a systematic review, without meta-analysis, of positive psychological well-being and cardiac health in both healthy and patient samples and described relationships consistent with those reported here. Non-systematic reviews have also had similar findings [73, 74].

Among the positive psychological constructs and their relationship to health, there has been substantial focus on optimism. However, we found positive affect and subjective well-being to have very similar rates of prospective connections to health outcomes than optimism,

suggesting that these constructs may be as important as optimism in understanding the relationship between positive states and health. In addition, positive psychological constructs were linked more consistently to clinical outcomes such as rehospitalizations and cardiac events than 'other' medical outcomes, which, in these studies, were most often biological outcomes such as inflammatory markers or lipid levels.

How might positive psychological constructs be linked to health outcomes in cardiac patients, and how might such mechanisms explain our findings? A number of articles have examined potential mediators of the association between positive constructs and health. These include a review by Pressman and Cohen [15], which examined positive affect and general health, and reviews or commentaries regarding optimism [71, 74] or overall positive psychological well-being [14, 73]. Such reviews have focused on both biological and behavioral effects that may be relevant to cardiac health. However, across studies there is much more consistent evidence linking positive psychological constructs to health behaviors beneficial to cardiac health (e.g., diet, exercise) [10, 73, 75], and much more mixed evidence regarding the effects of these constructs on biological markers of health [73, 74, 76].

Indeed, potentially greater effects of positive constructs on behavior as compared to direct effects on biology could be consistent with the findings in the current review (e.g., frequent links to rehospitalizations but mixed effects on biomarkers or short-term outcomes). Failure to adhere to key secondary prevention behaviors can lead to acute clinical events, and may do so above and beyond effects on specific cardiac biomarkers. Furthermore, the adverse cardiac effects of behavioral nonadherence may take place over a longer timeframe. Hence, positive psychological constructs may have weaker effects on specific biomarkers of health and on shorter-term assessments of health markers, but may have stronger effects on behavior-mediated, longer-term clinical outcomes. Additional studies to assess mechanisms linking positive psychological attributes and cardiovascular-related health outcomes are needed.

There are limitations of the analyzed studies that are important to note. The studies generally examined a heterogeneous group of positive psychological constructs and outcomes, which makes observations across studies (and quantitative meta-analysis of studies) more challenging. In the vast majority of studies, positive psychological constructs were measured at a single time point, and provided limited information about the duration of the positive psychological experience. In addition, many of the reported studies were secondary analyses, which may be more prone to publication bias. Though nearly all studies accounted for some covariates when examining the relationships between positive constructs and outcomes, the specific sociodemographic, medical, and psychological variables controlled in each study were inconsistent. We searched only for articles in English, Spanish, and Chinese, and additional eligible studies may have existed in other languages. Finally, the exploratory meta-analyses included only 11 studies, and these studies also had variability in the specific psychological construct examined and whether analyses were adjusted for covariates.

In conclusion, in patients with known heart disease, positive psychological constructs appear to be associated with reduced rates of serious adverse health outcomes and improved overall

health status. Additional studies to clarify which specific positive construct is most strongly associated with better outcomes are warranted, as are studies examining mediators of this effect. For example, prospective studies that simultaneously measure baseline levels of several different positive psychological constructs could improve data on the specificity of these relationships. Additionally, studies that assess subsequent outcomes (e.g., rehospitalizations) and several candidate mediators (e.g., physical activity, inflammatory markers) could provide important data about mechanism and magnitude of effect. Finally, intervention studies targeting positive constructs in cardiac patients are few [77–79], but if effective, these interventions have the potential to improve function, health, and survival in this vulnerable population.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Highlights

- Systematic review examining positive psychological constructs and health outcomes
- Included 30 studies involving over 14,000 patients with known heart disease
- Positive constructs were frequently associated with favorable health outcomes
- Significant relationships typically remained after covariate adjustment
- Exploratory meta-analysis using subset of studies had similar findings

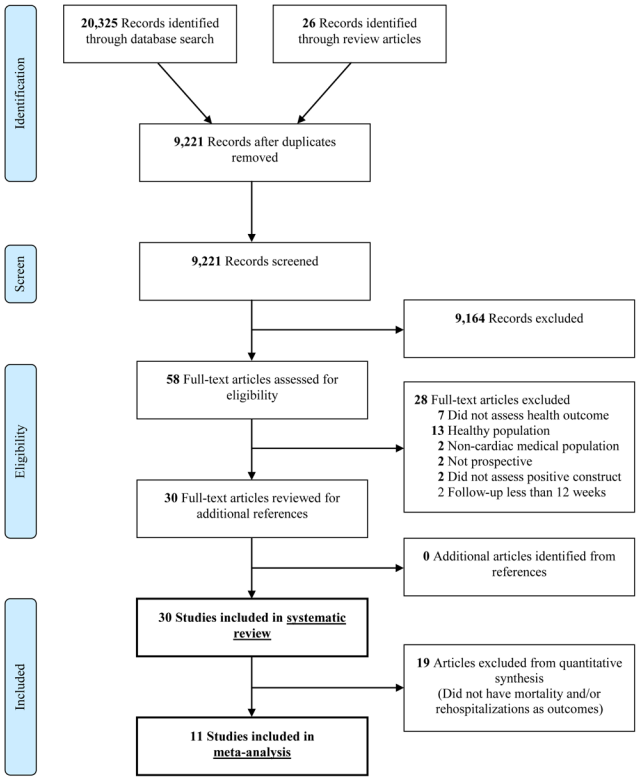


**Figure 1.**
Flow diagram of the literature search.

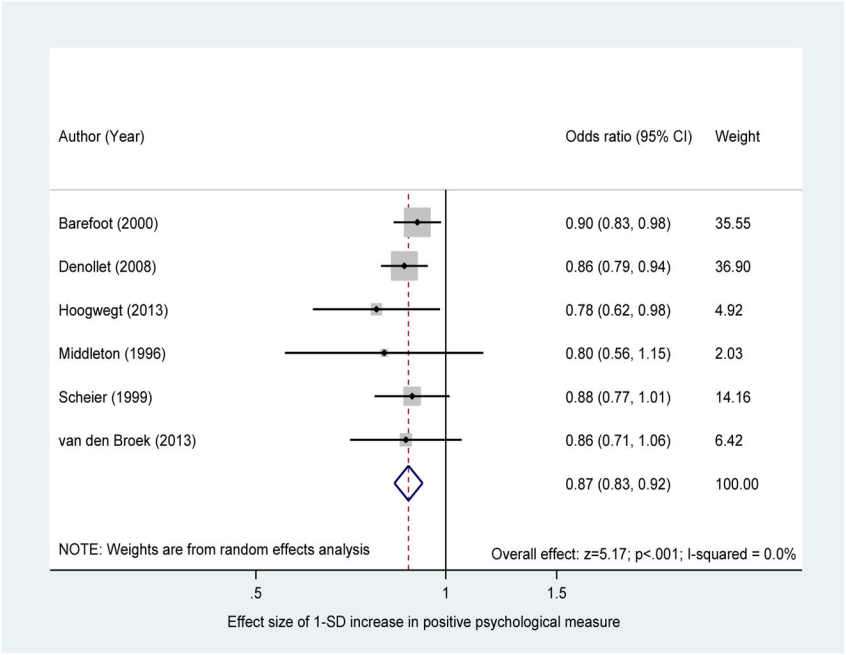


**Figure 2.**

Unadjusted associations between positive psychological constructs and mortality or rehospitalization.

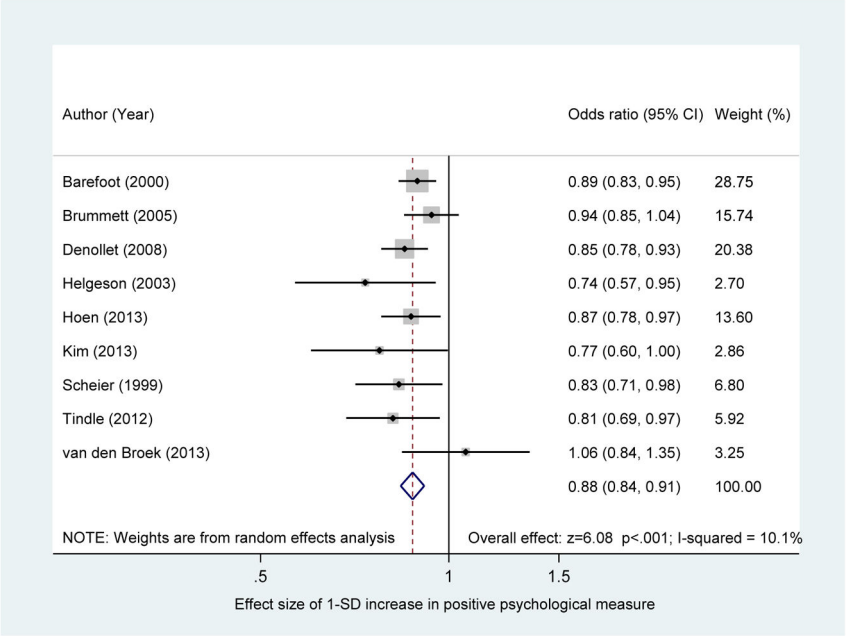


**Figure 3.**

Adjusted associations between positive psychological constructs and mortality or rehospitalization.

## Table 1

Electronic database search terms.

| Cardiac keyword | Positive psychological construct keyword |
|---|---|
| Cardiomyopathy | Optimism |
| Ischemic heart disease | Hope |
| Coronary | Gratitude |
| Ischemia | Positive affect |
| Cardiac | Happiness |
| Cardiac disease | Well-being |
| Cardiovascular | Life satisfaction |
| Cardiovascular disease | Life Orientation Test (LOT) |
| Heart | Life Orientation Test Revised (LOT-R) |
| Heart disease | Positive and Negative Affect Schedule (PANAS) |
| Heart failure | The Gratitude Questionnaire Six Item Form (GQ-6) |
| Congestive heart failure | Attributional Style Questionnaire (ASQ) |
| Myocardial infarction | Satisfaction With Life Scale (SWLS) |
| Acute coronary syndrome | |
| Coronary artery disease | |
| Coronary artery bypass graft | **PubMed sample search:** Heart[text word] AND happiness[text word] |
| Arrhythmia | |
| Ventricular arrhythmia | |
| Implantable cardioverter defibrillator | **PsycINFO sample search:** Heart AND happiness |
| Angina | |
| Unstable angina | |
| Atrial fibrillation | |

Note. All possible combinations were performed.

## Table 2

Summary of patient cohorts, positive constructs, and outcomes in eligible studies.

| Patient populations (*N*=30 studies) |
|---|
| **Stable coronary artery disease [CAD] (*n*=8)** [33, 35, 41, 47, 50, 51, 57, 58] |
| **Enrolled in cardiac rehabilitation (*n*=3)** [33, 41, 57] |
| **Unstable CAD (*n*=9)** [34, 37, 42, 43, 48, 49, 56, 64, 65] |
| **Following percutaneous coronary interventions (*n*=5)** [34, 43, 49, 56, 65] |
| **Acute coronary syndrome (*n*=2)** [43, 48] |
| **Coronary artery bypass graft surgery [CABG] (*n*=7)** [44, 54, 55, 59, 60, 67, 68] |
| **Cardiac transplantation (*n*=2)** [32, 53] |
| **Congestive heart failure (*n*=2)** [31, 66] |
| **Ventricular arrhythmia requiring implantable cardioverter defibrillator (*n*=1)** [52] |
| Positive psychological constructs |
| **Optimism/hope (*n*=15)** [32, 33, 37, 41, 43, 44, 54–57, 59, 60, 65, 67, 68] |
| **Positive affect (*n*=11)** [31, 34, 35, 37, 43, 49–52, 64, 66] |
| **Well-being (*n*=5)** [42, 47, 48, 67, 68] |
| **Other Purpose (*n*=2)** [53, 58] |
| Outcomes |
| **Objective medical outcomes** |
| **Mortality (*n*=9)** [35, 42, 43, 48–53] |
| **Adverse cardiovascular events (e.g., MI, heart failure) (*n*=5)** [43, 47, 50, 57, 58] |
| **Rehospitalization (*n*=5)** [35, 37, 54–56] |
| **Other (e.g., changes in biomarkers) (*n*=5)** [31, 33, 41, 59] |
| **Patient-reported outcomes** |
| **Functional status (*n*=4)** [44, 59, 64, 66] |
| **Health-related quality of life (*n*=4)** [32, 34, 65, 66] |
| **Other (e.g., pain) (*n*=7)** [44, 59, 60, 66–68] |

Note. MI=Myocardial Infarction.

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## Table 3

Study characteristics and analyses of eligible studies.

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| **Barefoot (2000)** | **N** | 1250 | **Well-being and cardiac mortality** (unadjusted) | RR=1.23, p=.019 |
| | **Population** | CAD, hospitalized for coronary angiography | **Well-being and cardiac mortality** (age, gender, income, disease severity) | RR=1.26, p=.001 |
| | **Age** | Median=52.0; 46, 58 (25th, 75th percentile) | | |
| | **Male** | 82%, n=1025 | | |
| | **Follow-up** | Median=15.2 years | **Well-being and cardiac mortality** (above, plus somatic symptoms, negative affect [Zung SDS]) | RR=1.00, p>.05<br>Note: RRs based on 2 SD increase in scores |
| | **Positive construct** | **Well-being:** Zung Self-Rating Depression Scale (Zung SDS) | | |
| | **Outcome** | **Mortality**: Cardiac | | |
| **Brouwers (2013)** | **N** | 210 | **Positive affect and inflammation** (positive affect, age, gender, time, BMI, activity level, smoking, education) | **GMS:** IL-6, p<.05; sTNFr2, p<.05; TNFa, p<.01<br>**PANAS:** IL-6, p<.1; sTNFr2, F=3.78, p=.053; TNFa, p<.05<br>**HADS:** sTNFr2, F=3.48, p=.068 |
| | **Population** | Stable CHF (LVEF <40%; New York Heart Association Class I–III) | | |
| | **Age** | Median=66.7 +/− 8.7 | **Positive affect and inflammation** (positive affect, age, gender, time, depression (Center for Epidemiologic Studies Depression Scale [CES-D]) | **GMS:** IL-6, p<.01; sTNFr2, p<.01; TNFa, p<.05<br>**PANAS:** IL-6, p<.1 |
| | **Male** | 79%, n=166 | | |
| | **Follow-up** | 18 months | | |
| | **Positive construct** | **Positive affect**: Global Mood Scale (GMS), Positive and Negative Affect Schedule (PANAS), Hospital Anxiety and Depression Scale (HADS) | | Note: All other associations, p>.1 |
| | **Outcome** | **Inflammation:** sTNFr1, sTNFr2, TNFa, IL-6, hsCRP | | |
| **Brummett (2005)** | **N** | 866 | **Positive affect and mortality** (age, gender, LVEF, CHF, number of diseased vessels, smoking) | HR=.80, 95% CI [.66, .97], p<.025 |
| | **Population** | Significant CAD (>1 vessel >75% occlusion) | | |
| | **Age** | Median=60.3, SD=9.1 | **Positive affect and mortality** (above, plus trait depression [8-item NEO-PI depression facet]) | HR=.88, 95% CI [.72, 1.07], p=.20 |
| | **Male** | 74%, n=643 | | |
| | **Follow-up** | M=11.4 years | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Positive construct** | **Positive affect:** NEO Personality Inventory (NEO-PI) | | |
| | **Outcome** | **Mortality:** All-cause | | |
| **Brummett (2009)** | **N** | 948 | **Positive affect and change in functional status** (functional status at baseline [DASI], negative emotion [CES-D], age, sex, social support [Interpersonal Support Evaluation List], marital status, CHF, LVEF, medical comorbidities) | β=.13, Standard Error (SE)=.06, p<.05 |
| | **Population** | Significant CAD (>1 vessel >75% occlusion) | | |
| | **Age** | Median=70.1, SD=6.3 | | |
| | **Male** | 65%, n=615 | | |
| | **Follow-up** | 3 years | | |
| | **Positive construct** | **Positive affect:** CES-D; 4-item positive affect subscale) | | |
| | **Outcome** | **Functional status:** Duke Activity Status Index (DASI) | | |
| **Denollet (2008)** | **N** | 874 | **High positive affect and morbidity/mortality** (unadjusted) | HR=.86, 95% CI [.79, .93], p=.0001 |
| | **Population** | CAD receiving PCI | | |
| | **Age** | M=62.2 +/− 10.9 | **Reduced positive affect (≤ 7) and morbidity/mortality** (age >60 years, gender, previous CABG, smoking, diabetes) | HR=2.55, 95% CI [1.46, 4.34], p=.001 |
| | **Male** | 72%, n=629 | | |
| | **Follow-up** | 2 years | | |
| | **Positive construct** | **Positive affect:** (HADS) | | |
| | **Outcome** | **Morbidity/mortality**: Composite of MI and all-cause mortality | **High positive affect and morbidity/mortality** (age >60 years, gender, relaxed affect/negative affect/depression/ anxiety [HADS]) | HR=.85, 95% CI [.78, .92], p<.0001 |
| **Echteld (2003)** | **N** | 158 | **Optimism and disease specific QoL** (unadjusted) | $r^2$=.00, p>.05 |
| | **Population** | CAD receiving PTCA | | |
| | **Age** | M=59.5, SD=9.0 | | |
| | **Male** | 80%, n=126 | | |
| | **Follow-up** | M=178 days (99–326 days) | | |
| | **Positive construct** | **Disease-specific optimism:** Leiden Screening Questionnaire for Heart Disease Patients (optimism subscale) | | |
| | **Outcome** | **Disease-specific Quality of Life (QoL):** Quality of Life after | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | | Myocardial Infarction Instrument (QLMI)<br>Myocardial Infarction Instrument (QLMI) | | |
| **Fitzgerald (2000)** | **N** | 50 | **Optimism and behavioral risk reduction** (angina functional severity class rating, cardiac function composite measure, number of endorsed CHD risk factors, internal locus of control rating [MHLC] and appraisals of control over the long-term course of the disease, daily symptoms, medical care and treatment) | $r^2$ change=.09, F=4.62, p<.05 |
| | **Population** | CABG | | |
| | **Age** | M=62.0, SD=9.1 | | |
| | **Male** | 84%, n=42 | | |
| | **Follow-up** | 8 months | | |
| | **Positive construct** | **Optimism:** Life Orientation Test (LOT) | | |
| | **Outcome** | **Behavioral risk:** Processes of Change Questionnaire | | |
| **Glazer (2002)** | **N** | 46 | **Optimism and change in VO2 max at 12 months** (age, gender) | p>.05 (no test statistic reported) |
| | **Population** | CHD attending cardiac rehabilitation | | |
| | **Age** | M=58.0 +/− 10.2 | | |
| | **Male** | 74%, n=34 | | |
| | **Follow-up** | 12 weeks (last week of 12-week cardiac rehabilitation program) | | |
| | **Positive construct** | **Optimism:** LOT | | |
| | **Outcome** | **VO2 max:** Exercise stress test | | |
| **Grunberg (2003)** | **N** | 119 (Visual Analog Scale at baseline), 108 (Visual Analog Scale before PCI) | | Median VAS score: 50th (25th, 75th percentile) |
| | **Population** | ACS receiving PCI | **Happiness & hopefulness pre-to-post PCI and ACEs during index hospitalization** (unadjusted) | **Happy: No ACEs:** 83 (52, 94), p=.02<br>**ACEs:** 59 (44, 84), p=.02<br>**Hope: No ACEs:** 89 (76, 96), p=.04<br>**ACEs:** 84 (48, 92), p=.04 |
| | **Age** | M=65.0; 54, 69 (25th, 75th percentile) | | |
| | **Male** | 99%, n=118 | | |
| | **Follow-up** | 6 months | | |
| | **Positive construct** | **Happy, hopeful:** Visual Analog Scale (VAS) | | |
| | **Outcome** | **ACEs during index hospitalization:** Death, MI, HF, recurrent ischemia<br>**Mortality** | **Happiness & hopefulness mood shifts and mortality at 6 months** (unadjusted) | **Happy: Survived:** 2 (-2, 17), p=.02<br>**Did not survive:** −6 (−13, −3), p=.02<br>**Hope: Survived:** ns<br>**Did not survive:** ns |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| **Helgeson (2003)** | **N** | 248<br>Admitted for CAD receiving PTCA (no prior CAD surgery) | **Optimism and cardiac rehospitalizations** (number of diseased vessels and percent stenosis remaining after original PTCA) | β=.48, OR=.62, p=.02 |
| | **Population** | M=57.0 +/− 10 (full sample) | | |
| | **Age** | 67%, n=199 (full sample) | | |
| | **Male** | 4 years | | |
| | **Follow-up** | **Optimism:** Cognitive Adaptation Theory Index (combo of LOT, Schooler Mastery Scale, Rosenberg Self Esteem Scale) | | |
| | **Positive construct** | | | |
| | **Outcome** | **Rehospitalizations:** Cardiac | | |
| **Hevey (2014)** | **N** | 164 | **Composite of comparative optimism at end of cardiac rehab and ACEs at 12 months** (age, gender, baseline distress [depression and anxiety via HADS], hyperlipidemia, hypertension, diabetes) | **Less comparative optimism associated with more ACEs:** β= −.89, OR=.44, 95% CI [.15, .64], p<.01 |
| | **Population** | CHD (MI, CABG, PCI, valve surgery, stable angina) (attended cardiac rehabilitation) | | |
| | **Age** | M=61.7 +/−8.7 | | |
| | **Male** | 76%, n=125 | **Comparative optimism at end of cardiac rehab and ACEs at 12 months** (unadjusted) | **Relation to typical others with cardiac event:** Those with ACEs had lower optimism than those with no ACEs: M=.02 vs. M=−.77; t=6.12, p<.001, d=.49<br>**Relation to others in the same class:** Those with ACEs had lower optimism: M=.05 vs. −.74; t=5.74, p<.001, d=.53<br>**Relation to typical others without cardiac event:** ns |
| | **Follow-up** | 1 year | | |
| | **Positive construct** | **Comparative optimism:** Author-created (3 items comparing perceived risk of recurring events) | | |
| | **Outcome** | **ACEs:** Readmissions for chest pain or angina, fatal or non-fatal MI, PCI or CABG | | |
| **Hoen (2013)** | **N** | 1018 | **Positive affect and all-cause mortality** (age) | HR=.84, 95% CI [.76, .92], p=.001 |
| | **Population** | Stable CHD | **Positive affect and cardiac events** (age) | HR=.89, 95% CI[ .79, 1.00], p=.06 |
| | **Age** | M=66.9, SD=10.9 | | |
| | **Male** | 82%, n=835 | **Positive affect and all-cause mortality** (age, history of MI, LVEF) | HR=.84, 95% CI [.76, .93], p<.001 |
| | **Follow-up** | M=7.1 +/− 2.5 years | | |
| | **Positive construct** | **Positive affect:** Positive and Negative Affect Schedule (PANAS) | **Positive affect and all-cause mortality** (above, plus depressive symptoms [Patient Health Questionnaire-9; PHQ-9], SSRI use) | HR=.87, 95% CI [.78, .97], p<.01 |
| | **Outcome** | **Cardiac events:** Heart failure, MI, stroke, TIA | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | | **Mortality:** All-cause | | |
| **Hoogwegt (2013)** | **N** | 607 | **Positive affect (median split ≥24) and outcomes** (unadjusted) | **All-cause mortality:** HR=.58, 95% CI [.37, .92], p=.02<br>**Cardiac hospitalization:** $\chi^2$=3.37, HR=.81, 95% CI [.65, 1.02], p=.07 |
| | **Population** | CAD outpatients | | |
| | **Age** | M=65.5, SD=10.7 | | |
| | **Male** | 75%, n=458 | **Positive affect (continuous) and outcomes** (unadjusted) | **All-cause mortality:** HR=.97, 95% CI [.95, .998], p=.033<br>**Cardiac hospitalization:** HR=.98, 95% CI [.97, .99], p=.004 |
| | **Follow-up** | 5 years | | |
| | **Positive construct** | **Positive affect:** Global Mood Scale (GMS) | **Positive affect (median split ≥24) and mortality** (age, sex, BMI, Tu comorbidity, psychotropic medications, negative affect [GMS], exercise) | **All-cause mortality**: HR=0.82, 95% CI [.50, 1.35], p=.43 |
| | **Outcome** | **Cardiac hospitalization:** Angina, MI, IHD, HF | | |
| | | **Mortality:** All-cause | | |
| **Jenkins (1994)** | **N** | 463 | **Optimism about success of surgery and symptoms of illness at 6 months** (unadjusted) | F=7.76 (df =2,422), p=.0005, Binomial Effect Size Display (BESD)=0.188 |
| | **Population** | CABG/cardiac valve surgery (first surgery) | | |
| | **Age** | <50=27%; 50–59=41%; 60–69=32% | **Well-being and symptoms of illness at 6 months** (unadjusted) | F=3.73, p=.02, BESD=−.178 |
| | **Male** | 83%, n=382 | | |
| | **Follow-up** | 6 months | | |
| | **Positive construct** | **Well-being:** Bradburn Scale | | |
| | | **Optimism:** Author-created, about success of surgery | | |
| | **Outcome** | **Symptoms of illness:** Author-created scale | | |
| **Jenkins (1996)** | **N** | 463 | **Optimism and cardiac symptoms** (age, gender, type of surgery) | $\chi^2$=5.03, p=.03 (also controls for sleep disturbance)<br>$\chi^2$=6.46, p=.01( also controls for dyspnea, fatigue, social support, depression [POMS Depression subscale]) |
| | **Population** | CABG/cardiac valve surgery (first surgery) | | |
| | **Age** | <50=27%; 50–59=41%; 60–69=32% | | |
| | **Male** | 83%, n=382 | **Optimism (low versus high) and cardiac symptoms** (unadjusted) | $\chi^2$=19.36, p=.001 |
| | **Follow-up** | 6 months | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Positive construct** | **Well-being:** Bradburn Scale<br>**Optimism:** Beck Hopelessness Scale (BHS) | **Well-being (low versus high) and cardiac symptoms** (unadjusted) | $\chi^2$=18.48, p=.005 |
| | **Outcome** | **Cardiac symptoms:** # of days of cardiac symptoms | | |
| **Jowsey (2012)** | **N** | 68 | **Optimism and all-cause mortality** (unadjusted) | p=.55 (no additional statistics reported) |
| | **Population** | Heart transplant | **Optimism and HRQoL** (age, sex, pre-transplant depression measured by MMPI, time from MMPI to transplant, time from transplant to HSQ) | **Mental HRQoL:** p=.04 (no additional statistics reported)<br>**Physical HRQoL:** p=.02 (no additional statistics reported) |
| | **Age** | M=50.3 +/− 11.7 | | |
| | **Male** | 79%, n=54 | | |
| | **Follow-up** | Median=4.9 years (pre to post transplant) | | |
| | **Positive construct** | **Optimism:** Minnesota Multiphasic Personality Inventory<br>Optimism-Pessimism Scale optimism subscale: 0–45=optimistic; 46–53=mixed; 54–100=pessimistic<br>**HRQoL:** Health Status Questionnaire (HSQ) | | |
| | **Outcome** | **Mortality:** All-cause | | |
| **Kim (2013)** | **N** | 1546 | **Purpose in life and MI** (age, gender, heart disease severity, self-rated health [items on general health status, change in health, mobility, agility, pain]) | OR=.73, 95% CI [.57, .93], p=.01 (by each unit increase in purpose in life) |
| | **Population** | CHD | | |
| | **Age** | M=72.2 +/− 9.4 | | |
| | **Male** | 49%, n=756 | **Purpose in life and MI** (above, plus anxiety, cynical hostility, depression [all of which used measures in the HRS Psychosocial Manual]) | OR=.76, 95% CI [.58, 1.00], p<.05 |
| | **Follow-up** | 2 years | | |
| | **Positive construct** | **Purpose in life:** Ryff's Scale | | |
| | **Outcome** | **Myocardial Infarction:** Fatal and non-fatal | **Optimism/positive affect and MI** (age, gender, heart disease severity, self-rated health) | **Optimism:** OR=.62, 95% CI [.51, .76], p<.001<br>**Positive affect:** OR=.68, 95% CI [.49, .95], p=.02 |
| **Mahler (2000)** | **N** | 212 | **Optimism (optimism x time) and pain at 12 months** (unadjusted; controlled for baseline optimism) | F=2.96, p=.02 (optimism alone was nonsignificant: p>.12) (controlled for baseline optimism) |
| | **Population** | CABG | | |
| | **Age** | M=61.4, SD=8.4 (out of 212) | **Optimism (optimism x time) and functional status at 12 months** (unadjusted; controlled for baseline optimism) | p>.40 (no additional statistics reported) |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Male** | 86%, n=168 (out of 197); 88%, n=186 (out of 212) | | |
| | **Follow-up** | 1 year | | |
| | **Positive construct** | **Optimism:** LOT (optimism subscale) | | |
| | **Outcome** | **Pain:** Wisconsin Brief Pain Questionnaire | | |
| | | **Functional status:** Sickness Impact Profile | | |
| **Middleton (1996)** | **N** | 121 | **Positive affect and rehospitalization** (unadjusted) | t=2.49, p=.014 (no additional statistics reported) |
| | **Population** | CVD hospitalized for CHF, IHD, AF, ACS (>55 years) | **Optimism and rehospitalization** (unadjusted) | t=1.22, p=.226 (no additional statistics reported) |
| | **Age** | M=69.9, SD=8.6 | | |
| | **Male** | 53%, n=64 | **Positive affect/optimism and rehospitalizations** (LOS, ADLs, physical health and personal adjustment [Multilevel Assessment Instrument], number of secondary disorders) | **Positive affect:** Wilks' lambda=.946, F=6.71, p<.01<br>**Optimism:** Wilks' lambda=.989, F=1.27, p>.05 |
| | **Follow-up** | 90 days | | |
| | **Positive construct** | **Positive affect:** Affect Balance Scale (ABS) | | |
| | | **Optimism:** HOPE Scale | | |
| | **Outcome** | **Rehospitalizations:** Non-elective | | |
| **Myaskovsky (2006)** | **N** | 66 (heart transplant only) | **Optimism and HRQoL** (age, education, health status [Karnofsky Score], social support, mastery, coping strategies [28-item brief COPE scale]) | **General health:** t=.79, p=.43<br>**Physical function:** t=−.10, p=.92<br>**Vitality:** t=2.11, p=.039<br>**Pain:** t=.74, p=.47<br>**Physical role:** t=18, p=.86<br>**Emotional role:** t=34, p=.74<br>**Social function:** t=2.51, p=.015<br>**Mental health:** t=2.14, p=.036 |
| | **Population** | Heart transplant (survived >2 months post-transplant) | | |
| | **Age** | >50=69% | | |
| | **Male** | N/A | | |
| | **Follow-up** | 1 year | | |
| | **Positive construct** | **Optimism:** LOT | | |
| | | **Outcome HRQoL:** SF-36 | | |
| **Pelle (2009)** | **N** | 220 (103 low positive affect; 117 high positive affect) | **Low positive affect (median split; <19=low) and outcomes** (unadjusted) | **Mental HRQoL:** β= −.25, t=−4.04, p<.001<br>**Physical; HRQoL:** β= −.22, t=−3.49, p=.001<br>**Cardiac symptoms:** β=.22, t=3.59, p<.001<br>**Feelings of disability:** β=.23, t=3.82, p<.001; |
| | **Population** | CHF outpatients | | |
| | **Age** | M=65.3, SD=9.5 | | |
| | **Male** | 76%, n=166 | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Follow-up** | 1 year | | |
| | **Positive construct** | **Positive affect:** GMS | **Low positive affect (median split; <19=low), and outcomes** (type D [Type D Scale], gender, age, no partner, low education, current smoking, NYHA I-III, LVEF, stroke/TIA, COPD, statins, calcium antagonists, diuretics, health status at inclusion) | **Mental HRQoL:** β= −.19, t=−2.92, p=.004<br>**Physical HRQoL:** β= −.11, t=−1.80, p=.07<br>**Cardiac symptoms:** β=.04, t=.79, p=.43<br>**Feelings of disability:** β=.10, t=2.02, p=.04 |
| | **Outcome** | **Physical/mental HRQoL:** SF-12<br>**Cardiac symptoms:** 24-item Health Complaints Scale<br>**Feelings of disability:** 24-item Health Complaints Scale | | |
| **Ried (2006)** | **N** | 2317 (1578 provided self-report data) | **Subjective well-being (poor/fair versus excellent/good) and outcomes** (unadjusted, n=2317) | **Adverse clinical outcomes:** RR=1.86, 95% CI [1.28, 2.70], p<.05<br>**Mortality:** RR=1.68, 95% CI [1.05, 2.68], p<.05 |
| | **Population** | CAD and HTN | | |
| | **Age** | M=67.0 +/−10 | | |
| | **Male** | 54%, n=1247 | **Subjective well-being (poor/fair versus excellent/good) and adverse clinical outcomes** (age, gender, race/ethnicity, education, DM, stroke, CABG, CHF, lipid-lowering agent, angina, abnormal angiogram, PVD, arrhythmia) | OR=2.35, 95% CI [1.39, 3.96], p=.002 (n=1554) |
| | **Follow-up** | 1 year | | |
| | **Positive construct** | **Subjective well-being:** Author-created | | |
| | **Outcome** | **Adverse clinical outcomes:** Mortality, stroke, nonfatal MI | | |
| **Scheier (1989)** | **N** | 51 (total), 48 (6 month analysis) | **Optimism and post-operative complications at 6 weeks** (# grafts, # main coronary arteries occluded 50% or more, total composite risk-factor variable) | F(1,43)=2.50, p>.10 (no additional statistics reported) |
| | **Population** | CABG (men <58 years) | | |
| | **Age** | M=48.5 +/− 6.5 | | |
| | **Male** | 100%, n=51 | **Optimism and resumption of vigorous physical exercise at 6 months** (same as above) | F=5.13, p<.03 |
| | **Follow-up** | 6 months | | |
| | **Positive construct** | **Optimism:** LOT | | |
| | **Outcome** | **Post-operative complications at 6 weeks**: Bivariate Y/N, shortness of breath, residual pain, CHF | **Optimism and rate of resumption of vigorous exercise at 6 months** (same as above) | F=3.17, p<.09 (ns) |
| | | **Self-report angina symptoms:** Rose Questionnaire | | |
| | | **Physical activity recovery:** (1) whether activity resumed, (2) time, in weeks, to resumption | | |
| **Scheier (1999)** | **N** | 283 | **Optimism and outcomes at 6 months** (unadjusted) | **Surgery/CAD rehospitalizations**: OR=.50, 95% CI [.33, .76], p<.01 |
| | **Population** | CABG (first-time) | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Age** | M=62.8 +/− 10.4 | | **All-cause rehospitalizations:** β=.06 +/−.03, OR=.78, 95% CI [.59, 1.03], p=.08 |
| | **Male** | 70%, n=198 | | |
| | **Follow-up** | 6 months | **Optimism and surgery/CAD rehospitalizations at 6 months** (sex, serum cholesterol, depression [CES-D], neuroticism [EYSENCK personality scale], self-esteem [Rosenberg Self Esteem Scale]) | β=.14 +/− .17, OR=.58, 95% CI [.34, .99], p<.05 |
| | **Positive construct** | **Optimism:** LOT-R | | |
| | **Outcome** | **Rehospitalizations:** Surgery and CAD-related | **Optimism and all-cause rehospitalizations at 6 months** (comorbidity [measured using a comorbidity score ranging from 0–7; author-created], CES-D, EYSENCK, Rosenberg Self Esteem) | β=.09 +/− .04, OR=.70, 95% CI [.50, .99], p<.05 |
| **Shepperd (1996)** | **N** | 22 | **Optimism and health behavior markers** (unadjusted) | **Body fat**: r=.81, p<.01<br>**Saturated fat**: r=.66, p<.01<br>**Cholesterol:** r=.30, p>.10<br>**Weight:** r=.36, p>.10<br>**HDL:** r=.43, p<.10<br>**LDL:** r=48, p<.10<br>**Aerobic capacity**: r=.45, p<.05<br>**Global coronary risk**: r=.43, p<.05 |
| | **Population** | Enrolled in cardiac rehabilitation (18 week, phase III) | | |
| | **Age** | M=61, Range=40–80 | | |
| | **Male** | 82%, n=18 | | |
| | **Follow-up** | 18 weeks | | |
| | **Positive construct** | **Optimism:** LOT | | |
| | **Outcome** | **Health behavior markers:** Heart Chec Plus Questionnaire (global coronary risk, percent body fat, and aerobic capacity); Treadmill test (aerobic capacity) | **Optimism and health behavior markers** (magnitude of health behavior goal, age) | **Body fat**: β=.705, $r^2$=.45, p<.01<br>**Saturated fat**: β=.719, $r^2$=.48, p<.01<br>**Cholesterol:** β=.062, $r^2$=.01, p=>.05<br>**Weight:** β=.275, $r^2$=.07, p>.05<br>**HDL:** β=.384, $r^2$=.11, p>.05<br>**LDL:** β=.440, $r^2$=.16, p>.05<br>**Aerobic capacity**: β=.587, $r^2$=.31, p<.01<br>**Global coronary risk:** β=.533, $r^2$=.26, p<.01 |
| **Sirri (2010)** | **N** | 95 | **Purpose in life and mortality** (unadjusted) | Log-rank test for survival: p=.007 |
| | **Population** | Heart transplant (at least 6 months prior to assessment) | **Purpose in life (median split) and all-cause mortality** (unadjusted) | OR=.28, 95% CI [.10, .76], p=.01 |
| | **Age** | M=56.0 +/− 10.1 | | |
| | **Male** | 83%, n=79 | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Follow-up** | 6 years | **Purpose in life and all-cause mortality** (age, DM, renal insufficiency, hostility/depression [Kellner's Symptom Questionnaire]) | p=ns (no additional statistics reported) |
| | **Positive construct** | **Purpose in life:** Ryff Scale | | |
| | **Outcome** | **Mortality:** All-cause | | |
| **Tindle (2012)** | **N** | 430 (total), 284 (depressed), 146 (nondepressed) | **Optimism (median split) and all-cause rehospitalization** (unadjusted) | HR=.56, 95% CI [.33, .94], p=.03 |
| | **Population** | CABG | | |
| | **Age** | M=64.9 +/−10.5 | **Optimism (median split) and all-cause rehospitalization** (education, baseline depression [Hamilton Rating Scale for Depression; HRSD], anxiety [primary care evaluation of mental disorders], physical activity, HRQoL [SF-36], perceived social support [perceived social support scale], adherence to medical advice [Ziegelstein Healthy Lifestyle Questionnaire]) | HR=.54, 95% CI [.32, .93], p=.03 |
| | **Male** | 61%, n=260 (total) | | |
| | **Follow-up** | 8 months | | |
| | **Positive construct** | **Optimism:** LOT-R | | |
| | **Outcome** | **Rehospitalizations:** All-cause | **Optimism (continuous) and all-cause rehospitalization** (s) | **Each 1 point increase associated with 5% lower risk of rehospitalization:** OR=.95, 95% CI [.91, .99], p=.04 |
| **van den Broek (2013)** | **N** | 591 | **Positive affect and outcomes** (unadjusted) | **All-cause mortality:** HR=.98, 95% CI [.96, 1.006], p=.153<br>**Cardiac mortality:** HR=.98, 95% CI [.96, 1.007], p=.16 |
| | **Population** | ICD (18–80 years) | | |
| | **Age** | M=62.7 +/− 10.1 | **Positive affect and outcomes** (age, gender, relationship, indication for ICD, CAD, CRT, LVEF, DM, smoking, beta blockers, ACE inhibitor, appropriate shocks, inappropriate shocks) | **All-cause mortality:** HR=1.007, 95% CI [.98, 1.03], p=.61<br>**Cardiac mortality:** HR=1.01, 95% CI [.98, 1.04], p=.41 |
| | **Male** | 81%, n=477 | | |
| | **Follow-up** | Median=1150 days | | |
| | **Positive construct** | **Positive affect:** GMS | | |
| | **Outcome** | **Mortality:** All-cause | | |
| | | **Mortality:** Cardiac | | |
| **van der Vlugt (2005)** | **N** | 567 | **Well-being and all-cause mortality** (unadjusted) | HR=1.0, 95% CI [.80, 1.4], p=ns |
| | **Population** | Acute MI | | |
| | **Age** | M=64.0 +/− 11.4 | | |
| | **Male** | 74%, n=418 | | |
| | **Follow-up** | Median=8 years (6–9 years) | | |

| Study characteristics | | | Analyses | Results |
|---|---|---|---|---|
| | **Positive construct** | **Well-being:** Heart Patients Psychological Questionnaire | | |
| | **Outcome** | **Mortality:** All-cause | | |
| **Versteeg (2009)** | **N** | 562 | **Positive affect 30 days post PCI and health status via EQ-VAS at 12 months** (unadjusted) | F=19.93, p<.001 (no additional statistics reported) |
| | **Population** | PCI receiving stent | | |
| | **Age** | M=62.4 +/− 10.8 | **Positive affect 30 days post PCI and health status via EQ-VAS at 12 months** (baseline health status, age, gender, multivessel disease, cardiac history [MI, PCI, CABG], comorbidity [HTN, hyperlipidemia, DM], smoking, negative affect [GMS]) | F=5.11, p=.02 (no additional statistics reported) |
| | **Male** | 73%, n=411 | | |
| | **Follow-up** | 12 months | | |
| | **Positive construct** | **Positive affect:** GMS | | |
| | **Outcome** | **Health status:** EuroQol 5 Dimension (EQ-5D), EuroQol Visual Analog Scale (EQ-VAS) | **Low positive affect at 30 days and EQ-5D domains at 12 months** (unadjusted) | **Self-care:** OR=5.12, 95% CI [1.48, 17.77], p=.01<br>**Usual activities:** OR=1.94, 95% CI [1.26, 2.98], p=.002<br>Note: All other domains, p=ns |

Note. ACE=Adverse Cardiovascular Event; ACS=Acute Coronary Syndrome; AF=Atrial Fibrillation; CABG=Coronary Artery Bypass Graft Surgery; CAD=Coronary Artery Disease; CHD=Coronary Heart Disease; CHF=Congestive Heart Failure; CI=Confidence Interval; CVD=Cardiovascular Disease; DM=Diabetes Mellitus; HF=Heart Failure; HR=Hazard Ratio; hsCRP=High Sensitivity C-Reactive Protein; HTN=Hypertension; ICD=Implantable Cardioverter Defibrillator; IHD=Ischemic Heart Disease; IL-6=Interleukin-6; LVEF=Left Ventricular Ejection Fraction; M=Mean; MI=Myocardial Infarction; ns= not significant; OR=Odds Ratio; PCI=Percutaneous Coronary Intervention; PTCA=Percutaneous Transluminal Coronary Angioplasty; PVD=Peripheral Vascular Disease; RR=Relative Risk; SD=Standard Deviation; SE=Standard Error; sTNFr1=Soluble Tumor Necrosis Factor Receptor-1, sTNFr2=Soluble Tumor Necrosis Factor Receptor-2; TIA=Transient Ischemic Attack; TNFa=Tumor Necrosis Factor-Alpha.

## Table 4

Proportions of statistically significant associations between positive psychological states and clinical outcomes.

| | All analyses Significant/Total (Percent) | Adjusted analyses [a] Significant/Total (Percent) |
|---|---|---|
| **By positive psychological construct** | | |
| Optimism | 16/26 (62%) | 9/15 (60%) |
| Positive affect | 12/20 (60%) | 8/13 (62%) |
| Well-being | 8/11 (73%) | 2/3 (67%) |
| Other | 3/3 (100%) | 3/3 (100%) |
| **By cardiac illness** | | |
| Coronary artery disease | 25/35 (71%) | 14/18 (78%) |
| Cardiac surgery | 11/15 (73%) | 5/8 (63%) |
| Heart failure | 3/6 (50%) | 3/6 (50%) |
| Arrhythmia | 0/4 (0%) | 0/2 (0%) |
| **By clinical outcome** | | |
| Mortality | 10/21 (48%) | 6/11 (55%) |
| Rehospitalization | 8/11 (73%) | 5/6 (83%) |
| Acute cardiac event | 9/10 (90%) | 5/5 (100%) |
| Other medical outcome | 2/7 (29%) | 2/7 (29%) |
| Patient-reported outcome [b] | 10/11 (91%) | 4/5 (80%) |

Note. Includes studies with 100 or more participants.

[a] Adjusted analyses include analyses with any covariate adjustment, with the most-adjusted model when multiple adjusted analyses were completed;

[b] self-reported measures of physical or cardiac symptoms, pain, function, health behaviors, and/or health-related quality of life.