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Associations between positive emotional well-being and stress-induced myocardial ischemia
Well-being scores predict exercise-induced ischemia

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ABSTRACT

Objective: Depressive symptoms have been associated with myocardial ischemia induced by mental (MSIMI) and exercise (ESIMI) stress in clinically stable ischemic heart disease (IHD) patients, but the association between positive emotions and inducible ischemia is less well characterized. The objective of this study was to examine the associations between ratings of well-being and stress-induced ischemia.
Methods: Subjects were adult patients with documented IHD underwent mental and exercise stress testing for the Responses of Myocardial Ischemia to Escitalopram Treatment (REMIT) trial. The General Well-Being Schedule (GWBS), with higher scores reflecting greater subjective well-being, and the Center for Epidemiologic Studies Depression Scale (CES-D) were obtained from the REMIT participants. Echocardiography was used to measure ischemic responses to mental stress and Bruce protocol treadmill exercise testing. Data were analyzed using logistic regression adjusting for age, sex, resting left-ventricular ejection fraction (LVEF), and resting wall motion score index, as well as health-related behaviors.
Results: GWBS scores were obtained for 210 individuals, with MSIMI present in 92 (43.8%) and ESIMI present in 64 (30.5%). There was a significant inverse correlation between GWBS-PE (Positive Emotion subscale) scores and probability of ESIMI (OR = 0.55 (95%CI 0.36–0.83), p = 0.005). This association persisted after additional control for CESD subscales measuring negative and positive emotions and for variables reflecting health-related behaviors. A similar inverse correlation between GWBS-PE and MSIMI was observed, but did not reach statistical significance (OR = 0.81 (95%CI 0.54–1.20), p = 0.28).
Conclusion: This is, to our knowledge, the first study demonstrating that greater levels of self-reported positive emotions are associated with a lower likelihood of ESIMI among patients with known IHD. Our results highlight the important interface functions of the central nervous and cardiovascular systems and underscore areas for future investigation.

1. Introduction

Negative emotions and the parallel psychiatric diagnoses, namely depression, are shown to predict the development of cardiovascular disease and increased mortality [1–3]. One limitation of commonly used measures of distress, such as the Beck Depression Inventory and Patient Health Questionnaire-9 [4], is they do not adequately assess the experience of positive emotion, another dimension of emotional functioning with implications for cardiovascular health.

Several studies have shown that high scores on measures of positive emotions are associated with a lower probability of early mortality [5], the development of cardiovascular disease [5–7], and subsequent cardiovascular events among individuals with cardiovascular disease [8,9]. Many of these findings include controls for negative emotion or psychiatric disease [5,7,8,10,11], demonstrating that positive emotion appears to be an independent predictor of disease development and progression. This underscores the importance of assessing both positive and negative emotions in studies investigating the influence of psychological factors on cardiovascular health

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The General Well-Being Schedule (GWBS) is a measure of various aspects of negative and positive emotional being and has been shown to be a predictor of health outcomes, including incident cardiovascular disease [7]. Among the domains of well-being comprising the GWBS, there is a subscale, GWBS-Positive Emotions (GWBS-PE), that assesses individual differences in the experience of both positive and negative emotion using a bipolar scale. Given the evidence documenting the importance of both positive and negative emotions to health, a measure that integrates that information into a single scale may confer advantages in the prediction of health outcomes.

One way of documenting the possible effects of well-being on ischemic heart disease (IHD) prognosis is via its association with intermediate biomarkers of adverse risk. Traditionally, inducible ischemia via exercise stress testing (ESIMI) is used as a risk indicator in IHD patients since it predicts a two-fold increase risk of mortality [12]. Mental stress-induced myocardial ischemia (MSIMI) is emerging as a reliable risk indicator in the IHD population with one pooled analysis of 5 studies showing that MSIMI was associated with a twofold increased risk of a combined end point of cardiovascular events or total mortality [13]. There are data supporting the association between negative emotions and inducible ischemia, as the severity of depressive symptoms has been linked to higher rates of MSIMI [14,15] and ESIMI [14]. Positive emotion measured by the Center for Epidemiologic Studies Depression Scale (CES-D) positive emotion subscale was associated with a lower rate of ESIMI [14]. However, this analysis did not control for negative emotion, making it difficult to draw conclusions regarding the relative contribution of positive and negative emotion to that association.

In the current study, we investigated the association between the GWBS Positive Emotions subscale (GWBS-PE), a bipolar measure of positive and negative emotion, and inducible ischemia in response to both mental and exercise stress in patients with clinically stable IHD. In addition, we adjusted for the individual effects of positive and negative emotions. Further, we explored whether various health behaviors are possible mechanisms linking positive emotions to health outcomes. We hypothesized that higher levels of positive emotion, independent of negative emotion, would predict lower rates of ESIMI and MSIMI.

2. Methods

2.1. Study design

Study participants were males and females 21 years of age or older recruited systematically for the REMIT study (NCT00574847) from the Duke University Health System department of cardiology outpatient clinics [16]. All participants had documented IHD, as defined by angiographic finding of coronary artery stenosis >70%, history of myocardial infarction, or status post re-vascularization procedures (i.e. coronary artery bypass grafting, or stenting). For complete details of the REMIT trial intervention, see the published methodology [16]. Because the GWBS was not added to the REMIT protocol until after recruitment had begun, scores are only available from 210 (67.7%) REMIT participants.

During two separate visits, participants underwent interviews and psychometric testing, followed by mental and exercise stress testing protocols. Stress testing was conducted at the Duke Cardiac Diagnostic Unit in the morning between 8 am and 11 am following a period of beta-blocker washout of 24–48 h. Three mental stress tasks (mental arithmetic, mirror trace, and anger recall) were administered in sequence, with a rest period of 6 min between tests. Approximately 20 min following mental stress testing, the patients completed treadmill exercise stress testing using the standard Bruce protocol [17], and testing was terminated according to the American College of Sports Medicine guidelines. Baseline and stress echocardiography was performed in the left-lateral position, with images captured during the final 3 min of each rest period and during the mental stress tasks. Images were acquired with a 3 MHz transducer in the harmonic imaging mode with a Phillips iE33 system (Bothell, WA) in the parasternal long- and short-axis views and apical 4- and 2-chamber views. Left ventricular ejection fraction (LVEF) is calculated from a 3 to 5 beat loop, and wall motion assessments are determined from 30 to 40 frames of systole from one cardiac cycle. Two experienced, blinded and independent raters performed echocardiographic readings of baseline and post-intervention images after the 6-week endpoint assessments using the American Society of Echocardiography 16-segment model [18]. Each segment was graded and scored as normal (1 = normal or hyperdynamic, score) or abnormal (2 = hypokinetic, 3 = akinetic, 4 = dyskinetic, or 5 = aneurysmal) wall motion. A wall motion score index (WMSI) was calculated as the sum of the segmental wall motion scores divided by the total number of the scored segments.

Inducible ischemia (both ESIMI and MSIMI) was defined as, compared to rest, the development of 1 or more ischemic markers during stress, including new or worsened wall motion abnormality (WMA); reduction of LVEF by 8% or more; or ST segment deviation (≥2 consecutive leads for ≥3 consecutive beats).

Participants were administered a battery of psychological assessments including the GWBS and the CES-D. The GWBS is an 18-item scale comprised of six subsets assessing various aspects of well-being and distress (depressed mood, anxiety, general health, vitality, emotional self-control, and a sense of positive well-being [GWBS-PE]), and has been demonstrated to be stable over time [19]. For the purpose of the present study, we will focus on the three item GWBS-PE subscale as it will allow us to model individual differences in the propensity to experience negative and positive emotion measured on a bipolar scale.A representative item from that scale is “How have you been feeling in general?” with six response options ranging from “In very low spirits” to “In excellent spirits”. We chose this scale because the content reflected positive emotion in contrast to other facets of well being (i.e. self-control or general health). Also, the bipolar nature of each item of the scale had appeal as it integrates information about positive and negative emotion into a single scale.

The CES-D is a 20-item questionnaire in which patients report on the frequency of depressive symptoms experienced in the past 2 weeks using a 4-point Likert scale (range from “Rarely” to “All of the time”). Factor analytic studies suggest that the items can be meaningfully summarized as four unipolar subscales including a four item scale that measures individual differences in the experience of positive emotion (e.g. I was happy) and a seven item scale that measures individual differences in the experience of negative emotion (e.g. I was depressed) [20,21]. A study of IHD patients reported a moderate, inverse association between those two scales [22]. We chose the CES-D subscales in order to test whether any associations between GWBS-PE and inducible ischemia are due to individual differences in the experience of positive emotions, negative emotions or both.

Patients were also asked to provide information about various health related behaviors including smoking, exercise and BMI. Smoking status was determined by self-report and grouped into current smokers and former/never smokers. Exercise status data was collected via self-report survey of the number of episodes in the last week of mild (minimal effort), moderate (not exhausting) or strenuous (heart beats rapidly) exercise. The sum of these three indicators was used as a measure of exercise frequency. BMI was calculated as weight (kg) / (height in m) [2] from data that was gathered from the electronic medical record.

2.2. Statistical analysis

Logistic regression models were used to examine the associations between GWBS-PE scores and MSIMI and ESIMI, adjusting for age, sex, resting LVEF, and resting WMSI (Model I). Subsequent models were refitted to provide additional control for negative emotion (CESD-NE) scores (Model II), positive emotion (CESD-PE) scores (Model III), and a final model that controlled for both the CESD-NE and CESD-PE scores (Model IV).