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Anxiety Sensitivity and Physical Inactivity in a National Sample of Adults with a History of Myocardial Infarction

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Abstract

Background: The psychological factors underlying physical inactivity in vulnerable cardiac adult populations remain understudied. Anxiety sensitivity, a cognitive vulnerability defined as fear of the physical, cognitive, and social consequences of anxiety, may be an important modifiable determinant of physical inactivity. We examined the association of anxiety sensitivity, and each anxiety sensitivity subscale (physical, cognitive, and social concerns), with physical inactivity in adults with a history of myocardial infarction (MI).

Methods: Using cross-sectional data from a nationally representative survey of adults (n=1417) in the United States who reported a health professional diagnosis of MI, we used weighted logistic regression models to evaluate the association between anxiety sensitivity (overall, and each subscale) and physical inactivity (self-reported exercise 0-1 days/week), with adjustment for age, gender, race, education, number of MIs, and depression

Results: Overall, 34.3% reported physical inactivity. Anxiety sensitivity was associated with greater odds of physical inactivity (OR=1.01, 95%CI:1.00,1.02, $p=.026$). Of the subscales, only physical concerns were associated with physical inactivity (OR=1.02, 95%CI:1.01,1.04, $p=.008$) in the final model. High vs. low fear of shortness of breath was most consistently associated with physical inactivity (OR=1.49 95%CI:1.08,2.06, $p<.021$).

Conclusions: Anxiety sensitivity generally, and fear of the physical sensations of anxiety (i.e., “fear of shortness of breath”) specifically, are important correlates of physical inactivity in adults with a history of MI. Future research should replicate these findings, and experimentally test whether cardiac rehabilitation interventions that include an adjunctive component targeting

reduction of anxiety sensitivity overall, or specific somatic symptoms, improve physical activity in this population.

Keywords

anxiety sensitivity; exercise; heart disease; psychosocial; health behavior; United States of America

More than 1 in 3 adults in the United States (US) have at least one type of cardiovascular disease (CVD) [1], and the prevalence of a myocardial infarction (MI) in the US is three percent [2]. While adherence to regular physical activity recommendations and evidence-based cardiac rehabilitation programs can reduce recurrent cardiovascular events or death by 27-46% [1, 3, 4], most CVD patients, including those with a history of a myocardial infarction, do not achieve these physical activity benchmarks. In fact, only 16% of adults with coronary heart disease meet guideline recommended physical activity levels when measured objectively [5], and only 15-30% of CVD patients participate in cardiac rehabilitation programs [6]. Although previous research to explain the low rates of adherence to physical activity recommendations among CVD patients broadly has focused on sociodemographic factors and provider barriers to cardiac rehabilitation treatment [6, 7], comparatively less research has examined how anxiety sensitivity, a modifiable cognitive vulnerability, may impact physical activity in patients with a history of MI, with a few exceptions [8, 9].

Anxiety sensitivity is considered a transdiagnostic multi-dimensional marker of distress, psychopathology, and health risk behavior that is characterized by a fear of the negative consequences of anxiety-related sensations. [10–14]. There are three interrelated subdimensions of anxiety sensitivity, specifically a social concerns subdimension (e.g., fear that the visible physical manifestations of anxiety symptoms [sweating] will result in social expulsion), a physical concerns subdimension (e.g., fear that heart palpitations will result in a heart attack), and a cognitive concerns subdimension (e.g., fear that difficulties with concentration are an indication of mental incapacitation or insanity) [15]. Anxiety sensitivity is also considered a cognitive vulnerability because people with elevated levels of anxiety sensitivity are more likely to be vigilant to signs and cues that indicate anxious arousal, to interpret their anxiety symptoms to be catastrophic and negative, which then further increases their anxiety and leads to avoidance of behaviors or activities that mimic or generate feared sensations [11, 14]. Anxiety sensitivity is associated with increased risk of various negative cardiovascular health factors, including lack of exercise, medication non-adherence, smoking, depression, unhealthy eating practices, low working memory, and poor CVD illness prognosis [9, 14, 16–23].

Previous studies examining the influence of psychosocial factors on physical activity in the general population have historically focused on depression [24, 25] and have had small sample sizes, thereby limiting the generalizability of the results. Similarly, research investigating anxiety sensitivity and exercise among patients undergoing cardiac rehabilitation [9] has also been subject to small samples. To address these prior limitations, we leveraged a large national sample of adults with CVD to examine the association of

anxiety sensitivity with physical inactivity in a nationally representative sample of adults with a history of MI in models that accounted for important confounders. We also explored whether each of the anxiety sensitivity subscales were independently associated with physical inactivity. In accordance with previous research in healthy adults [17, 26], and in CVD patients [9], we hypothesized that increasing levels of anxiety sensitivity would be associated with greater odds of physical inactivity because of the convergence between feared anxiety sensations and the sensations typically experienced while engaging in moderate-vigorous intensity physical activity (e.g., shortness of breath, dizziness, heart palpitations). For adults with a prior history of a myocardial infarction, it is possible that fear of somatic sensations such as increased heart rate, shortness of breath, and heart palpitations may be reminiscent of the initial cardiac event, and lead to experiential avoidance altogether of moderate-vigorous intensity physical activity (i.e., exercise) that evokes these sensations [9, 14]. Thus, while we expected each of the subscales to be positively associated with physical inactivity, we expected to observe the strongest associations for the physical inactivity estimates associated with the physical concerns subscale.

Methods

Procedures

As described in greater detail elsewhere [27], we conducted a national online survey of adults living in the United States. Inclusion criteria included adult age defined as 18 years of age or older, and self-reported doctor or health professional diagnosis of MI. Between May 2013 to July 2013, YouGov (<https://today.yougov.com>), a web-based polling research company, administered the online survey to 1500 English-speaking or Spanish-speaking adults who were recruited from a volunteer panel of 1.2 million users. In exchange for completing the survey, participants earned points that were then redeemed for rewards per YouGov panel member guidelines. The age, sex, and race distribution of MI as reported in the 2010 National Health Interview Survey [28] was used to establish the sampling targets and the sampling weights. A two-step matching methodology was used to select the sample. First a random sample was drawn from the target population. Second, a matched set of survey respondents to these marginals was created using the proximity matching method to derive a “representative” sample [29]. Survey response rates were acceptable, with a 45.8% response rate for the English language administered survey and a 16.2% response rate for the Spanish language administered survey. The Institutional Review Board of Columbia University approved this study and informed consent was obtained from all participants.

Measures

Anxiety sensitivity.—Anxiety sensitivity was measured with the Anxiety Sensitivity Index (ASI), a 16-item self-report questionnaire of fear of anxiety-related symptoms [30]. A 0 (“very little”) to 4 (“very much”) point Likert scale is used to score each item. Sample items include “It scares me when my heart races” and “It is important for me to stay in control of my emotions.” Responses to the individual items are summed to generate a total ASI score. Higher total scores indicate greater anxiety sensitivity. The internal consistency of the ASI in this sample of adults with CVD was excellent (Cronbach’s $\alpha = 0.94$). Herein, the total ASI score represented the higher-order anxiety sensitivity factor. Total scores for

each of the anxiety sensitivity subdimensions were also calculated and the internal consistency estimates are provided below [27]: the physical concerns (Cronbach's $\alpha = 0.92$), social concerns (Cronbach's $\alpha = 0.73$), and cognitive concerns subscales (Cronbach's $\alpha = 0.87$).

Physical Activity: Participants' responses to the single question: "In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate, (e.g., playing sports, exercising, briskly walking or cycling for recreation or transportation) was used to measure physical activity. This single-item question has been demonstrated to have good validity and reliability [31]. Physical inactivity was defined as exercising 0-1 days/week and physical activity was defined as exercising ≥ 2 days/week.

Covariates.—Sociodemographic and medical history covariates included self-reported age, gender (male, female), race, educational attainment (high school or less, some college, 4 years or more of college) and number of lifetime MIs. The Patient Health Questionnaire (PHQ-8) [32] was used to measure depressive symptoms. Scores for the PHQ-8 range from 0 to 24, with higher scores indicating greater severity of depressive symptoms. The PHQ-8 has strong psychometric properties that are comparable to those of the original PHQ-9 scale and high sensitivity and specificity for major depression [33]. Depression was categorized as PHQ-8 score of 16 or greater.

Analysis Plan—The analyses were restricted to adult participants with complete physical activity, anxiety sensitivity, and covariate data ($n = 1417$). There were 83 participants with incomplete data, representing 5.5% missing data, which is less than the recommended 10% required for imputation [34]. There were no statistically significant differences between those with complete and incomplete data in the primary outcome and exposure variable. However, participants with complete data compared to those with incomplete data were more likely to be older, non-Hispanic White, and to have lower scores on the cognitive subscale of the ASI. All analyses were weighted to account for the sampling design. Physically inactive (exercise 0-1 days/week) and physically active (exercise ≥ 2 days/week) adults were compared on demographic and clinical characteristics using t-test for continuous variables and Chi-squared test for categorical variables. Logistic regression models were used to evaluate the association between physical inactivity and anxiety sensitivity level (expressed continuously), as well as its association with each of the three anxiety sensitivity subscales (physical, cognitive, and social; all continuously expressed). Crude odds ratios (OR) were initially calculated (Model 1). The models were then adjusted for age, gender, race/ethnicity, education, and number of prior MIs (Model 2), and then further adjusted for depression (Model 3). As a secondary analysis, the above analyses were repeated expressing anxiety sensitivity as a dichotomous variable: high anxiety sensitivity ($ASI \geq 24$) vs. low anxiety sensitivity ($ASI < 24$); these cut-offs were based on initial normative data with a general non-cardiac population [11, 35]. We also conducted three supplemental analyses to: (a) determine which of the exertion-related somatic symptom items within the ASI were most strongly associated with physical inactivity, and (b) examine the association of anxiety sensitivity and physical activity treated as a continuous outcome (i.e., number of days

exercised in the past week), and (c) examine the association of anxiety sensitivity and physical inactivity after adjustment for health burden, operationalized as a total count of “yes” responses to the question has a doctor of nurse ever diagnosed you with the following physical and mental health conditions: high blood pressure or hypertension, high blood cholesterol, heart failure, other heart problems, diabetes, kidney problems (e.g., urine infection from your kidney, kidney stones, nephritis or glomerulonephritis, kidney failure, dialysis, or kidney transplant), liver disease, blood clot in your leg vein or lung requiring blood thinning medicine, peripheral arterial disease (clogged arteries in the leg), stroke or TIA (transient ischemic attack), cancer or malignant tumor, depression, anxiety, HIV, any other major disease or health problem, or any other emotional, behavioral, or mental disorder. All statistical analyses were performed using SAS software (version 9.4; SAS Institute, Cary, NC), with SAS SURVEY procedures used to account for survey weights.

Results

Table 1 presents the weighted participant demographic and psychosocial characteristics overall and by physical activity status. Overall, there were 1417 participants and the mean age was 64.7 ($SE=0.35$). Most participants were male (60.9%), non-Hispanic White, had some college or completed a 4-year or postgraduate degree, and had an average history of 1.62 MIs ($SE=0.04$). There were 487 participants or 34.4% who reported physical inactivity (exercise 0-1 days/week) and 930 or 65.6% who reported physical activity (exercise ≥ 2 days/week). Those who were physically inactive were older, less likely to be male, and more likely to have lower educational attainment than those who were physical active (Table 1). Further, those who were physically inactive had statistically higher depressive symptom scores and anxiety sensitivity scores than those who were physical active.

Table 2 presents the unadjusted and adjusted weighted multivariable logistic regression analyses of the association of anxiety sensitivity with physical inactivity. A one-point increase in total anxiety sensitivity resulted in a 1% increase in the odds of physical inactivity ($OR=1.01$, 95% CI: 1.01, 1.02, $p=.012$) in unadjusted models. Similarly, after progressive adjustment for age, gender, race, education, and number of MIs, a one-point increase in the total anxiety sensitivity score was associated with a 2% increased odds of physical inactivity ($OR=1.02$, 95% CI: 1.01, 1.03, $p=.002$). In weighted logistic regression models that further adjusted for depression, the association between anxiety sensitivity and physical inactivity remained statistically significant ($OR=1.01$, 95% CI: 1.00, 1.02, $p=.026$). Similarly, a unit increase in each of the subscale domains was associated with a 3-4% increase in the odds of physical inactivity (Table 2). Specifically, one-unit increases in the physical concerns subscale ($OR=1.03$, 95% CI: 1.01, 1.05, $p=.001$), cognitive concerns subscale ($OR=1.04$, 95% CI: 1.00, 1.08, $p=.045$), and the social concerns subscale ($OR=1.04$, 95% CI: 1.00, 1.08, $p=.031$) were each associated with increased odds of physical inactivity in models adjusted for age, gender, race, education, and number of heart attacks. However, only the independent association of the physical concerns subscale and physical inactivity was statistically significant after a final adjustment for depression. In secondary analyses using anxiety sensitivity cut-off scores, high anxiety sensitivity relative to low anxiety sensitivity was associated with a 48% increase in the odds of physical

inactivity (OR=1.48, 95% CI: 1.11, 1.98) after controlling for age, gender, race, education, and number of MIs.

In supplemental analyses that examined the association of fear of specific somatic symptoms with physical inactivity, participants with fear of shortness of breath scores in the top tertile had higher odds of physical inactivity compared to those in the lowest tertile (OR=1.49; 95% CI: 1.09, 2.06, $p=.021$) in the fully adjusted model. Additional supplemental analyses using a continuous physical activity outcome, found that the total anxiety sensitivity score ($b=-.02$; 95% CI: $-.03, -.01$), and each of the anxiety sensitivity subscales (physical: $b=-.03$; 95% CI: $-.05, -.02$; cognitive: $b=-.07$; 95% CI: $-.10, -.04$; social: $b=-.06$; 95% CI: $-.09, -.03$) were all inversely associated with physical activity, and these findings were consistent after adjustment for important confounders (Supplemental Table 1). Similarly, supplemental analyses with an additional adjustment for health burden did not appreciably change the estimates of the overall association of anxiety sensitivity with physical inactivity; though the estimate was no longer statistically significant it was in the expected direction. Importantly the physical concerns subscale remained statistically associated with physical inactivity after further adjustment for health burden (Supplemental Table 2).

Discussion

While regular physical activity remains a viable prevention and intervention target for reducing CVD morbidity and mortality, it remains an elusive public health goal. Our results show that in a large national survey of adults with a history of myocardial infarction in the United States, nearly 35% were physically inactive (i.e., exercising 0–1 days/week). These rates mirror the national rates of cardiac rehabilitation use post MI [1], and collectively underscore the importance of research efforts for increasing physical activity in this particular vulnerable patient population.

In support of our hypotheses, and consistent with previous cross-sectional and prospective research documenting a negative relationship between anxiety sensitivity and physical activity among adults without CVD [16, 17], and also among adults with CVD in a cardiac rehabilitation program [9], an incremental point increase in total anxiety sensitivity resulted in a 2–4% increase in the odds of physical inactivity in models that accounted for sociodemographic factors, MI history and total health burden. These findings were consistent when each anxiety sensitivity subscale was independently evaluated; though only the physical concerns subscale remained significantly associated after adjustment for depression and health burden. Previous research has found that the cognitive and social subdimensions of anxiety sensitivity are associated with depression.[36] As such, the cognitive and social subscales of anxiety sensitivity may reflect common ruminative cognitive processes and social concerns that are also present in those with depression, which may explain why these subdimensions were no longer statistically significant after adjustment for depression.

Importantly, in supplemental analyses of the somatic arousal and exertion related anxiety sensitivity items, only fear of shortness of breath remained statistically associated with physical inactivity, even after final adjustment for depressive symptoms. These results

suggest that fear of shortness of breath may be a robust yet modifiable deterrent to physical activity for cardiac patients, and may warrant specific attention in behavioral interventions to promote healthy behavior change. Among adults with a prior history of MI, shortness of breath, in particular, may be most reminiscent of the initial cardiac event, and contribute most to experiential avoidance of moderate-vigorous intensity physical activity (i.e., exercise) that evokes this sensation. Future research should focus on replication in more diverse samples, and examine whether patients who fear shortness of breath in fact experience more shortness of breath, which may confound the estimates observed.

While this study provides an important contribution to the science of health behavior change in adults with a history of myocardial infarction, a few limitations warrant discussion. First, the study data are cross-sectional, which limits the ability to infer causality. Second, we do not have information on important health behaviors or health conditions such as body mass index, smoking, addictive behaviors, physical injuries or disabilities that would limit physical activity. Body mass index may be a critically important confounder given the previous research that found that BMI moderated the relationship between anxiety sensitivity and exercise exertion among adults who were obese [17]. Third, the sample is composed of an online panel of mostly non-Hispanic White adults who self-reported an MI event, as such the generalizability is limited because of lack of racial/ethnic diversity and self-selection biases related to who opts in or out of online survey studies. Relatedly, this survey did not include adults without a history of MI, and as such we are unable to compare if the associations of anxiety sensitivity with physical inactivity differ by presence or absence of MI history. Fourth, the original ASI instead of the ASI-3 was used to measure anxiety sensitivity and its subdimensions. Future research should use the ASI-3, which is optimized to measure the subdimensions of ASI.[ISP CHK ALL Underline] Further, self-reported physician diagnoses of cardiovascular events were not adjudicated, and as such subject to recall bias. Lastly, we were unable to differentiate between those who exercised 0 days versus 1 day. However, the inclusion of those who exercised 1 day would probably bias the results towards the null, and likely may have underestimated our effects.

To our knowledge, our results are among the first to provide corroborating empirical evidence in a large national sample of adults with a history of MI in the United States that anxiety sensitivity, a transdiagnostic cognitive vulnerability, and fear of the physical sensations related to anxiety such as shortness of breath in particular, may be important psychological correlates of physical inactivity. Future research should replicate these findings using prospective designs and with diverse samples. Importantly, there is some early and preliminary evidence using pre-test and post-test design to suggest that an adapted cognitive behavioral therapy program for panic attack for patients with heart failure resulted in reductions in anxiety, depression, and recurrent CVD hospital admissions and hospital length of stay.[37] Future research might explore in a randomized controlled trial or another experimental design whether cardiac rehabilitation interventions that include an adjunctive component targeting reduction of anxiety sensitivity overall, such as interoceptive cue exposure for somatic symptoms or cognitive reframing for anxiety symptoms, or targeted reduction of specific somatic symptoms only (i.e., shortness of breath) may subsequently improve physical activity for adults with CVD, and potentially lower cardiac event recurrence risk in this vulnerable patient population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Weighted Participant Demographic and Psychosocial Characteristics Overall and by Physical Inactivity Status (N=1417)

		Physical Inactivity	Physical Activity	
	Overall (N=1417)	0-1 days exercised/week (n=487)	2 days exercised/week (n=930)	
Variable	Mean (SE) / N (%)	Mean (SE) / N (%)	Mean (SE) / N (%)	p-value
Age, years (mean $\pm$ SE)	64.7 (0.35)	65.7 (0.53)	64.1 (0.45)	0.022
Male, N (%)	866 (60.9%)	273 (56.4%)	593 (63.3%)	0.019
Race/Ethnicity, N (%)		--	--	0.307
White	1198 (82.1%)	432 (85.2%)	766 (80.4%)	--
Black	121 (9.2%)	31 (8.4%)	90 (9.6%)	--
Hispanic	31 (4.2%)	6 (3.0%)	25 (4.8%)	--
Other	67 (4.5%)	18 (3.3%)	49 (5.2%)	--
Education, N (%)		--	--	0.001
High school graduate or lower	236 (16.3%)	103 (21.0%)	133 (13.8%)	--
Some college or 2-yr college	579 (41.3%)	202 (42.4%)	377 (40.7%)	--
4-yr college or postgraduate	602 (42.5%)	182 (36.6%)	420 (45.6%)	--
Depressive symptoms (PHQ-8), (mean $\pm$ SE)	6.02 (0.18)	7.28 (0.30)	5.36 (0.21)	<0.001
ASI score (mean $\pm$ SE)	16.70 (0.40)	18.07 (0.65)	15.99 (0.50)	0.011
Prior MIs (no.) (mean $\pm$ SE)	1.62 (0.04)	1.62 (0.07)	1.62 (0.05)	0.980

Note. SE, standard error; ASI, anxiety sensitivity index; PHQ-8, Patient Health Questionnaire; MI, myocardial infarction

Table 2.

Weighted Logistic Regression Models of Association of Anxiety Sensitivity Total Score, Subscales, and Physical Inactivity (N=1417)

	Model 1		Model 2		Model 3	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
ASI Total Score	1.01 (1.01-1.02)	0.012	1.02 (1.01-1.03)	0.002	1.01 (1.00 - 1.02)	0.026
ASI Physical subscale	1.02 (1.01-1.04)	0.003	1.03 (1.01-1.05)	0.001	1.02 (1.01-1.04)	0.008
ASI Cognitive subscale	1.03 (0.99-1.06)	0.139	1.04 (1.00-1.08)	0.045	1.02 (0.98-1.06)	0.363
ASI Social subscale	1.02 (0.99-1.06)	0.129	1.04 (1.00-1.08)	0.031	1.03 (0.98-1.07)	0.186

Note. The ASI total score and each of the ASI subscales were entered into separate models. OR, odds ratio; CI, confidence interval; ASI, anxiety sensitivity index.

^aModel unadjusted.

^bModel adjusted for age, gender, race, education, number of myocardial infarctions

^cModel fully adjusted for age, gender, race, education, number of myocardial infarctions, and depression (PHQ-8 ≥ 16).