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Relation of Perceived Health Competence to Physical Activity in Patients With Coronary Heart Disease

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Abstract

Physical activity is highly associated with mortality, especially in patients with coronary heart disease. We evaluated the effect of perceived health competence, a patient's belief in their ability to achieve health-related goals, on cumulative physical activity levels in the Mid-South Coronary Heart Disease Cohort Study (MCHDCS). The MCHDCS consists of 2587 outpatients (32% female) with coronary heart disease at an academic medical center network in the United States. Cumulative physical activity was quantified in metabolic equivalent (MET)-minutes per week with the International Physical Activity Questionnaire. We investigated associations between the two-item perceived health competence scale (PHCS-2) and MET-minutes/week after adjusting for comorbidities and psychosocial factors with linear regression. Nearly half of participants (47%) exhibited low physical activity levels (<600 MET-minutes/week). Perceived health competence was highly associated with physical activity after multivariable adjustment. A non-linear relationship was observed, with the strongest effect on physical activity occurring at lower levels of perceived health competence. There was effect modification by gender ($p=0.03$ for interaction). The relationship between perceived health competence and physical activity was stronger in women as compared to men; an increase in the PHCS-2 from 3 to 4 was associated with a 73% increase in MET-minutes/week in women (95% confidence interval (CI) 43–109%, $p<0.0001$) as compared to a 53% increase in men (95% CI 27–84%, $p<0.0001$). In conclusion, low perceived

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health competence was strongly associated with less physical activity in coronary heart disease patients and may represent a potential target for behavioral interventions.

Keywords

Perceived health competence; physical activity; coronary heart disease

Introduction

Physical inactivity is highly associated with mortality in patients with coronary heart disease.¹ Psychosocial factors related to physical activity levels include social support and self-efficacy.^{2,3} However, self-efficacy was originally conceptualized by Bandura⁴ as highly specific to a behavior in a particular situation and therefore necessitates context-specific measures.⁵ The Perceived Health Competence Scale (PHCS) was developed to measure a more generalized construct that is specific to the health domain but not any particular health behavior. Perceived health competence is the degree to which a person believes in their ability to alter or control health outcomes, such as dietary habits or tobacco consumption.⁶ Coronary heart disease (CHD) patients with higher perceived health competence may be more likely to engage in regular physical activity because of the belief that their behavior can alter their health outcomes. Therefore, we analyzed the relationship between perceived health competence and physical activity in the Mid-South Coronary Heart Disease Cohort Study (MCHDCS).

Methods

The MCHDCS was developed with support from the Patient-Centered Outcomes Research Institute's Mid-South Clinical Data Research Network. At the time of study, this network included Vanderbilt University Medical Center (VUMC), the Vanderbilt Health Affiliated Network (VHAN, a clinically integrated network of over 40 hospitals and 400 ambulatory practices in the region), and Greenway Health (which provides integrated electronic health record software to practices around the country). Participants in the present study were enrolled at VUMC and nearby VHAN sites. The institutional review board of Vanderbilt University approved the study.

We developed a computable phenotype⁷ to identify patients with CHD using the VUMC Research Derivative (RD), which includes inpatient and outpatient encounters.⁸ Patients with CHD were defined on the basis of International Classification of Diseases (ICD) and Current Procedure Terminology (CPT) billing codes. The positive predictive value of the definition was 98.5% and the sensitivity was 94.6%. To identify a pool of potentially eligible patients for the present survey, we applied the phenotype to patient records from VUMC and VHAN sites via the RD. We included patients with inpatient or outpatient clinical encounters from January 2009 to April 2015. Using this pool of patients with CHD, study staff then recruited survey participants through face-to-face contact at scheduled cardiology or primary care visits. Additional methods included mailing a letter or sending an email with directions to an online survey, mailing a paper copy of the survey, or telephone recruitment.⁹ Study participants were enrolled between August 2014 and September 2015. All surveyed

participants provided informed consent and were offered \$10 for survey completion. Study demographics, recruitment methods and representativeness have been detailed in prior work.⁹

The primary outcome was physical activity as a continuous variable, defined as metabolic (MET)-minutes per week. This outcome was captured by the short form of the International Physical Activity Questionnaire (IPAQ) which has been validated in many countries and patient populations.¹⁰ The IPAQ short form is a 7-item instrument with four domains: leisure time physical activity, domestic and gardening activities, work-related physical activity, and transport-related physical activity. These individual domains were used to calculate MET-minutes/week as recommended.^{10,11} For descriptive purposes, we characterized low physical activity as <600 MET-minutes/week, moderate physical activity as 600–2999 MET-minutes/week, and high physical activity as ≥3000 MET-minutes/week.¹² The distribution of MET-minutes/week was right-skewed, thus it was log-transformed prior to analysis as a continuous outcome variable.

Perceived health competence was assessed with a short form of the Perceived Health Competence Scale.^{5,13} The PHCS-2 uses a 5-point Likert response scale ranging from 1 = “strongly disagree” to 5 = “strongly agree.” Because the original PHCS scale was balanced with four positively and four negatively worded items, the PHCS-2 also contains both a positively (“I am able to do things for my health as well as most other people”) and a negatively (“It is difficult for me to find effective solutions for health problems that come my way”) worded item which were correlated $-.38$ ($p < 0.001$) in this sample. The negatively worded item was reverse-coded before summing it with the positively worded item to produce a summed scale that could range from 2 to 10. The higher the PHCS-2 score, the greater the respondent’s perception that he/she can alter or control his/her health outcomes.

The survey also included items on sociodemographic characteristics including marital status, level of education, household income, gender, race and ethnicity. Self-rated health status was measured using five items from the Patient Reported Outcomes Measurement Information System (PROMIS) Global Health Scale,¹⁴ which asks about general, physical, social, and mental health, and quality of life. These items are scored on a 5-point scale ranging from 1 = “poor” to 5 = “excellent”. Self-reported problems during the last 7 days related to depression, pain, and sleep were also assessed with single items endorsed by the PCORI Patient-Reported Outcomes Task Force for use across CDRNs. Smoking status (current smoking or not) was obtained from an item in the National Adult Tobacco Survey.¹⁵ Perceived social support was measured using six items from the ENRICH Social Support Inventory.¹⁶ Health literacy was assessed using the 3-item Brief Health Literacy Screen,¹⁷ which asks patients to rate their confidence level with reading health information, and a 3-item version of the Subjective Numeracy Scale,¹⁸ which asks patients about their comfort with numerical data and calculations. Beta blocker and calcium channel blocker use as well as left ventricular ejection fraction (LVEF) were ascertained from the electronic medical record.

All analyses were conducted in R version 3.1.2.¹⁹ Descriptive statistics for the study population, including median, 25th percentile and 75th percentile for continuous variables as

well as count and percentage for dichotomous variables were reported. Baseline characteristics of male and female MCHDCS participants were compared using Pearson's Chi-square test and non-parametric Wilcoxon tests. The only variable with >5% missing data was income (14.9% missing due to survey non-response). Therefore we used multiple imputation to account for missing data.²⁰

We used a pre-specified multivariable linear regression model to examine the associations between the PHCS-2 and physical activity. Due to strong evidence of non-linear covariate effects on the PHCS-2 (p-value<0.001 for the overall non-linear effect test), we used restricted cubic splines with four knots.²¹ Because the outcome (MET-minutes/week) was log-transformed, the associated regression parameter estimates are interpreted as the expected % change in the outcome per unit change in each covariate while holding other covariates constant.

Results

A flow diagram for cohort recruitment is presented in Figure 1. The final cohort of 2587 participants had a median age of 69, and was 32% female, and 88% White (Table 1). More than half the cohort had a high school degree and had attended at least some college. Men reported higher income levels than women. A significant portion (38%) of the cohort had diabetes and 7% had systolic heart failure, defined as LVEF <50%. The majority (77%) were on beta blocker medications. Most participants reported high perceived health competence, with a median PHCS-2 score of 8 (out of 10). The 25th and 75th percentiles of the PHCS-2 were 6 and 10, respectively.

The distribution of MET-minutes/week was highly skewed in the cohort (Figure 2), with the majority of participants exhibiting low physical activity in comparison with a few highly active patients. When categorized into physical activity levels, 47% of participants had low physical activity (<600 MET-minutes/week) as compared to 15% of participants with high physical activity (>3000 MET-minutes/week). Women exhibited lower cumulative physical activity than men (Figure 2, median 438 MET-minutes/week vs. 816 MET-minutes/week, p<0.001).

Both age, sex and race-adjusted as well as fully adjusted effects of perceived health competence and other covariates on physical activity, defined as % change in MET-minutes/week, are displayed in Table 2. The effect of the PHCS-2 on physical activity in the age, sex and race adjusted model diminishes slightly after adjusting for other covariates. Perceived health competence exhibited a nonlinear association with physical activity and demonstrated effect modification by gender (P=0.033 for interaction). We plotted the multivariable-adjusted association of the PHCS-2 with log-transformed MET-minutes/week separately by gender (Figure 3). The effect of perceived health competence on physical activity was greatest at the lower ranges (below a PHCS-2 score of 6) of the distribution in both men and women, but was larger in women than in men. An increase in the PHCS-2 from 3 to 4 was associated with a 73% increase in MET-minutes/week in women (95% CI 43–109%, p<0.0001) as compared to a 53% increase in MET-minutes/week in men (95% CI 27–84%,

$p < 0.0001$). The effect of perceived health competence on physical activity tapered from 5 to 6 and was no longer significant in the upper ranges of the PHCS-2 (from 9 to 10).

As shown in Table 2, depression was inversely associated with physical activity. Neither social support nor living with a spouse was associated with physical activity. Self-reported quality of life was very strongly associated with physical activity, with a 95% increase in physical activity for each point on the 1–5 scale (95% CI 71–122%, $p < 0.0001$). Numeracy was associated with physical activity but health literacy was not. Systolic heart failure, body mass index, diabetes and peripheral vascular disease (PVD) were all inversely associated with physical activity, with heart failure and PVD exhibiting the greatest effects. The use of beta blockers or calcium channel blockers was not associated with physical activity.

Discussion

In this cohort of 2587 patients with CHD, perceived health competence (PHCS-2) was associated with physical activity (MET-minutes/week) after adjusting for demographic, psychosocial and clinical characteristics as well as self-reported health status. Perceived health competence exhibited a non-linear association with physical activity, with the largest changes in physical activity seen at the lower range of the PHCS-2 scale. These effects were stronger in women as compared to men.

Physical activity levels were low in our cohort, likely a result of age, coronary heart disease and associated comorbidities. In a prior 12-country study, the IPAQ had a median score of approximately 2500 MET-minutes/week in middle-aged adults¹⁰ (compared to 690 MET-minutes/week in our cohort). Study participants had similar perceived health competence levels (median PHCS-2 scores of 8) as those previously reported in a cohort of patients hospitalized with acute coronary syndrome or congestive heart failure.¹³ PHCS-2 scores in both of these studies were well above the midpoint, indicating that participants generally felt competent with regards to their health. Notably, the full 8-item Perceived Health Competence Scale exhibits a similar distribution with a median significantly above the midpoint in multiple populations.⁵

Prior work has demonstrated that greater perceived health competence, as measured by the PHCS-2, is associated with positive health behaviors such as a healthy diet and smoking abstinence as well as self-reported quality of life in patients hospitalized with cardiovascular disease.²² Perceived health competence is also associated with health information-seeking behaviors,⁶ better medication adherence,²³ and a decreased burden of care amongst family caregivers²⁴ in other patient populations. Our study builds upon this prior work by illustrating the relationship between perceived health competence and physical activity levels among adults with CHD.

The relationship of perceived health competence with physical activity in this patient sample is non-linear, with greater increases in physical activity seen at the lower range of the construct. The increased magnitude of the association between physical activity and the PHCS-2 at the lower end of the scale indicates that low levels of perceived health competence could be a significant risk factor for physical inactivity, reflecting a patient's

lack of confidence in managing or attempting to improve his/her health. Conversely, increases in the PHCS-2 are associated with much smaller physical activity increases at the higher range of the construct. There appears to be a threshold level at which patients do not derive significant further benefit in terms of higher physical activity from increases in perceived health competence, though this relationship could also be influenced by a ceiling effect given the fact that median PHCS-2 scores were relatively high. Notably, the PHCS-2 demonstrated a stronger association with physical activity in women, though the shape of the non-linear relationship between the PHCS-2 and physical activity was similar across genders.

Taken together, these findings indicate that the PHCS-2 could potentially be used in the outpatient clinical setting to identify patients with cardiovascular disease who are at risk for a variety of unhealthy behaviors, including physical inactivity. Cardiac rehabilitation programs improve self-efficacy (a construct related to perceived health competence) for physical activity with a combination of monitored physical conditioning, prescribed exercise, and cardiovascular risk factor education.^{25,26} Almost all participants in this cohort would be eligible for cardiac rehabilitation programs (which are indicated in patients with chronic stable angina, acute myocardial infarction or coronary artery bypass grafting).²⁷ Interventions encouraging these patients to maximize cardiac rehabilitation attendance could potentially increase perceived health competence and physical activity levels. Studies in cardiac rehabilitation settings have demonstrated that although women initially have lower task and barrier efficacy, they experience greater increases in self-efficacy than men during rehabilitation programs.²⁸ Therefore, women with low perceived health competence may especially benefit from cardiac rehabilitation programs, but might require additional support to overcome barriers to initial attendance.

Our study has limitations. First, our study used self-reported physical activity, which is subject to recall and response bias.²⁹ Second, the study findings may have limited generalizability amongst diverse ethnic or racial backgrounds as the study population was drawn from an academic medical center network and participants were mostly White. However, the PHCS has been used previously amongst a wide variety of ages and ethnic backgrounds.^{5,6,13,23,24} Lastly, while we found a robust relationship between the short PHCS-2 and physical activity, the full 8-item version of the PHCS might demonstrate an even stronger association. This longer instrument might be less useful for screening populations as described above, however.

In conclusion, we identified low cumulative physical activity levels in a cohort of outpatients with coronary heart disease. Lower levels of perceived health competence as measured by the PHCS-2 were associated with less physical activity after adjusting for comorbidities and psychosocial factors, and this association was stronger in women as compared to men. The association between the PHCS-2 and physical activity was also stronger at the lower range of the instrument.

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Figure 1.
Flow diagram for recruitment in the Mid-South Coronary Heart Disease Study.

	Physical activity levels			
	MET-minutes/week	Low	Medium	High
All (N=2587)	690 (139, 1878)	47% (1228)	38% (981)	15% (378)
Men (N=1768)	816 (198, 2160)	43% (762)	40% (710)	17% (296)
Women (N=819)	438 (45, 1386)	57% (466)	33% (271)	10% (82)

Figure 2. Physical activity in study participants, defined as metabolic-equivalent (MET)-minutes per week. Low activity is defined as <600 MET-minutes/week. Moderate activity is defined as 600 and <3000 MET-minutes/week. High activity is defined as ≥3000 MET-minutes/week.

Figure 3. Multivariable-adjusted association of perceived health competence with physical activity in men and women. Perceived health competence is measured by the two-item Perceived Health Competence Scale (PHCS-2). Physical activity is defined as log-transformed metabolic equivalent (MET)-minutes per week. The non-linear association between PHCS-2 and MET-minutes/week is displayed with the solid line and the shaded, 95% confidence interval region.

Table 1

Baseline characteristics of participants in the Mid-South Coronary Heart Disease Study. *

Characteristic	All (N=2587)	Men (N=1768)	Women (N=819)	p- value ^I
Age (years)	69 (61, 76)	69 (62, 76)	69 (61, 76)	0.61
Race				<0.001
White	2250 (88%)	1575 (90%)	675 (84%)	
Non-White	297 (12%)	166 (10%)	131 (16%)	
Perceived health competence scale-2 ²	8 (6, 10)	8 (6, 10)	8 (6, 10)	<0.001
Depression ³	2 (1, 3)	2 (1, 2)	2 (1, 3)	<0.001
Living with spouse	1832 (71%)	1413 (80%)	419 (51%)	<0.001
Social support ⁴	4 (3, 5)	4 (3, 5)	4 (3, 5)	0.40
Quality of life ⁴	3 (3, 4)	4 (3, 4)	3 (3, 4)	<0.001
Pain ⁴	2 (1, 3)	2 (1, 3)	2 (2, 4)	<0.001
Sleep ⁴	4 (3, 5)	4 (3, 5)	4 (2, 5)	<0.001
Brief Health Literacy Scale ⁵	14 (11, 15)	14 (11, 15)	14 (11, 15)	0.015
Subjective Numeracy Scale ⁶	5 (4, 6)	5 (4, 6)	5 (3, 5)	<0.001
Education ⁷	4 (3, 5)	4 (3, 5)	4 (3, 4)	<0.001
Income ⁸	4 (3, 6)	5 (3, 6)	3 (2, 5)	<0.001
Left ventricular ejection fraction <50%	181 (7%)	136 (8%)	45 (6%)	0.041
Body mass index (kg/m ²)	30 (26, 34)	29 (26, 33)	30 (26, 35)	0.64
Chronic obstructive pulmonary disease	123 (5%)	63 (4%)	60 (7%)	<0.001
Current smoker	207 (8%)	135 (8%)	72 (9%)	0.31
Diabetes mellitus	979 (38%)	656 (37%)	323 (39%)	0.26
End-stage renal disease	42 (2%)	30 (2%)	12 (2%)	0.67
Peripheral vascular disease	173 (7%)	123 (7%)	50 (6%)	0.42
Systolic blood pressure (mm Hg)	126 (119, 135)	126 (119, 135)	127 (120, 137)	0.087
Stroke or transient ischemic attack	92 (4%)	67 (4%)	25 (3%)	0.35
Beta blocker	1983 (77%)	1355 (77%)	628 (77%)	0.98
Calcium channel blocker	1095 (42%)	697 (39%)	398 (49%)	<0.001

* All values displayed as medians (25 %, 75 %) or numbers (percentages).

^IThe Wilcoxon test was used for continuous variables; the Pearson test for categorical variables.

²Perceived health competence scale-2 is a score from 2–10 (10 is highest).

³Score from 1–5 (5 is the lowest level of depression).

⁴Score from 1–5 (1 is poor, 5 is excellent).

⁵Score from 1–15 (15 is highest).

⁶Score from 1–6 (6 is highest).

⁷ Education was defined as a 6-level ordinal variable: (1 = 8th grade or less; 2 = some high school; 3 = high school graduate or General Equivalency Diploma; 4 = some college; 5 = college graduate; 6 = more than college degree)

⁸ Income was defined as a 7-level ordinal variable (1 = less than \$10,000; 2 = \$10,000 to \$19,999; 3 = \$20,000 to \$34,999; 4 = \$35,000 to \$49,999; 5 = \$50,000 to \$74,999; 6 = \$75,000 to \$99,999; 7 = \$100,000 or more).

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Association of perceived health competence with physical activity, defined as metabolic equivalent-minutes per week, in the Mid-South Coronary Heart Disease Study (N=2587).

Table 2

Characteristic	% change in metabolic equivalent-minutes/week					
	Age, sex and race adjusted*			Fully adjusted*		
	% change	95% CI	p-value	% change	95% CI	p-value
Perceived Health Competence Scale-2¹						
Men						
3 -> 4	97	64, 138	<0.001	53	27, 84	<0.001
5 -> 6	89	60, 125	<0.001	49	26, 76	<0.001
9 -> 10	63	23, 117	<0.001	11	-6, 47	0.46
Women						
3 -> 4	120	82, 166	<0.001	73	43, 109	<0.001
5 -> 6	111	77, 151	<0.001	68	42, 100	<0.001
9 -> 10	82	35, 144	<0.001	25	-68	0.13
Age (Increase from 61 [25 th] to 76 [75 th])	-3.3	-28, 29	0.77	-20	-40, 6.7	0.11
Non-White	-16	-40, 18	0.33	0.7	-28, 41	0.97
Depression ²	-	-	-	14	0.4, 29	0.043
Living with spouse	-	-	-	8.9	-8, 44	0.55
Social support ³	-	-	-	-7.1	-15, 1.1	0.09
Quality of life ³	-	-	-	95	71, 122	<0.001
Pain ³	-	-	-	-9.4	-18, -0.2	0.046
Sleep ³	-	-	-	2.8	-6.4, 13	0.56
Brief Health Literacy Scale ⁴	-	-	-	-0.7	-5, 4.0	0.77
Subjective Numeracy Scale ⁵	-	-	-	17	5.5, 29.7	0.003
Education ⁶	-	-	-	7.2	-3.2, 19	0.18
Income ⁷	-	-	-	-7.6	-16, 1.3	0.09
Left ventricular ejection fraction <50%	-	-	-	-38	-59, -7.5	0.02
Body mass index (Increase from 26.2 Kg/m ² [25 th] to 33.6 Kg/m ² [75 th])	-	-	-	-8	-37, -16	<0.001

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Characteristic	% change in metabolic equivalent-minutes/week					
	Age, sex and race adjusted			Fully adjusted*		
	% change	95% CI	p-value	% change	95% CI	p-value
Chronic obstructive pulmonary disease	-	-	-	-11	-46, 47	0.65
Current smoker	-	-	-	-26	-51, 10.2	0.14
Diabetes mellitus	-	-	-	-23	-8, -3.2	0.02
End-stage renal disease	-	-	-	-7	-57, 128	0.99
Peripheral vascular disease	-	-	-	-53	-69, -28	0.001
Systolic blood pressure (Increase from 119 mm Hg [25 th %] to 135 mm Hg [75 th %])	-	-	-	10.5	-3.4, 26.4	0.15
Stroke or transient ischemic attack	-	-	-	3.1	-41, 79	0.92
Beta blocker	-	-	-	-5.1	-26, 21	0.68
Calcium channel blocker	-	-	-	-7.7	-26, 15	0.47

CI, confidence interval.

* The fully adjusted model is adjusted for all listed covariates.

¹ Perceived health competence scale-2 is a score from 2–10 (10 is highest).

² Score from 1–5 (5 is the lowest level of depression).

³ Score from 1–5 (1 is poor, 5 is excellent).

⁴ Score from 1–15 (15 is highest).

⁵ Score from 1–6 (6 is highest).

⁶ Education was defined as a 6-level ordinal variable: (1 = 8th grade or less; 2 = some high school; 3 = high school graduate or GED; 4 = some college; 5 = college graduate; 6 = more than college degree)

⁷ Income was defined as a 7-level ordinal variable (1 = less than \$10,000; 2 = \$10,000 to \$19,999; 3 = \$20,000 to \$34,999; 4 = \$35,000 to \$49,999; 5 = \$50,000 to \$74,999; 6 = \$75,000 to \$99,999; 7 = \$100,000 or more).