

Association of Socioeconomic Status and Exercise Capacity in Adults With Coronary Heart Disease (from the Heart and Soul Study)

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Lower socioeconomic status (SES) was associated with reduced treadmill exercise capacity and predicted adverse cardiovascular outcomes. Why patients with low SES had reduced exercise capacity and whether this relation existed in patients with coronary heart disease (CHD) was not known. Using data from the Heart and Soul Study, the association of 4 indicators of SES (household income, education, housing status, and occupation) with treadmill exercise capacity was analyzed in 943 men and women with stable CHD. In multivariable linear regression models adjusted for demographic variables, co-morbidities, medication use, and health behaviors (smoking, alcohol use, body mass index, physical activity, and medication adherence), exercise capacity significantly decreased in a graded fashion from the highest to lowest categories of each SES variable ($p < 0.001$ for all trends). Differences in exercise capacity between the lowest and highest SES categories were 2.4 METs for household income, 1.8 METs for education, 2.3 METs for housing, and 1.3 METs for occupation. In similarly adjusted logistic regression models comparing the lowest with the highest categories of SES, low SES was strongly associated with impaired exercise capacity (defined as < 5 METs; odds ratios for income 5.5, 95% confidence interval [CI] 1.9 to 16.0; education 4.3, 95% CI 2.0 to 9.5; housing 4.5, 95% CI 2.1 to 9.6; and occupation 2.8, 95% CI 1.4 to 5.7, $p \leq 0.001$ for all trends). In conclusion, 4 indicators of low SES were strongly associated with decreased exercise capacity in patients with CHD. Differences in traditional cardiac risk factors and health behaviors did not explain this association. © 2008 Elsevier Inc. All rights reserved. (Am J Cardiol 2008;101:462–466)

Lower socioeconomic status (SES) was linked with increased cardiovascular morbidity and mortality, but the reasons for this association were not well understood.^{1–7} We examined the association of multiple SES indicators (income, education, housing status, and occupation) with treadmill exercise capacity in 943 ambulatory outpatients with coronary heart disease (CHD) from a wide range of socioeconomic backgrounds. We sought to determine whether the relation between SES and exercise capacity was explained by demographic factors, co-morbidities, medication use, or health behaviors.

Methods

The Heart and Soul Study is prospective cohort study of psychosocial variables and health outcomes in patients with CHD. The complete methods of the study were described previously.⁸ Briefly, subjects were recruited from 2 Department of Veterans Affairs Medical Centers (San Francisco Veterans Affairs Medical Center and the Veterans Affairs Palo Alto Health Care System, California), 1 university medical center (University of California, San Francisco), and 9 public health clinics (Community Health Network of San Francisco). To be eligible, participants needed ≥ 1 of: history of myocardial infarction, angiographic evidence of stenosis $\geq 50\%$ in ≥ 1 coronary vessel, evidence of exercise-induced ischemia using treadmill electrocardiogram or stress nuclear perfusion imaging, or history of coronary revascularization. Those who were unable to walk 1 block or were planning to leave the area within 3 years were excluded. From September 2000 to December 2002, a total of 1,024 ambulatory men and women with established CHD enrolled. This cross-sectional analysis was limited to the 943 subjects who completed exercise treadmill testing. The protocol was approved by the appropriate institutional review boards, and all subjects provided written informed consent.

Subjects completed questionnaires with detailed demographic data. We assessed the 4 different SES variables of annual household income (6 categories) divided by household size (5 categories), level of education (8 categories), housing status (4 categories), and occupation (9 categories).

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The Heart and Soul Study was supported by the Department of Veterans Affairs, Washington, DC; the National Heart Lung and Blood Institute (R01 HL079235), Bethesda, Maryland; the American Federation for Aging Research (Paul Beeson Scholars Program), New York, New York; the Robert Wood Johnson Foundation (Faculty Scholars Program), Princeton, New Jersey; the Ischemia Research and Education Foundation, South San Francisco, California; and the Nancy Kirwan Heart Research Fund, San Francisco, California.

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Table 1
Characteristics of 943 subjects by exercise capacity (in METs)

Characteristics	Normal Exercise Capacity (≥ 5 METs) (n = 714)	Impaired Exercise Capacity (< 5 METs) (n = 229)	p Value
Age (yrs)	65.4 $\pm$ 10	71.0 $\pm$ 11	<0.001
Men	602 (84%)	183 (80%)	0.17
White race	424 (59%)	150 (65%)	0.25
Hypertension	483 (68%)	178 (78%)	0.004
Diabetes mellitus	160 (22%)	76 (33%)	0.001
Heart failure	100 (14%)	56 (24%)	<0.001
Myocardial infarction	380 (53%)	121 (54%)	0.90
Coronary artery bypass grafting	265 (37%)	81 (35%)	0.63
Percutaneous revascularization	307 (43%)	69 (30%)	0.001
Chronic pulmonary disease	100 (14%)	47 (21%)	0.02
Depression	114 (16%)	57 (25%)	0.002
Exercise-induced wall motion abnormality	158 (22%)	70 (31%)	0.008
Resting left ventricular ejection fraction (%)	62 $\pm$ 9	61 $\pm$ 10	0.01
Medication use			
Aspirin	572 (80%)	169 (74%)	0.05
Renin-angiotensin system inhibitor	349 (49%)	135 (59%)	0.008
β Blocker	411 (58%)	139 (61%)	0.39
Statin	488 (68%)	127 (56%)	<0.001
Systolic blood pressure (mm Hg)	131 $\pm$ 19	134 $\pm$ 19	0.04
Diastolic blood pressure (mm Hg)	75 $\pm$ 10	72 $\pm$ 11	0.002
Total cholesterol (mg/dl)	177 $\pm$ 41	177 $\pm$ 47	0.82
Low-density lipoprotein cholesterol (mg/dl)	104 $\pm$ 33	101 $\pm$ 34	0.21
High-density lipoprotein cholesterol (mg/dl)	46 $\pm$ 14	44 $\pm$ 14	0.06
Triglycerides (mg/dl)	138 $\pm$ 131	150 $\pm$ 124	0.20
Current tobacco use	132 (19%)	52 (23%)	0.17
Heavy alcohol use	218 (31%)	59 (26%)	0.15
Body mass index	28 $\pm$ 5	29 $\pm$ 6	<0.001
Physical inactivity	210 (29%)	116 (51%)	<0.001
Medication nonadherence	58 (8%)	16 (7%)	0.58

Table 2
Difference in mean exercise capacity between highest and lowest categories of socioeconomic status (SES)*

SES Variable	Age-Adjusted		Adjusted for Confounders†		Adjusted for Confounders Plus Health Behaviors		Adjusted for Confounders, Health Behaviors, and Other SES Variables	
	Mean Difference in METs (95% CI)	p Value Trend	Mean Difference in METs (95% CI)	p Value Trend	Mean Difference in METs (95% CI)	p Value Trend	Mean Difference in METs (95% CI)	p Value Trend
Income	3.4 (2.6–4.2)	<0.001	2.6 (1.8–3.4)	<0.001	2.4 (1.6–3.1)	<0.001	1.8 (1.0–2.6)	<0.001
Education	2.9 (2.1–3.6)	<0.001	2.1 (1.4–2.8)	<0.001	1.8 (1.1–2.5)	<0.001	1.1 (0.2–1.9)	0.02
Housing	3.3 (2.4–4.1)	<0.001	2.6 (1.8–3.4)	<0.001	2.3 (1.5–3.0)	<0.001	1.9 (1.1–2.7)	<0.001
Occupation	2.4 (1.6–3.1)	<0.001	1.7 (1.0–2.3)	<0.001	1.3 (0.6–1.9)	<0.001	0.3 (–0.4–1.1)	0.20

* n = 726 for analyses including occupation, n = 850 for all others.

† Adjusted for all variables listed in Table 1 except health behaviors (tobacco use, heavy alcohol use, body mass index, physical inactivity, and medication nonadherence).

CI = confidence interval.

For each SES variable, categories with comparatively few responses were combined with the nearest category. Household income was adjusted for household size by dividing the median of the income category by the median of the household size category. For occupation, those answering “other” were excluded from analyses involving occupation. A sensitivity analysis including the other occupation category produced similar results. This yielded 5 categories for adjusted annual household income (<\$10,000, \$10,000 to \$19,999, \$20,000 to \$29,999, \$30,000 to \$39,999, and

>\$40,000), 5 categories for level of education (high school not completed, high school completed, <4 years of college, 4 years of college completed, and graduate or professional school completed), 3 categories for housing status (from lowest to highest SES: hotel room, boarding house, or shelter; apartment or retirement community; and house), and 5 categories for occupation, which were grouped using Census-based methods from previous work on SES and heart disease (from lowest to highest SES: service and laborers; clerical and sales; craftsmen, foremen, manufac-

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