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Physical Activity as a Potential Mechanism Through Which Social Support May Reduce Cardiovascular Disease Risk

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Abstract

Social support has been associated with a reduced risk of cardiovascular disease (CVD). It has been suggested that the protective effect of social support is mediated through the autonomic nervous system and/or unhealthy lifestyle behaviors, but data are sparse, especially in diverse populations. The purpose of this study was to evaluate possible pathways through which social support may reduce cardiovascular disease risk. Baseline data from The National Heart, Lung, and Blood Institute Family Intervention Trial for Heart Health were included in this analysis (N = 501, mean age 48 ± 13 years, 66% female, 36% nonwhite). Social support was calculated using the Enhancing Recovery in Coronary Heart Disease Patients Social Support Instrument, a validated tool measuring emotional and instrumental support. Emotional support is defined as the belief that one is cared about (high = score ≥ 18); instrumental social support is defined as help with services (high = score ≥ 3). Demographics, physical activity, and diet were assessed by standardized questionnaires, and cardiovascular disease risk factors were measured systematically. Linear regression models were adjusted for age, race/ethnicity, sex, marital status, and education. Higher instrumental social support was positively associated with minutes of physical activity per week ($P = .007$). Higher emotional social support was positively associated with number of days of physical activity per week ($P = .023$), number of servings of wine per week ($P = .007$), and increased high-density lipoprotein cholesterol ($P = .014$). A mediational analysis was performed, and the relationship between emotional social support and high-density lipoprotein cholesterol was significantly attenuated by physical activity days per week and number of servings of wine per week. No significant associations were found for other potential mediators tested including body mass index, waist circumference, and intake of omega-3 fatty acids, beer, or liquor. In this ethnically diverse population, emotional social support was linked to higher high-density lipoprotein cholesterol levels through increased physical activity and wine intake, suggesting possible mechanisms through which social support may reduce cardiovascular disease risk.

Keywords

cardiovascular disease; depression; physical activity; social support

Psychosocial factors, including lack of social support, have been associated with increased morbidity and mortality among patients with cardiovascular disease (CVD).¹ Having at least

one strong relationship is a predictor of good health in general,² and for those who have severe CVD, intimate ties and the emotional support provided by them can significantly increase survival rates.³ Social relationships serve different functions; in this study, we focus on those that provide emotional support, defined as the existence or availability of people who let one know that they are cared about, valued, and loved,⁴ and instrumental support, or assistance with tangible items such as household chores.

Previous research has shown that social support may work to reduce CVD risk factors by directly affecting physiological processes, such as reducing cardiovascular reactivity to psychosocial stressors,⁵ and/or improving adherence to lifestyle goals such as weight management.⁶ One of the most commonly documented relationships between social support and CVD risk factors is that of social support and hypertension. A recent study suggests that increasing one's social connectedness level may reduce elevated blood pressure to a similar degree as losing weight and exercise.⁷ Similarly, in a study of adult Polish men, married men were found to have lower blood pressure than men who were never married.⁸ Stewart et al⁹ showed that hypertensive patients were able to modify their cardiovascular risk factors when provided with a socially supportive environment including a healthcare practitioner and a family member.

Although some studies have addressed gender differences in social support and its association with CVD risk, few data have examined the association between social support and CVD risk factors in diverse populations. The purposes of this study were to examine the association between emotional and instrumental social support and CVD risk factors among an ethnically diverse population of family members of patients hospitalized for coronary heart disease, to correlate social support with traditional and nontraditional CVD risk factors, and to evaluate potential mechanisms through which social support may reduce CVD risk.

Methods

Design and Subjects

This is a cross-sectional analysis of baseline data from the National Heart, Lung, and Blood Institute Family Intervention Trial for Heart Health, a randomized controlled clinical trial that enrolled family members of patients admitted to New York-Presbyterian Hospital/Columbia University Medical Center campus between 2005 and 2007 (N = 501; mean age 48 ± 13 years, 66% female, 36% nonwhite). The purpose of the Family Intervention Trial for Heart Health was to test the effectiveness of a hospital-based standardized screening and educational intervention to increase adherence to national prevention goals.

The study population consisted of adult family members, spouses, or cohabitants of diagnosed cardiac patients who were recruited at the time of hospitalization of the family member for coronary heart disease. English and Spanish-speaking men and women between the ages of 20 and 79 years were eligible. Participants must not have had any established CVD, diabetes, active liver disease, or chronic kidney disease. All participants were required to give informed consent, and the study was approved by the Institutional Review Board of Columbia University Medical Center.

Lifestyle Measures

Each participant completed a standardized questionnaire including demographic data (ie, age, sex, race/ethnicity, household income, education, and current medical status), medical history, lifestyle (ie, smoking status), medication use, and family history of CVD. Bilingual staff members were available to assist participants, and all forms were available in English and Spanish.

Physical Activity

Physical activity information was assessed at baseline using standardized questions, which have been adapted from the Behavioral Risk Factor Survey, and validated. The questions collected information about the number of days per week participants engaged in physical activity, as well as the number of minutes per day. The following questions were included: “At least once a week, do you engage in any regular physical activity (brisk walking, jogging, bicycling, etc.) long enough to work up a sweat?” “If yes, how many days per week do you engage in physical activity that works up a sweat?” “For each time you engage in physical activity, how many minutes do you exercise for?”

Dietary Assessment

Dietary intake was assessed using the Gladys Block Food Frequency Questionnaire (1998), a validated food frequency questionnaire. The Gladys Block Food Frequency Questionnaire provides data on participants’ micronutrient and macronutrient intake including saturated fat (% and grams), total fat, monounsaturated fat, omega-3 fatty acids, cholesterol, sodium, and fiber (soluble and insoluble).

Screening Visit

As part of the Family Intervention Trial for Heart Health, trained healthcare professionals performed standardized cardiometabolic risk factor screenings including blood pressure, height, weight, body mass index, waist circumference, high-density lipoprotein cholesterol (HDL-C), triglycerides, fasting glucose, and high-sensitivity C-reactive protein (CRP). Training manuals for standardized screenings were provided to all staff. After the screening, participants were randomized to a stage of change-matched special intervention including individualized counseling and education from a prevention counselor or a control group. Lifestyle approaches to risk reduction were based on national CVD prevention guidelines.¹⁰

Blood Pressure

Systolic and diastolic blood pressure was assessed by an automated blood pressure monitor in the Columbia University General Clinical Research Center using standard protocol.¹¹ Participant was sitting and was asked to relax their arm muscles and rest for 5 minutes before blood pressure was taken. Participant’s arm was supported at heart level, with palm up. Trained personnel palpated the brachial artery, positioned the cuff 1 in. above the site of brachial pulsation and center bladder of cuff above the artery. Fully deflated cuff was wrapped snugly around the upper arm. The research-grade automated blood pressure monitor was activated. Hypertension was defined as a systolic blood pressure ≥ 140 mm Hg or a diastolic blood pressure ≥ 90 mm Hg based on national guidelines.¹²

Body Composition

Height was measured by precision, wall mounted, standardized height rod that is located in each examination room of the Columbia University General Clinical Research Center. Participant is barefoot or wearing only socks, weight is distributed evenly on both feet, and the head is positioned in the horizontal plane. Measurement is made and recorded within 0.1 cm. Body weight was taken by research grade, portable, Healthometer scales and recorded to the nearest 1.00 lb. Body mass index was calculated directly by the standard formula: Weight (kg)/Height (m)². Overweight was defined as body mass index = 25.0 to 29.9 kg/m² and obesity was defined as body mass index ≥ 30 kg/m² in accordance with national guidelines.¹²

Waist circumference was measured by trained examiners while the participant stood erect with abdomen relaxed, arms to the sides, and feet together. An inelastic, standard tape measure was placed in a horizontal plane around the abdomen. The plane of the tape was parallel to the floor,

across bare skin if feasible. Measurements were recorded to the nearest 0.1 in. Increased waist circumference was defined as >35 in. in women and >40 in. in men.¹²

Laboratory Measures

Lipids, Glucose, and High-Sensitivity CRP

Plasma glucose, lipids (total cholesterol, HDL-C, low-density lipoprotein cholesterol, triglycerides), and high-sensitivity CRP were evaluated from venous blood that was drawn from all participants at baseline after a 6- to 12-hour fast. Determination lipids were performed on blood collected in tubes containing EDTA and were stored and analyzed (Roche Diagnostics) in the Columbia University General Clinical Research Center at -70°C up to 2 weeks. The Centers for Disease Control lipid quality control program certifies the General Clinical Research Center Core Laboratory. All cholesterol esters in human serum are hydrolyzed by microbial cholesterae to free cholesterol and fatty acids. In the presence of oxygen, free cholesterol is oxidized by cholesterol oxidase to cholest-4-en-one + H_2O_2 . The H_2O_2 reacts in the presence of peroxidase to 4-aminophenazone to form o-quinone imine dye. The intensity of the color is proportional to the cholesterol concentration and is determined spectrophotometrically on a Hitachi 912. The intraassay and interassay coefficients of variation are 1.1% and 3.4%, respectively. The HDL-C assay is also performed on the Hitachi 912 chemical analyzer using the HDL-C plus second generation assay for direct measurement of HDL-C in human serum and plasma. The automated method uses polyethylene glycol-modified enzymes and dextran sulfate. The intraassay and interassay coefficients of variation are 1% and 3%, respectively. Triglycerides were also determined by enzymatic methods and have an intraassay and interassay coefficients of variation of 0.9% and 3.0%, respectively. Low-density lipoprotein cholesterol was calculated using the Friedewald equation, and if triglycerides exceed 400 mg/dL, low-density lipoprotein was assessed using a direct measurement assay. The enzymatically amplified sandwich type ELISA CRP Quantitative assay was used for the measurement of high-sensitivity CRP. It is a standard solid-phase enzyme-linked immunoabsorbent assay with intraassay and interassay coefficients of variation less than 3.9% and 5.1%, respectively.

Based on national guidelines, dyslipidemia was defined as HDL-C <50 mg/dL in women or <40 mg/dL in men and triglycerides ≥ 150 mg/dL.^{10,13} Impaired nonfasting glucose was defined as glucose ≥ 100 mg/dL based on the American Diabetes Association Expert Recommendations.¹⁴ High-sensitivity CRP was defined as ≥ 3.0 mg/L according to national guidelines.¹⁵

Psychosocial Measures

Enhancing Recovery in Coronary Heart Disease Patients Social Support Inventor

Social support was measured using the Enhancing Recovery in Coronary Heart Disease Patients (ENRICHD) Social Support Inventory (ESSI), a 7-item self-report measure used in the Enhancing Recovery in Coronary Heart Disease Patients (ENRICHD) trial.¹⁶ It was originally developed to assess social support among post-myocardial infarction patients, including availability of instrumental aid and emotional support. The ENRICHD trial included a large, diverse population, and the ESSI was chosen for use in this study because of its high test-retest reliability, good convergence with standard emotional support measures, and its link to cardiac outcomes. The ESSI is also recommended for use when a short screening instrument is desired, as in the case of this study. A sample question measuring emotional support from the ESSI is, "Is there someone available to you whom you can count on to listen to you when you need to talk?" Answers are rated as the following: none of the time (1), a little of the time (2), some of the time (3), most of the time (4), and all of the time (5). The scoring criterion for low emotional social support is based on the participant's score on 5 out of 7 items (items 1,

2, 3, 5, and 6). To qualify as having low emotional social support, patients must have had a score of ≤ 2 on at least 2 of the 5 items and a total score of ≤ 18 . The fourth item on the questionnaire measures instrumental social support by asking participants if there is someone available to help them with daily chores. In this study, participants were characterized as having low instrumental social support if they scored ≤ 2 on this item.

Depression

Level of depressive symptoms was assessed by the Beck Depression Inventory–Second Edition.¹⁷ This 21-item self-report instrument for measuring the severity of depression in adults is the most widely used self-report measure of depression (for the past 2 weeks) for clinical and normal patients. Respondents are asked to endorse the most characteristic statements covering the time frame of the past 2 weeks, consistent with the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* criteria for major depression. The Beck Depression Inventory–Second Edition is scored by summing the ratings for the 21 items. Each item is rated on a 4-point scale ranging from 0 to 3, and total scores range from 0 (no depression) to 63 (severe depression). Low depression score is considered <10 and has been associated with decreased risk for cardiac morbidity and mortality.

Statistical Analysis

All data were recorded and double entered into Microsoft Access databases, and statistical analysis was performed using the SAS Version 9.1 statistical software (SAS Institute, Inc, Cary, North Carolina). Categorical data are presented as frequencies and percentages. Continuous data are presented as means and standard deviations. Emotional and instrumental social support levels were characterized as continuous data, with scores ranging from 0 to 25 for emotional social support and 0 to 5 for instrumental social support. Continuous data were correlated with each other using Pearson or Spearman correlation coefficients when data were not normally distributed. Predictors of social support were assessed using linear regression models to adjust for age, sex, race/ethnicity, and education. Statistical significance was set at $P < .05$.

Mediational analyses were performed for significant predictors to determine appreciable difference in Beta coefficient in linear regression models. Significant change in Beta was set at 15%. According to Baron and Kenney, testing mediation requires the estimation of 3 regression equations: regressing the mediator on the independent variable, regressing the dependent variable on the independent variable, and regressing the dependent variable on both the independent variable and on the mediator.¹⁸ In this study, establishing mediation of the relationship between social support and CVD risk by a certain variable required that the variable in question was related to social support; that the CVD risk factor was related to social support; that the CVD risk factor was related to the variable in question; and that when all parts were examined concurrently within this framework, adjustment for the variable in question attenuated the association between social support and the CVD risk factor.

Results

Baseline characteristics of the participants are shown in Table 1. There was a high prevalence of obesity and physical inactivity in this population. Approximately two-thirds were women and one-third were racial/ethnic minorities. Mean age was 48 ± 13 years.

Approximately 12% of this ethnically diverse population experienced low emotional social support (feeling loved and/or cared about), and 48% experienced low instrumental social support (help with chores). Approximately 31% of the population had depressive symptoms ranging from mild to severe (Table 2).

Associations between risk factors and emotional and instrumental social support are shown in Table 3. Higher instrumental social support was positively and significantly associated with minutes of physical activity per week ($P = .007$). Higher emotional social support was also positively and significantly correlated with number of days of physical activity per week ($P = .023$), number of servings of wine per week ($P = .007$), and increased HDL-C ($P = .014$). Other significant univariate correlates of social support were nonminority status ($P < .001$), higher education level ($P = .024$), a low depression score ($P < .001$), and being married ($P < .001$).

A mediational analysis between emotional social support and HDL-C revealed that the relationship between the two was significantly attenuated by number of physical activity days per week (Table 4). The Beta coefficient changed from 0.443 to 0.383, with the addition of physical activity to the mediational model greater than 15% change. We ran a similar analysis for wine intake and found that it was also a mediator, with the coefficient changing from 0.443 to 0.374 with the addition of wine intake. No significant associations were found for other potential mediators tested including smoking, body mass index, waist circumference, and intake of monounsaturated fats, omega-3 fatty acids, beer, or liquor.

Discussion

The main findings of this study are that in this ethnically diverse population, emotional social support was linked to higher HDL-C levels through increased physical activity and wine intake, suggesting that physical activity and wine intake are possible mechanisms through which social support and connectedness may affect CVD risk. These findings are consistent with previous research documenting a link between high social support level and increased physical activity.^{19,20} Physical activity and wine intake are well established as positive contributors to HDL-C.²¹ In addition, recent data suggest a strong association between low social support and the metabolic syndrome, with low HDL-C being one of the criteria for the condition.²² Our findings may be relevant for counseling patients and their partners about the benefits of social support.

In our study, depression was significantly correlated with both emotional and instrumental social support levels. However, depression was not a mediator in the model for emotional social support and HDL-C; there was no significant association between HDL-C and depression in our population, although others have observed this. Because of this, we adjusted for depression, but our results were not materially different. Depression may confound the relationship between social support and HDL-C, and some research suggests that depression and social support covary so strongly that these psychosocial variables should always be measured together, as opposed to being measured independently.²³ It is important to note that approximately 39% of participants were classified as having “possible denial of true feelings.” An extremely low score (0–4) on the depression inventory is below average in the normal category and suggests the possibility that the participant is denying some depressive symptoms by answering the questions in accordance with social desirability. Previous research has shown a link between very low scores on self-report measures of depression and a higher likelihood of denial or minimization of true feelings. As stated by Ketterer et al,²⁴ denial may be a source of measurement error and, subsequently, may weaken a test of the association between depression and an objective disease outcome. Because we did not measure disease outcomes in this study, this factor should not have affected our results.

In conclusion, we showed that specific components of social support, including emotional and instrumental components, may be beneficial in improving risk factors for CVD, such as HDL-C, and physical activity may be an important modulator of this beneficial effect. Although we found that wine intake also acted as a potential mediator for the positive relation between social

support and HDL levels, it is not recommended as a strategy to prevent CVD due to other potentially negative effects.²⁵

Our data may have implications for clinical practice, as efforts to enhance social support may be targeted to the type of support that is likely to enhance physical activity. Healthcare providers who strive to increase social support as a prevention strategy in patients at risk for CVD may also need to consider patients' physical activity levels to achieve the desired reduction in risk level. Healthcare providers can enhance positive social support by encouraging patients to set goals with family members toward accumulating more physical activity, which has consistently been linked to a reduced risk of clinical CVD events.^{26,27}

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TABLE 1

Characteristics of Participants

	Overall (N = 501)	Means ± SD
Characteristic	n (%)	—
Age (mean ± SD)	48 ± 13	—
White	322 (64%)	—
Female	332 (66%)	—
>High school education	304 (61%)	—
Employed	370 (74%)	—
Married/Living with someone	328 (65%)	—
No health insurance	70 (14%)	—
Current cigarette smoker	51 (10%)	—
Body mass index	317 (63%)	28 ± 6
≥ 25 kg/m ²		
Blood pressure	44 (9%)	127 ± 16/77 ± 11
≥ 140/90 mm Hg		
LDL cholesterol	370 (74%)	122 ± 34
≥ 100 mg/dL		
Total Cholesterol	255 (51%)	204 ± 39
≥ 200 mg/dL	255 (51%)	204 ± 39
HDL cholesterol	108 (22%)	59 ± 19
< 40 mg/dL (men) or		
< 50 mg/dL (women)		
Waist > 40 in. (men) or	189 (38%)	36 ± 6
> 35 in. (women)		
Triglycerides ≥ 150 mg/dL	106 (21%)	116 ± 67
Exercise ≤ 3 times/wk	407 (81%)	2 ± 2/27 ± 34
(< 30 min/d)		
Saturated fat ≥ 10% of diet	294 (59%)	11 ± 3

Abbreviations: HDL, high-density lipoprotein; LDL, low-density lipoprotein.

TABLE 2
Prevalence of Psychosocial Risk Factors

TABLE 3

Associations Between Cardiovascular Risk Factors and Social Support Using Linear Regression

	Emotional Social Support	Instrumental Social Support
Body mass index	−0.046	−0.016
Physical activity minutes per day	0.085	0.121 ^a
Physical activity days per week	0.103 ^a	0.069
Total cholesterol	0.073	0.059
LDL cholesterol	0.008	0.04
HDL cholesterol	0.111 ^a	0.028
Triglycerides	0.042	0.031
Systolic blood pressure	−0.044	0.018
Diastolic blood pressure	−0.033	0.058
Beck Depression Index Score	−0.491 ^a	−0.324 ^a
Number of wine/sherry/ port servings	0.124 ^a	0.124 ^a
Number of beer and ale servings	−0.01	−0.051
Number of spirits/liquor servings	0.053	0.041

Abbreviations: HDL, high-density lipoprotein; LDL, low-density lipoprotein.

^aSignificant at $P < .05$.

TABLE 4**Mediational Analysis of Emotional Social Support, HDL Cholesterol, and Physical Activity**

Emotional social support score			
HDL cholesterol	Beta = .44344312	<i>P</i> = .014	
Emotional social support score			
Number of Physical Activity Days Per Week	Beta = .0423707019	<i>P</i> = .023	
Number of physical activity days per week			
HDL cholesterol	Beta = 1.49883726	<i>P</i> = .001	
Emotional social support score		Number of physical activity days per week	
HDL cholesterol	Beta = 0.38311164 ^a	Alpha = 1.42389610	<i>P</i> = .001

Abbreviation: HDL, high-density lipoprotein.

^aChange in Beta is greater than 15%.