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The association of pre-diagnosis social support with survival after heart failure in the Cardiovascular Health Study

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Abstract

Background: Although social support has been shown to be associated with survival among persons with cardiovascular disease, little research has focused on whether social support, measured prior to the onset of heart failure, can enhance survival after diagnosis.

Objective: To assess the association between pre-diagnosis social support and post-diagnosis survival among older adults with heart failure.

Design: We obtained the data from the Cardiovascular Health Study. We used two measures of social support, the Lubben Social Network Scale and the Interpersonal Support Evaluation List.

Participants: Non-institutionalized adults aged 65 or older from four sites in the U.S. with primary enrollment in 1989–1990.

Main Measures: The analytic dataset included 529 participants with a social support measure within two years prior to diagnosis of heart failure.

Key Results: After adjustment for demographic covariates, cardiovascular risk factors, and general health status, mortality rates were lower among participants in the highest tertile of social

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CONFLICT OF INTEREST

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network scores (HR 0.74, 95% CI: 0.59, 0.93) and the middle tertile (HR 0.73 [0.58, 0.90]), compared to the lowest tertile. Results with interpersonal support were null.

Conclusions: These findings suggest that pre-diagnosis structural social support may modestly buffer heart failure patients from mortality.

Keywords

Mortality; Social network; Interpersonal support

INTRODUCTION

There is a wealth of literature demonstrating the association between better social support and survival. A 2010 meta-analysis of 308,849 participants found a 50% increased likelihood of survival for participants with stronger social relationships. [1] Social support has been proposed to act through multiple pathways to enhance health and improve survival, both directly and indirectly. In addition to actions that could be described as direct caregiving support, social support may also work though unintended support, such as modeling healthy behaviors, and indirect pathways, such as providing emotional resources that buffer the response to a stressor. [2,3]

The study of social support and outcomes in the setting of specific conditions may provide additional scientific knowledge and inform targets for intervention. A body of literature supports the importance of social support and other psychosocial factors for survival among persons with cardiovascular disease [4–9]. The prognostic importance of social support in heart failure (HF) patients has received less attention. Moreover, most research to date has used readily-accessible proxy measures of social network (e.g. marital status) [10,11], or assessed social support after HF diagnosis. [12–15] Measures of social support after the onset of HF may be confounded by the severity of disease, and may not reflect general levels of social support experienced during the pre-clinical phase of disease.

The goal of this study was to evaluate the association between social support assessed prior to the onset of HF and survival after HF diagnosis. We used two established measures of social support, the Lubben Social Network Scale (LSNS) and the Interpersonal Support Evaluation List (ISEL), in a well-characterized biracial cohort of adults 65 and older. These measures capture social network (LSNS) as a measure of structural social support and functional social support (ISEL). We hypothesized that participants with high social support prior to the onset of HF would live longer with HF compared to those with low social support.

METHODS

Study population

The Cardiovascular Health Study (CHS) is a prospective observational cohort study of 5,888 adults over age 65 designed to study risk factors for cardiovascular disease. Study participants were recruited from Medicare eligibility lists in Forsyth County, North Carolina; Sacramento County, California; Washington County, Maryland; and Pittsburgh,

Pennsylvania. Primary enrollment occurred in 1989–1990, with a supplemental cohort of 687 black participants enrolled in 1992–1993. Eligible participants were: 1) aged 65 years or older; 2) not institutionalized; 3) expected to remain in the current community for 3 years or longer; 4) not under active treatment for cancer; and 5) able to provide informed consent without a proxy. Study visits were completed annually through 1998–1999, with follow-up by phone every six months between study visits and since 1999. Additional information was collected from medical records and interviews with proxies when necessary. The study was approved by institutional review boards at each site and informed consent was obtained from all participants [16].

Exposure: social support

CHS participants were asked about two aspects of social support: social networks as an assessment of structural social support and interpersonal support as a measure of functional social support.(Appendix Figure 1) The primary measure of social support for this analysis was social network strength, measured by the Lubben Social Network Scale (LSNS), which has been used in previous studies. [17–21] The LSNS was adapted from the Berkman-Syme Social Network Index to be used among older populations [22]. The LSNS includes 10 questions, each scored 0–5, for a total score ranging from 0 to 50. The Lubbens scale has a Cronbach's alpha of 0.7 [22].

CHS participants also completed the 6-item version of the Interpersonal Support Evaluation List (ISEL) [18,23]. The full-length ISEL was designed to measure four functions of perceived support and has been validated.[24] The 6-item ISEL includes two questions assessing perceived availability of three different types of support: belonging (or emotional), appraisal (or informational), and tangible (or instrumental) and has been used in previous studies of older adults.[25–27] Scores for all questions were summed to create an overall score for interpersonal support. Each question is rated on a 4-point scale for a total score from 6 to 24, with a lower score reflecting better interpersonal support; for this analysis, ISEL scores were multiplied by −1 so that a higher (less negative) score would reflect better support. The Cronbach's alpha for the ISEL has been reported as ranging from 0.452 to 0.752.[28]

We chose to use social network scores as our primary measure of social support due to the more specific nature of the questions and to previous findings in CHS that social network scores were more stable over time than ISEL scores [18]. Additionally, the LSNS scores had better statistical properties (wider range, more normal distribution) than ISEL scores. In CHS, the LSNS and ISEL were both assessed annually at baseline and follow-up years 2–5 and 10. For this analysis, the most recent measurement taken before the incidence of HF (but not more than two years prior to HF onset) was used as the exposure of interest.

Outcome: survival after HF

The outcome of interest was survival after onset of heart failure. We identified CHS participants who developed incident heart failure before 2000 (two years after the last assessment of social support in 1998) and assessed survival through June 2015. Heart failure incidence was one of the cardiovascular events that was adjudicated for all participants by a

CHS outcome-assessment committee.[29] The incidence of heart failure was defined as the earliest date at which a participant had a diagnosis of HF from a physician and was under medical treatment for HF (a current prescription for both a diuretic and a digitalis or vasodilator). Potential events were identified from self-report, review of hospital discharge summaries and Medicare data.

Deaths were identified by a review of obituaries, medical records, death certificates, the Centers for Medicare and Medicaid Services health care utilization database for hospitalizations, and household contacts. Complete follow-up for ascertainment of mortality status was achieved through June 2015.

Other measures

Covariate values were taken from the same study visit as the social support data (the most recent visit within two years before the onset of HF). Age at HF diagnosis was calculated by summing age at baseline with time from baseline to HF incidence, and was modeled linearly. Sex and race were determined by self-report at study baseline; race was categorized as white or black (<1% of participants identified as other racial categories were classified as white). Medications (antihypertensive, oral hypoglycemic, and lipid-lowering) were determined by inspection of prescription bottles and categorized as user/non-user for each.[30] CHD status (defined as MI, angina, coronary bypass or angioplasty) was determined by comparing the date of the visit with incidence dates of CHD as established by committee. Systolic and diastolic blood pressure were measured every year except 1995. Cystatin-C was measured by assays of serum specimens taken from fasting participants, at baseline and follow-up years 4 and 8 [31]. General health status (dichotomized to excellent/very good vs. good, fair, or poor health) was assessed every year except 1991. Self-reported limitations in activities of daily living (ADLs) were available every year (dichotomized to none vs. any). The 10-item version of the Center for Epidemiologic Studies Depression Scale Depression score was measured every year and was included as a continuous variable [32,33]. Body mass index (kg/m^2) was assessed at baseline and follow-up years 4 and 8 and included as a continuous variable. Physical activity was determined with the modified Minnesota Leisure Time Activities questionnaire at baseline and follow-up years 4 and 8. Participants were asked about the frequency and duration of 15 different types of activities over the past two weeks. Activities were assigned metabolic equivalents according to intensity and total kilocalories expended per week were estimated for each person and were included in the model as a continuous variable. Marital status was asked at each visit, with response options of married, widowed, divorced, separated, and never married; these were dichotomized to married vs. not married for analysis.

Statistical methods

The analytic sample was restricted to CHS participants who developed HF before June 2000, two years after the last assessment of social support in 1998 (N=1,253). (Appendix Figure 2) We then excluded participants who did not have an LSNS measurement within two years prior to HF onset (N=594); the majority of these (361, 61%) developed HF more than 2 years after the fifth follow-up visit but before the 10^{th} follow-up visit, a period when LSNS was not measured. Characteristics of those with and without an eligible LSNS measurement

are shown in Appendix Table 1. Finally, we excluded participants with missing data for one or more adjustment covariates, after carrying the last value forward for up to three visits (N=130). The final analytic dataset included 529 participants.

Descriptive statistics were used to summarize the analytic population by tertiles of LSNS score. We visualized unadjusted patterns of survival after HF diagnosis by tertile of LSNS using a Kaplan-Meier curve. We ran Cox proportional hazards models to model the hazard of mortality among CHS participants with HF, adjusted for various demographic and clinical characteristics. We confirmed that the proportional hazards assumption was met visually and using Schoenfeld residuals. Model 1 adjusted for age at HF diagnosis, sex, marital status (ISEL only) and race. We did not adjust for marital status for the LSNS analyses since nearly all (99%) of married participants co-habituated with others, although we did explore adjustment in a sensitivity analysis. Model 2 adjusted for additional measures of health status. Health status covariates were selected a priori as factors that were associated with social support and mortality, and included antihypertensive medication, lipid medication, oral hypoglycemic medication, BMI, ADLs, general health status, SBP, DBP, cystatin-C, and marital status; covariates with $p>0.2$ were removed from the final model (antihypertensive medication, ADLs, and depression score). Model 3 adjusted for potential mediators, depression and physical activity. We conducted a parallel set of models for using tertiles of interpersonal support as the primary exposure of interest. We also assessed effect measure modification by race, sex, and marital status using interaction terms with both measures of social support. We calculated adjusted median survival time by evaluating the survival function for each tertile of social network score and mean values of all other covariates, and identifying the time when the adjusted survival function was equal or less than 0.5.

All analyses were conducted using Stata 13.1 (College Station, TX).

RESULTS

Social support was only measured at selected years in CHS follow-up, thus there is missingness in the social network measures by study visit. (Appendix Table 1). Participant with social network data were slightly younger, and less likely to be female, black, or single compared to those without social network data. They were also more likely to report better health status and longer time from heart failure to death. Participants with high social network scores were younger and more likely to be married than participants with lower social network scores. (Table 1) Participants with high social network scores also had higher BMIs, lower depressive symptoms, and better interpersonal support scores. Social network scores were moderately correlated with interpersonal support scores (r=0.42). The reliability coefficients (Chronbach's alpha) were 0.59 for social network and 0.72 for social support. Survival with heart failure (days from HF incidence to death) was also patterned by social network strength, such that CHS participants in the lowest tertile of LSNS scores had the highest mortality while those in the highest tertile had the lowest mortality (Figure 1).

With Model 1, the patterning in survival by tertile of LSNS score was robust to adjustment for age at HF diagnosis, sex, and race and appeared to demonstrate a threshold effect. Participants in the highest tertile of LSNS had an 29% lower rate of mortality compared to

those in the lowest tertile of LSNS score (HR 0.71, 95% CI: 0.57, 0.89) (Table 2). Participants in the middle tertile had a 25% lower rate of mortality (HR 0.75 [0.60, 0.92]). After additional adjustment for cardiovascular risk factors and general health status, the association with mortality was attenuated slightly. The adjusted median survival time was 4.4 years for those in the lowest tertile, and 5.5 years for those in the middle and highest tertiles of LSNS score. Additional adjustment for potential mediators, physical activity and depression, had a modest effect on the estimates. As a sensitivity analysis, we adjusted for marital status, and the effect sizes were modestly attenuated: HR 0.78 (95% CI: 0.61, 0.97) and 0.85 (95% CI: 0.66, 1.08) for middle and high, respectively

There was no association of interpersonal support and mortality. In Model 1, mortality rates among participants in the highest and middle tertile of interpersonal support scores were non-significantly lower than those in the lowest tertile of interpersonal support (highest, HR 0.85 [0.69, 1.04]; middle, HR 0.96 [0.77, 1.19]). After additional adjustment, these results remained not significant and were attenuated towards the null.

There was no evidence of effect measure modification by sex, race, or by marital status (all p-values for interaction >0.05).

DISCUSSION

We found that social support, assessed by social network strength measured prior to HF incidence was modestly associated with survival with HF. After adjustment for general health status and cardiovascular risk factors, CHS participants with social network scores in the lowest tertile had a median survival roughly one year shorter than those with higher social network scores. After adjustment for various health measures, social network strength (LSNS) retained significance in moderate levels compared to low levels of social network strength though associations with interpersonal support (ISEL) were null. These findings suggest that pre-diagnosis structural social support may modestly buffer HF patients from post-diagnosis adverse outcomes.

These results are consistent with previous research demonstrating that low social support is a risk factor for mortality among patients with cardiovascular disease [4,34]. There is a growing body of evidence that demonstrates the importance of social support in HF patients, but nearly all studies have either used readily-available proxy assessment of social support or assessed social support after HF diagnosis. Being married, a measure of structural social support, is associated with greater survival [10,35], and better martial quality among those who are married is also associated with better survival. [11,36] One study found that lack of functional support prior to hospitalization (but not necessarily prior to HF incidence) was associated with increased 1-year risk of fatal and non-fatal cardiovascular outcomes, particularly among women [37] Several studies have implemented established tools to assess social support in diagnosed heart failure patients. For example Chung et al. assessed social support using the Multidimensional Perceived Social Support Scale found poor social support was associated with worse event-free survival, and this effect was increased among those reporting depressive symptoms. Another study by Murberg and Bru found that social isolation was associated with mortality in 119 clinically stable patients with heart failure.

[34] Social isolation, which represents a lack of social network, has been established as a risk factor for incident cardiovascular disease and mortality. [38] Although these studies contribute importantly to establishing a relationship between social support and heart failure outcomes, our study builds upon this prior work by 1) using established assessments of structural and functional social support and 2) ensuring that the diagnosis of heart failure did not impact perceived social support by assessing social support prior to heart failure onset.

There are many tangible mechanisms through which social support could affect survival, including improved self-care behaviors such as diet, exercise, medication adherence, and transportation to medical appointments.[39] Beyond health behaviors, social support can also affect outcomes through pathways that are more difficulty to assess including reduced stress, enhanced mood, and improved resilience [40–42]. The fact that structural social support was more strongly associated with mortality than functional social support suggests that the mechanism mediating this relationship are likely to be tangible mechanisms. However, structural and functional support are correlated, and include some overlapping items, so investigating these mechanisms is complicated by the likely comingling of pathways and potential for different aspects of social support to operate through different pathways [42]. Additionally, the difference in associations between the two measures could also be due to properties of the scale, such as the reliability of the measures. Marital status is often used as a simple measure of structural social support, particularly in clinical settings, and adjustment for marital status had a modest affect on our results, suggesting some overlap. Disentangling the mediating mechanisms between social support and health outcomes is an important objective for designing effective interventions to reduce morbidity.

Some limitations affect the interpretation of this work. Although CHS had 1,253 eligible participants with HF, nearly half of them did not have a social support within two years of their incident event. This is because the social support measures were only assessed at selected follow-up visits. There were also differences in available data by age, sex, race, and health status; these factors are also associated with follow-up time. This missingness is by design and unlikely to bias our estimates, however it may have reduced our ability to detect statistically significant associations. Additionally, the top tertile of ISEL scores consisted entirely of participants who reported the maximum level of support, which demonstrates ceiling effects of this tool. Finally, it is possible that unmeasured or residual confounding affects these results, or that social support changed after HF diagnosis in a differential manner. There are a wide range of contributing factors to mortality after heart failure, many of which (e.g. access and utilization of health care, environmental support for healthy diet and exercise) are likely associated with a patient’s social environment. However, adjustment for relevant health covariates as the most proximate risk factors for mortality did not substantively change the pattern of results.

In this analysis of a well-characterized cohort of older adults followed for up to 25 years, including assessment of social support at multiple time points throughout study follow-up, we found that pre-disease structural social support was associated with survival after onset of HF. These findings support the importance of structural social support throughout the lifecourse, not only after emergence of medical conditions. Future research should clarify

the mechanisms by which structural social support gets ‘under the skin’ and expand to more diverse populations.

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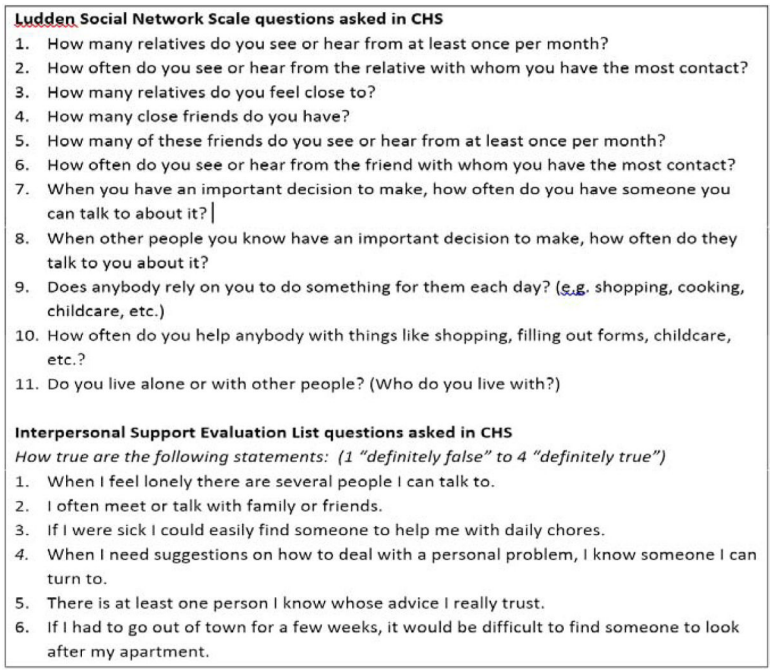
Appendix

Appendix Table 1.

Characteristics of participants with and without social network data within two years prior to onset of heart failure.

	No social network data		Have social network data		
	N	Mean or %	N	Mean or %	p-value
Study visit prior to HF	552		659		
2		0.4%		10.6%	
3		0.2%		11.7%	
4		0.5%		13.4%	
5		1.5%		13.7%	
6		3.1%		14.0%	
7		3.6%		11.7%	
8		21.4%		0.3%	
9		19.8%		0.0%	
10		21.7%		0.0%	
11		7.3%		24.7%	
12 or later		20.7%		0.0%	<0.001
Age at HF incidence	552	81.9	659	79.2	<0.001
Female	552	54.5%	659	48.0%	0.02
Black	552	23.0%	659	11.5%	<0.001
Married	552	47.1%	659	57.4%	<0.001
SBP	496	140.2	654	141.0	0.57
DBP	495	68.3	654	69.9	0.03
% on oral hypoglycemic medication	547	12.6%	659	13.8%	0.54
% on lipid lowering medication	547	9.3%	659	6.4%	0.06
Cystatin-C	402	1.3	557	1.2	0.15
Physical activity (total kcals, median)	481	600	649	600	0.15

	No social network data		Have social network data		
	N	Mean or %	N	Mean or %	p-value
BMI	406	27.5	622	27.1	0.19
Depressive symptoms (mean)	1215	6.2	659	6.2	0.90
Very good or excellent general health status	551	15.3%	657	22.1%	<0.01
Days from HF to death (mean)	552	1503	659	1968	<0.001



Ludden Social Network Scale questions asked in CHS

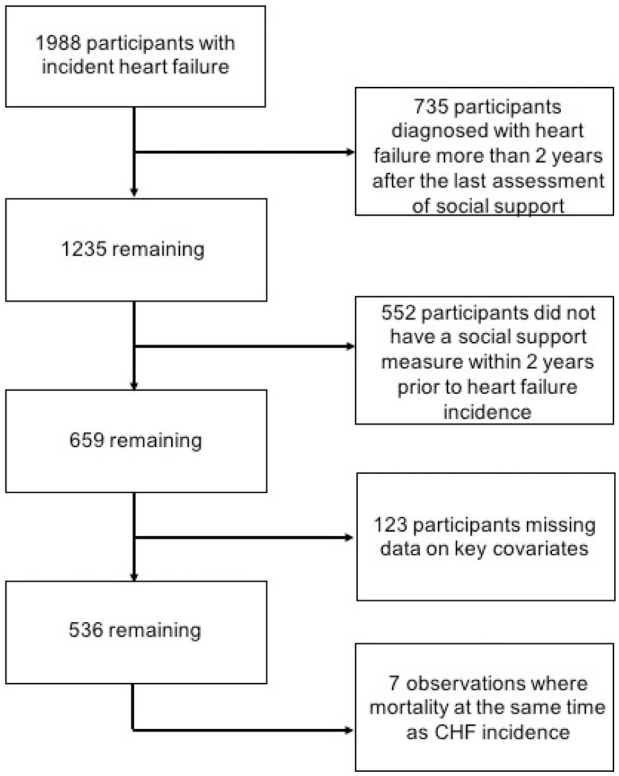
1. How many relatives do you see or hear from at least once per month?
2. How often do you see or hear from the relative with whom you have the most contact?
3. How many relatives do you feel close to?
4. How many close friends do you have?
5. How many of these friends do you see or hear from at least once per month?
6. How often do you see or hear from the friend with whom you have the most contact?
7. When you have an important decision to make, how often do you have someone you can talk to about it?
8. When other people you know have an important decision to make, how often do they talk to you about it?
9. Does anybody rely on you to do something for them each day? (e.g. shopping, cooking, childcare, etc.)
10. How often do you help anybody with things like shopping, filling out forms, childcare, etc.?
11. Do you live alone or with other people? (Who do you live with?)

Interpersonal Support Evaluation List questions asked in CHS

How true are the following statements: (1 "definitely false" to 4 "definitely true")

1. When I feel lonely there are several people I can talk to.
2. I often meet or talk with family or friends.
3. If I were sick I could easily find someone to help me with daily chores.
4. When I need suggestions on how to deal with a personal problem, I know someone I can turn to.
5. There is at least one person I know whose advice I really trust.
6. If I had to go out of town for a few weeks, it would be difficult to find someone to look after my apartment.

Appendix Figure 1:
Social support questions used in CHS



Appendix Figure 2:
Flow diagram of study inclusion

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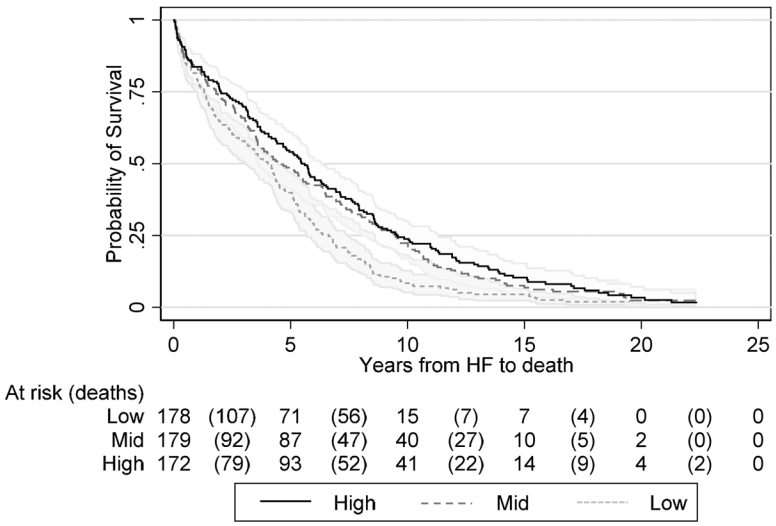

Figure 1.

Kaplan-Meier survival curves for time to death after heart failure incidence, by tertile of social network score measured prior to heart failure incidence in the Cardiovascular Health Study.

Table 1.

Characteristics of participants prior to incident heart failure (HF) in the Cardiovascular Heart Study.

	Low SN (N=182)	Mid SN (N=181)	High SN (N=173)	p-value
Age at HF diagnosis (mean)	80.0	78.6	77.8	<0.01
Female	51.1%	42.5%	49.7%	0.22
Black	13.7%	10.5%	6.9%	0.11
Married	35.7%	68.5%	78.6%	<0.001
Systolic blood pressure (mmHg, mean)	137.6	141.6	141.3	0.19
Diastolic blood pressure (mmHg, mean)	68.9	69.9	70.2	0.56
% on oral hypoglycemic medication	14.3%	13.8%	12.7%	0.91
% on lipid lowering medication	7.1%	5.5%	7.5%	0.73
Cystatin-C (mean)	1.25	1.26	1.22	0.64
Total kcals of physical activity (mean)	1108	1114	1471	0.06
Body mass index (kg/m^2, mean)	26.4	27.0	27.9	0.01
Depressive symptoms (mean)	7.6	5.6	4.7	<0.001
Very good or excellent general health status	18.7%	23.8%	28.3%	0.10
Social network score prior to HF (mean)	23.1	32.4	39.4	<0.001
Interpersonal support score prior to HF (mean)	−10.0	−8.1	−7.5	<0.001
Days from social network measurement to HF incidence (mean)	304	280	281	0.37
Days from HF to death (mean)	1628	2173	2381	<0.01
Days from HF to death (median)	1398.5	1618	1997	0.03

Table 2.

Adjusted hazard ratios for social network and interpersonal support scores on survival after heart failure diagnosis in the Cardiovascular Health Study.

	Low	Mid		High	
	HR	**HR**	**95% CI**	**HR**	**95% CI**
LUBBEN SOCIAL NETWORK SCALE	N=182	N=181		N=173	
Model 1: adjusted for age at HF diagnosis, sex, and race	1 (ref)	0.75	0.60, 0.92**	0.71	0.57, 0.89**
Model 2: Model 1 + health covariates†	1 (ref)	0.73	0.58, 0.90**	0.74	0.59*, 0.93
Model 3: Model 2 + physical activity, depression	1 (ref)	0.74	0.59, 0.92**	0.79	0.63*, 1.00
INTERPERSONAL SUPPORT EVALUATION LIST	N=227	N=146		N=163	
Model 1: adjusted for age at HF diagnosis, sex, marital status, and race	1 (ref)	0.96	0.77, 1.19	0.85	0.69, 1.04
Model 2: Model 1 + health covariates†	1 (ref)	0.97	0.78, 1.20	0.90	0.73, 1.11
Model 3: Model 2 + physical activity, depression	1 (ref)	1.03	0.83, 1.28	0.93	0.75, 1.15

Note. HF, heart failure. For all models, N=529.

† Health covariates include lipid medication, oral hypoglycemic medication, SBP, DBP, general health status, BMI, cystatin C.

* $p<0.05$

** $p<0.01$