Published in final edited form as:
Am J Med. 2011 February ; 124(2): 164–170. doi:10.1016/j.amjmed.2010.09.011.

Association between Social Isolation and Left Ventricular Mass

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Abstract

Background—Social isolation is associated with progression of cardiovascular disease with the most socially isolated patients being at increased risk. Increased left ventricular mass is a predictor of cardiovascular morbidity and mortality. It is not yet clear whether social isolation is a determinant of increased left ventricular mass.

Methods—We performed a cross-sectional study of Northern Manhattan Study participants who were free of clinical cardiovascular disease, had obtained transthoracic echocardiograms (n=2021) and a baseline questionnaire on social habits. Social isolation was defined as the lack of friendship networks (knowing fewer than 3 people well enough to visit within their homes). Echocardiographic left ventricular mass was indexed to height$^{2.7}$, analyzed as a continuous variable and compared between exposure groups.

Results—The prevalence of social isolation was 13.5%. The average left ventricular mass was significantly higher (50.2 gm/m$^{2.7}$) in those who were, as compared to those who were not (47.6 gm/m$^{2.7}$), socially isolated ($p<0.05$). Higher prevalence of social isolation was found among those less educated, uninsured or unemployed.There were no significant race-ethnic differences in the prevalence of social isolation. In multivariate analysis, there was a trend toward an association between social isolation and increased left ventricular mass in the total cohort ($p=0.09$). Among Hispanics, social isolation was significantly associated with greater left ventricular mass.

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The authors had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. All of the authors meet criteria for authorship, including acceptance of responsibility for the scientific content of the manuscript.

Disclosures: The authors report no conflicts of interest.

Hispanics who were socially isolated averaged 3.9 gm/ht$^{2.7}$ higher left ventricular mass compared to those not socially isolated (p=0.002). This relationship was not present among non-Hispanic blacks or whites.

Conclusion—In this urban tri-ethnic cohort, social isolation was prevalent and associated with indices of low socioeconomic status. Hispanics who were socially isolated had a greater risk for increased left ventricular mass.

Keywords

social isolation; left ventricular mass; Hispanics; psychosocial factors

Epidemiological data have shown that echocardiographic left ventricular hypertrophy as defined by increased left ventricular mass, is an independent predictor of morbidity and mortality from cardiovascular disease.[1, 2] Blacks and Hispanics are known to have a higher average left ventricular mass than whites,[3, 4]. These associations are independent of arterial hypertension, diabetes mellitus, and other traditional cardiovascular risk factors. Underlying psychosocial factors, either emotional factors such as hostility and anger, or chronic stressors such as low social support, may contribute to the differential burden of increased left ventricular mass seen in various race-ethnic groups.[5]

Within the past few years, there has been renewed interest in social isolation and its relationship to cardiovascular health and well-being.[6] The hypothesis that health can be affected by supportive interactions with individuals within one's social network has now been strengthened by evidence on the relationship between measures of social support and morbidity as well as all-cause mortality.[7–10] Studies of social environment and cardiovascular disease risk suggest that the most socially isolated patients are at increased risk of cardiovascular disease.[11] Race likely has a broad impact on social networks in American society. Non-Hispanic blacks have smaller networks of confidants and markedly smaller friendship networks than non-Hispanic whites,[12, 13] with much less known about Hispanics in this regard.

Although not completely understood, the mediating mechanisms are hypothesized to involve both health behaviors and neuroendocrine pathways. Examples of influences on health behaviors include a positive association between social support and exercise, and significant inverse associations with smoking.[9, 10] Sympathetic stimulation has been shown to vary with exposure to stressful environments in the workplace and at home.[14, 15] Studies indicate that low social support may be related to blood pressure reactivity.[16 7] It is possible that more socially isolated individuals have blood pressure responses to stress that are larger and more prolonged, in the absence of the buffering effects of social support during a stressor [17], thereby experiencing more frequent sympathetic activation. Chronic or even intermittent adrenergic stimulation, even in the absence of overt hypertension, can cause increased left ventricular mass.[18–20]

The relationship between social isolation and increased left ventricular mass, however, has not been elucidated in multiethnic cohorts inclusive of Hispanics. We performed a cross-sectional study hypothesizing that social isolation will be associated with increased left ventricular mass and that this relationship would vary by race-ethnicity.

Methods

Study population

The Northern Manhattan Study (NOMAS) is a population-based prospective cohort study of stroke-free individuals designed to investigate cardiovascular and stroke risk factors and

prognosis in a multi-ethnic urban population of the northern Manhattan (New York) area. The methods of subject recruitment and enrollment into NOMAS have been described previously.[4, 21, 22] Briefly, community subjects from northern Manhattan were eligible if they (1) had never been diagnosed with a stroke, (2) were ≥ 40 years of age, and (3) resided in northern Manhattan for at least 3 months in a household with a telephone. Stroke-free subjects were identified by random digit dialing. Of those called, 90% participated in a telephone interview used for screening and recruiting participants, and 75% of those who were eligible and invited to participate came to Columbia University Medical Center (CUMC) for an in-person evaluation during which all demographic and social resource information was obtained. The study was approved by the Institutional Review Boards at CUMC and the University of Miami, and all participants gave written informed consent. Participants who were free of clinical cardiovascular disease (defined as having a history of bypass surgery, angioplasty, or myocardial infarction) and received technically adequate transthoracic echocardiograms (n=2021) completed a baseline questionnaire on social resource information.

Information about risk factors was collected through standardized in-person interviews by trained research assistants, and physical examinations were performed by study physicians. Blood pressure (BP) was measured with mercury sphygmomanometers and cuffs of appropriate site. Hypertension was defined as a BP recording ≥140/90 mmHg (based on an average of two BP measurements during one sitting by a trained research assistant), the participant's self-report of a history of hypertension, or antihypertensive medication use. Diabetes mellitus was defined by the participant's self-report of such a history, use of insulin or hypoglycemic agent, or fasting glucose ≥ 126mg/dL. Height and weight were determined by the use of calibrated scales. Assessments were conducted in English or Spanish, depending on the primary language of the participant. Race-ethnicity was based on self-identification through a series of questions modeled after the 2000 US census, and conformed to the standard definitions outlined by Directive 15. Current smoking was defined by smoking within the past year. The measures of physical activity have been previously described.[23] In brief, questionnaires administered were used to record the frequency and duration of different recreational activities during the 2-week period before the interview. For our analysis, we evaluated either the presence/absence of physical activity and the presence/absence of current smoking.

Social Isolation

Social isolation, our primary exposure of interest, was defined and assessed as previously described in NOMAS.[24] Briefly, we assessed social isolation according to response to the question "How many people do you know well enough to visit with in their homes." Ordinal response categories were 1=none, 2=one or two, 3=three or four, or 4=five or more. Social isolation was defined as lack of friendship networks dichotomized as knowing fewer than three people well enough to visit with in their homes. Thus, we focused on the presence and structure (number of friends) related to these friendship networks rather than the perceived effects or quality of such networks. NOMAS social isolation questions regarding the presence and size of friendship networks were adapted from the Berkman Social Network Index[25] and have been associated with vascular risk factors and outcomes.[22, 26]

Other social/economic resources included marital status, years of education, and health insurance type. Education was further dichotomized into those who had completed high school versus those who had not. Mutually exclusive insurance categories were defined as no insurance, private insurance, Medicare only, and Medicaid/Medicare.

Echocardiographic left ventricular mass

Transthoracic 2-dimensional echocardiography was performed according to the recommendations of the American Society of Echocardiography (ASE).[27] left ventricular mass was calculated according to the simplified ASE formula[28]:

$$\textbf{ASE left ventricular mass} = 1.04\,(\text{LV internal diameter} + \text{LV septal thickness} + \text{LV posterior wall thickness})^3 - (\text{LV internal diameter})^3$$

Since the **ASE left ventricular mass** overestimates autopsy left ventricular mass by 20%, the modified ASE formula proposed by Devereux, et al.[29] was applied: **left ventricular mass** = 0.8 (**ASE left ventricular mass**) + 0.6.

Left ventricular mass was then indexed to body size by dividing raw left ventricular mass by height to the allometric power of 2.7 and analyzed as a continuous variable.

Statistical analyses

Distributions of risk factors were compared for the entire cohort and across each race-ethnic group using Chi-square for categorical variables and ANOVA for continuous variables. Categorical variables are expressed as frequencies and percentages. The relationship between left ventricular mass and baseline characteristics and social isolation was assessed using linear regression models. Regression models are reported unadjusted and adjusted for classical risk factors for increased left ventricular mass including age, sex, body mass index (BMI), diabetes, physical activity, hypertension, and education level. One-way analysis of variance was used to test differences among group left ventricular mass means. To address any potential issue with outliers, we used a robust analysis approach employing median regression. To investigate the potential effect of race-ethnicity on the relationship between social isolation and left ventricular mass, interaction terms were included for Hispanics, blacks, and whites and for Hispanic vs. non-Hispanics.

Results

Table 1 describes the demographic characteristics and social resources of our cohort. Participants were primarily elderly, hypertensive, overweight, mostly uninsured, and with little education. There was a 13.5% prevalence of social isolation. Those socially isolated were significantly older, less educated, tended to be less insured or on Medicaid, and more likely to be unemployed or retired. There was a non-significant trend that those married tended to be less socially isolated. Details regarding the number of friends reported by participants is shown in Figure 1 for the total cohort and according to race-ethnic status. There were no significant race-ethnic differences in the prevalence of social isolation.

In unadjusted analyses, mean left ventricular mass was higher among those socially isolated (50.2 ± 18.7 gm/m$^{2.7}$ among those with social isolation vs. 47.6 ± 15.5 gm/m$^{2.7}$ among those not isolated; unadjusted p=0.03). Table 2 shows social isolation was a univariate predictor of left ventricular mass on graded continuous analysis. Being married showed an inverse relation with left ventricular mass on univariate analysis. There was, however, no significant association between the number of friends and marital status (p=0.16).

Figure 2 shows that, for the total cohort, those most socially isolated had on average 4.1 gm/m$^{2.7}$ higher left ventricular mass than those with the least degree of isolation. In fully adjusted models (Table 3), social isolation showed a non-significant trend for predicting increased left ventricular mass in the total cohort. A social isolation*race interaction was

seen (p=0.004) when strata compared Hispanics versus non-Hispanics. Table 3 shows that among Hispanics, left ventricular mass averaged 3.9 gm/$m^{2.7}$ higher among the more socially isolated Hispanics versus those not socially isolated (p=0.002). This relationship was not present among non-Hispanic whites, and there was a non-significant trend towards an inverse relationship among non-Hispanic blacks. Among the total cohort, Hispanics, non-Hispanic blacks and non-Hispanic whites, 17%, 15%, 21% and 15% of the variance in left ventricular mass respectively, was explained by our multivariate model. When mean left ventricular mass was analyzed as a function of the number of friends in a person's social network (Figure 2), a graded significant inverse relationship was seen among Hispanics; among non-Hispanic whites, the relationship was most significant among the two extremes (those most socially isolated versus those with the least degree of social isolation); among non-Hispanic blacks a non-significant direct relationship was seen. The β coefficient for social isolation in univariate median regression was 1.91 (SE=1.12, p=0.09) and remained non-significant in multivariate median regression (p=0.22).

Discussion

A linear relationship between social support and health status has been well documented. [11, 30–32] Social isolation has been shown to prospectively predict mortality and serious morbidity both in general population samples[33, 34] and in individuals with established morbidity[35], especially coronary heart disease[36]. However, our understanding of how and why social isolation is risky for health or, conversely, how and why social ties and relationships are protective of health, still remains quite limited. Our data support a possible role for social isolation as a factor influencing left ventricular mass. It is possible that subclinical cardiovascular disease such as increased left ventricular mass may be a mediating mechanism or modifying factor in the pathway by which a lack of social networks contribute to cardiovascular morbidity and mortality but ours was not a prospective study. Our multivariate model controlled for standard cardiac risk factors, and such factors do not fully account for or explain the deleterious effects of social isolation on left ventricular mass among Hispanics.

Social isolation may be related to left ventricular mass through a number of underlying mechanisms including psycho-physiologic stress related to isolation, depression, and poorer regulation of risk factors due to decreased medication compliance and decreased participation in healthful activities. Poor social friendship networks may turn off the means of obtaining health-related information [37] and enhance health risk behaviors. [9, 38, 39] Poor social support may lead to increased left ventricular mass via mental stress that is not buffered by the supportive presence of others. Mental stress activates neuro-endocrine components including the hypothalamic-pituitary-adrenal-axis and autonomic nervous system [11] Mental stress may induce hypertension[40], and increase cardiovascular reactivity[41] and endothelial dysfunction [42], all of which lead to increased left ventricular mass. The deleterious effects of social isolation are likely multifactorial. Further study is warranted to test these hypotheses.

Our definition of social isolation represents the presence of a primary, informal network that incorporates friends or friend-neighbors. This type of primary support network would most likely be associated with tasks involving leisure activities, hobbies, companionship, community events, shopping, and perhaps religious services. Hence, lack of friendship networks may provide a mechanism for lack of access to a wide range of resources supportive of health, such as medical referral networks, access to others dealing with similar problems, or opportunities to acquire needed resources via jobs, shopping, or financial institutions.

The spouse/partner constitutes another type of primary support network that has been associated with decreased mortality, particularly among men.[43] Indeed the proximity of friend networks may also take on a more prominent role in those who have lost a spouse. In our cohort, age was also associated with poorer social support as those socially isolated were older and had increased left ventricular mass. Social isolation tended to correlate with measures of low socioeconomic status. Although educational level, our most robust socioeconomic status measure, remained significant for the total cohort in our multivariate models, it was not significant among any of the race-ethnic groups (all $p>0.20$) when social isolation was also in the model. Socioeconomic status has been shown to be a determinant of left ventricular mass.[4] It is possible that social isolation is a partial mediator of the relationship between socioeconomic status and left ventricular mass but this remains to be further studied.

Although the prevalence of social isolation was not significantly different among the race-ethnic groups, social isolation was associated with increased left ventricular mass among Hispanics but not in the other race-ethnic groups. Our analyses suggest that race-ethnicity may be a proxy for differences in the strength of social resources. Indeed, the strong social support systems among Hispanics who are poor but maintain traditional kin groupings[24] may account for the lower mean left ventricular mass in the not socially isolated group. Hispanics may be more likely to stress family values over educational attainment: maintaining traditional kinship values that include living in extended family units and taking care of the sick and elderly. This is expressed in the core Hispanic belief of *familism*. Familism is having strong bonds with nuclear and extended family members thus extending a high level of perceived family support. Most studies on familism suggest that it has salutary effects and may explain the better-than-expected health outcomes observed in Hispanics.[44] For example, family members are often a source of financial and emotional support which can facilitate access to health services,[45] and better prevention practices including medical adherence.[46, 47] Non-Hispanic blacks typically have not retained traditional kin norms. Despite levels of poverty similar to Hispanics, the elimination of traditional norms among non-Hispanic blacks has likely resulted in population level stresses, isolation of family values, and mistrust of both medical and other community resources. It may be that familism enhances the social friendship network among Hispanics in a manner that is not found in other race-ethnic groups studied.

That there was a non-significant trend towards an inverse relationship of social isolation with left ventricular mass among non-Hispanic blacks was surprising in light of the evidence that social support is beneficial in reducing stress among non-Hispanic blacks.[48] However, prior studies used a different assessment tool to determine social isolation which may account for the different results. Alternatively, it our results may suggest that a more extensive social network is burdensome among non-Hispanic blacks for unclear reasons. The standard error of the regression coefficient for non-Hispanic blacks was the largest among the race-ethnic groups, likely the result of the limited number of non-Hispanic blacks in our cohort. The β coefficient for social isolation was non-significant in univariate or multivariate median regression which argues against outliers influencing the relation seen between social isolation and LVM among non-Hispanic blacks.

As for the relationship among non-Hispanic whites, although having no friends is clearly worse than having the highest number of friends, there is no significant trend seen. It seems as if among non-Hispanic whites, LVM has a non-linear relationship with social isolation. However, there is no way we could either prove or disprove this because the number of friends were categorized as ordinal variables. It is possible that what matters is not so much increasing isolation but a shift in the form and type of social connection. This will require further study.

Study Strengths and Limitations

A major strength of these analyses includes the use of a community based multiethnic cohort. Limitations of the study with regard to social support include the inability to capture individual participation in religious activities, senior centers, and other community-based organizations. Further, the data collected are limited in their ability to characterize the mechanisms by which social isolation impacts on left ventricular mass. Our study was cross-sectional in nature and thus causality cannot be inferred nor temporality be established. Unmeasured variables and residual confounding may account for some of the observed differences. Our interaction term was only significant when looking at Hispanics vs. non-Hispanics and not significant ($p>0.20$) when looking at Hispanics, whites, and blacks separately. Because of the limited number of participants in non-Hispanic race-ethnic groups and a power issue within each strata, our study was underpowered to detect statistically significant small to moderate interactions. Using values for mean left ventricular mass in those with and without social isolation and a two-sided type-I error of 0.05, the current sample had only 55% power to detect the 2.5 $gm/m^{2.7}$ difference in left ventricular mass and would have much less power for within-strata analysis. Nevertheless, socially isolated Hispanics were at a significantly higher risk of increased left ventricular mass than the other groups. Lastly, our findings may not be generalizable to all Hispanics; 88% of our Hispanic sample consists of Caribbean-Hispanics from the Dominican Republic, Cuba, and Puerto Rico. Confirmation by other investigators using other Hispanic populations is required.

Conclusion

Our findings suggests that it may be important to try to ensure that all individuals, especially elderly individuals, have social ties with at least one or a few other individuals. This may mean the need to develop both individual and population level strategies to identify individuals who are likely to be socially isolated. One such strategy is systematic screening by health care providers into the social components of the patient's lifestyle with recommendations to become more involved in community type activities. From a public health perspective, increased funding for community organizations to promote programs in which people get together and share common interests may be needed to reduce social isolation and ultimately help reduce or prevent increased left ventricular mass and possibly subsequent cardiovascular disease.

Acknowledgments

Funding Sources: RLS, MSV (R01 NS29993) and MDT (K24 NS02241) are supported by the National Institute of Neurological Disorders and Stroke. CJR is supported by the Robert Wood Johnson Foundation Harold Amos Medical Faculty Development Award, and a National Heart, Lung, and Blood Institute Mentored Research Career Development Award (K23 HL079343-01A2).

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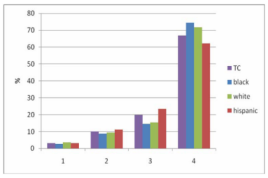

Figure 1. Proportion of Participants according to Number of Friends in Social Network by Race
How many people do you know well enough to visit with in their homes?
1 = None
2 = one or two
3 = three or four
4 = five or more

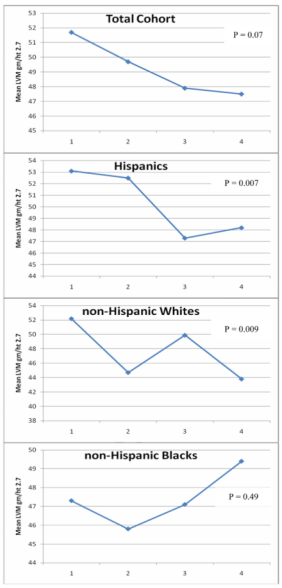

Figure 2. Mean left ventricular mass according to Number of Friends in Social Network by Race
How many people do you know well enough to visit with in their homes?
1 = None
2 = one or two
3 = three or four
4 = five or more

Table 1

Baseline Characteristics*

Percentage/Mean ± SD	Not Social Isolated n=1750	Socially Isolated n=271	P value
Age	67.7 ± 9.5	69.6 ± 10.4	0.004
Race-Ethnicity: Black	22.4	18.8	0.36
Hispanic	56.9	60.9	
White	20.7	20.3	
Women	60.5	61.3	0.80
Diabetes Status	21.5	25.5	0.14
Hypertension Status	67.8	70.9	0.32
Current Smoker	16.3	20.3	0.10
Physical Activity	58.8	50.2	0.008
BMI (kg/m2)	27.7 ± 5.3	27.6 ± 5.9	0.86
Left Ventricular Mass (gm/ht$^{2.7}$)	47.7 ± 15.5	50.2 ± 18.7	0.03
Married	35.8	29.9	0.057
Education ≥HS	47.3	36.9	0.001
Unemployed (or Retired)	77.5	88.6	<0.0001
Unskilled Labor	39.5	46.1	0.03
Insurance Status: Medicaid/Medicare	45.4	60.7	<0.0001
Uninsured	12.5	12.6	
Private	42.1	26.9	

*BMI (n-2018) and current smoking status (n-1993) were the only baseline characteristics with missing values.

Table 2

Univariate Regression Analysis of Factors Associated with Left Ventricular Mass

	Regression Coefficient (β)[†]	SE	P value
Social isolation	2.56	1.04	0.01
Age (per year)	0.22	0.04	<0.001
Male Sex	−0.83	0.73	0.26
BMI (per kg/m2)	0.95	0.06	<.0001
Diabetes Status	3.57	0.85	<.0001
Physical Activity	−0.10	0.10	0.31
Hypertension Status	7.40	0.75	<.0001
SBP (per mm Hg)	0.19	0.02	<.0001
Hispanic[§]	3.67	0.91	<.0001
Black[§]	3.61	1.08	0.0009
Current Smoking	0.30	0.96	0.75
Education ≥HS	−2.58	0.71	0.0003
Marriage	−1.77	0.74	0.02

[†] β reflects the change in left ventricular mass (gm/ht$^{2.7}$) associated with a change in one unit of left ventricular mass determinants, e.g.- For each unit increase in age (1 year) there is an average 0.22 gm/ht$^{2.7}$ increase in left ventricular mass.

[§] compared with non-Hispanic Whites

Table 3

Multivariate Regression Analysis of Factors Associated with Left Ventricular Mass

	Regression Coefficient (β)†	SE	P value
Social isolation	1.65	0.96	0.09
Age (per year)	0.32	0.04	<0.0001
Male Sex	1.36	0.68	0.05
BMI (per kg/m2)	0.99	0.06	<0.0001
Diabetes Status	1.05	0.80	0.19
Hypertension Status	4.2	0.73	<0.0001
Education ≥HS	−1.43	0.67	0.03
Physical Activity	−0.67	0.67	0.32
Stratified by Race-ethnicity¶			
Hispanics n=1162	3.9	1.23	0.002
Blacks n=443	−4.3	2.3	0.06
Whites n=418	0.17	2.07	0.94

† β reflects the change in left ventricular mass (gm/ht$^{2.7}$) associated with a change in one unit of left ventricular mass determinants, e.g.- For each unit increase in age (1 year) there is an average 0.32 gm/ht$^{2.7}$ increase in left ventricular mass.

¶ Adjusted for age, sex, BMI, physical activity, hypertensive status, educational level, and diabetes