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Variation in the Impact of Social Network Characteristics on Physical Functioning in Elderly Persons: MacArthur Studies of Successful Aging

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Objectives. Social support and social networks have been shown to exert significant effects on health and functioning among elderly persons. Although theorists have speculated that the strength of these effects may differ as a function of sociodemographic characteristics and prior health status, few studies have directly tested the moderating effects of these variables.

Methods. Longitudinal data from the MacArthur Study of Successful Aging were used to examine the effects of structural and functional social support on changes in physical functioning over a 7-year period, measured by the Nagi scale, in a sample of initially high-functioning men and women aged 70 to 79 years. Multiple regression analyses were used to test the main effects of social support and social network variables, as well as their interactions with gender, income, and baseline physical performance.

Results. After controlling for potential confounding effects, respondents with more social ties showed less functional decline. The beneficial effects of social ties were stronger for respondents who were male or had lower levels of baseline physical performance.

Discussion. The effects of social support and social networks may vary according to the individual's gender and baseline physical capabilities. Studies of functional decline among elderly persons should not ignore this population variation in the effects of social networks.

THE aging of the United States population, recent developments in medical treatment, and improvements in health behaviors have resulted in a dramatic increase in the elderly population. Unfortunately, many elderly people experience functional disabilities that compromise their quality of life, so the added years of life can be marred by physical impairment. As a consequence, preservation of functional independence in elderly persons has become an important goal of medical research. Although it was once commonly believed that functional decline was inevitable in old age, recent studies have revealed that some elderly people seem to be protected from functional decline, and a significant proportion of impaired elderly people regain physical functioning (Beckett et al., 1996; Crimmins & Saito, 1993).

Subsequent studies have identified the demographic, medical, behavioral, and psychological characteristics associated with maintenance of functional independence. Compared with elderly people who experience functional decline, "successful agers"—those who experience little or no decline—are more likely to be male, White, free of chronic disease, and have high levels of education and income (Mor, Wilcox, Rakowski, & Hiris, 1994; Seeman, Berkman, Blazer, & Rowe, 1994; Strawbridge, Cohen, Shema, & Kaplan, 1996). Those who practice healthy behaviors such as physical activity (Seeman et al., 1995; Simonsick et al., 1993; Strawbridge et al., 1996) and refrain from unhealthy behaviors such as smoking (Parker, Thorslund, Lundberg, & Kareholt, 1996) and heavy alcohol consumption (Scherr, LaCroix, Wallace, & Berkman, 1992) also are likely to age more successfully. In addition, psychosocial factors such as self-efficacy (Mendes de Leon, Seeman, Baker, Richardson, & Tinetti, 1996; Seeman & Unger, 1997), lack of depression (Strawbridge et al., 1996), and good self-rated health (Mor et al., 1994) are associated with more successful aging.

Social support and social networks also are associated with health outcomes in elderly persons, including a lower risk of mortality, cardiovascular disease, cancer mortality, and functional decline (for reviews, see Berkman, 1995; Seeman, 1996; Thoits, 1995). These protective effects of social networks may result from several processes. These include provision of access to information about health and health care services (Bloom, 1990), encouragement of healthy behaviors (Bovbjerg et al., 1995; Mermelstein, Cohen, Lichtenstein, Kanmark, & Baer, 1986), encouragement of health care utilization (Bleeker, Lamers, Leenders, & Kruyssen, 1995), provision of tangible aid (Thoits, 1995), provision of emotional support to facilitate coping with life stress (Thoits, 1995), enhancement of feelings of self-esteem and control (Krause & Borawski-Clark, 1994),

and influences on neuroendocrine or immune functioning (Seeman, Charpentier, Berkman, et al., 1994; Uchino, Cacioppo, & Kiecolt-Glaser, 1996).

Although the main effects of social variables on health have been documented, the extent to which these effects may vary across population subgroups is not known. Three variables that may moderate the effects of social support/social networks on health are income, gender, and level of physical functioning, as described below.

Income

Social support may have stronger benefits for elderly people with low income. People with low income may have greater exposure to health threats including inadequate or unsafe housing conditions, crime-ridden neighborhoods, and inadequate nutrition (Robert & House, 1996). These people may have a greater need for social support and they may suffer more when they lack adequate social support. Conversely, elderly people with adequate income are able to afford health care, assistive devices, nutritious food, travel, and entertainment, and they are able to pay others to help them with household tasks. Therefore, elderly people with adequate income may be able to compensate for a lack of social support by paying for appropriate housing, household help, or travel to visit distant relatives or friends. This may result in an interaction between social support and income; lack of social support may lead to more negative health effects among people with low income.

Gender

The effects of social support also may differ by gender. Many elderly women may have devoted significant portions of their lives to caretaking and developing supportive friendships, so they may be more accustomed to marshaling social support networks and asking for help. Many elderly men, in contrast, may have devoted significant portions of their lives to career achievement, so they may not have developed supportive social networks or the skills to marshal social support. This gender difference in social networks can lead to two different predictions about the nature of gender differences in the effects of social support on health. First, because women may be more skilled at marshaling social support, the effects of social support may be stronger for women, because women are better prepared to recruit social network members to provide instrumental or emotional support in the appropriate ways at the appropriate times. Men, in contrast, may be reluctant to ask for support, or they may seek it less skillfully than women do. This would lead to the prediction that social support would have stronger effects for women, because women are able to obtain and use it more effectively.

Conversely, social support may have stronger effects for men. Because many men are unaccustomed to marshaling social support when they need it, those men with low levels of social support may be especially isolated, which may put them at especially high risk for negative health outcomes. Women with low social support, however, may be able to compensate for social isolation by forming new social contacts or strengthening weak ones. This scenario would predict that social support would show stronger effects for men, because there would be a greater disparity in health between people with low and high social support among men than among women.

It is not clear whether there are gender differences in the effects of social support on health outcomes. Some studies have found more beneficial effects for men (Barer, 1994; House, Robbins, & Metzner, 1982; Umberson, Wortman, & Kessler, 1992); some have found more beneficial effects for women (Tower & Kasl, 1996); and some have found no gender differences (Berkman & Syme, 1979; Umberson, 1996). In addition, most research on gender differences in the effects of social support has focused on mortality or psychological distress; few studies have used functional status as an outcome variable.

Health Status

Social support/social networks also may have stronger effects for elderly people who are in poorer health. The support and assistance provided by social network members might be more valuable for elderly people with lower levels of physical functioning, because these individuals require more assistance. Elderly people with high levels of physical functioning are more able to perform activities of daily living (ADLs), and they do not have to cope with the severe emotional consequences of chronic illness and functional limitations. Therefore, the buffering effects of social support and social networks may be especially powerful for those elderly people who have impaired physical functioning and who need to cope with the physical and psychological consequences of their limitations. The combination of poor physical functioning and low social support may have especially harmful consequences for health.

To date, most studies of social influences on health have concentrated on main effects; few have investigated whether these effects vary by gender, income, or health status. The present study examines two functional aspects of social ties (instrumental support and emotional support) and two structural aspects of social ties (marital status and number of other social ties) in relation to changes in self-reported physical functioning over a 7-year period. More specifically, this study investigates whether the strength of these relationships varies by gender, income, or health status. Analyses were performed to answer two research questions:

1. Are social support and social network characteristics associated with decline in self-reported physical functioning over a 7-year period?
2. Do the associations between social network characteristics and physical functioning differ according to gender, income, or baseline health status?

METHODS

Sample

The data used in this study are from the MacArthur Studies of Successful Aging, a longitudinal study of relatively high-functioning men and women ages 70–79 years. As described by Berkman et al. (1993), participants were subsampled on the basis of age and physical and cognitive functioning from three community-based cohorts of the National Institute on Aging's Established Populations for Epidemiologic Studies of the Elderly (EPESE) in Durham, North Carolina, East Boston, Massachusetts, and New Haven, Connecticut (Cornoni-Huntley et al., 1986). Only those respondents aged 70–79 were included

in the study to minimize the effects of age on subsequent analyses of factors associated with the maintenance of health and functioning.

Of the 4,030 men and women who met the age criterion, 1,313 were identified as high functioning on the basis of four criteria of physical functioning (no ADL disability, no more than one reported mild disability on eight items tapping gross mobility and range of motion; ability to hold a semitandem balance for at least 10 seconds; and ability to stand from a seated position five times within 20 seconds) and two criteria of cognitive functioning (scores of 6 or more correct on the 9-item Short Portable Mental Status Questionnaire [Pfeiffer, 1975] and ability to remember at least three elements on a delayed recall of a short story).

Of the 1,313 men and women classified as high functioning, 1,189 (90.6%) agreed to participate and provided informed consent. Baseline data were collected between May 1988 and December 1989. The cohort was reinterviewed between October 1995 and February 1997. The mean time between interviews was 86 months. Of the 1,189 men and women interviewed at baseline, 273 (23%) died before the follow-up interview (32% of the men and 16% of the women). Of those who survived, complete data on physical functioning at both baseline and follow-up were available for 850 respondents. These 850 respondents, who represent 93% of those who were alive at follow-up and 71% of the original sample, constitute the sample used in this analysis.

Measures

Dependent variable.—The outcome measure used in this analysis is change in physical functioning from 1988 to 1995, as measured by the Nagi physical functioning scale (Nagi, 1976). This scale measures the respondent's perceived difficulty in performing five tasks: pushing/pulling large objects, stooping/kneeling, lifting/carrying 10 pounds, reaching/extending arms, and writing/handling small objects. The Nagi score represents the number of tasks that the respondent rated as "some difficulty," "a lot of difficulty," or "unable to do." Nagi scores can range from 0 to 5, with higher scores indicating more impairment. Because the baseline sample was restricted to individuals with Nagi scores of 0 or 1, the change in Nagi score could range from –1 (a 1-point improvement in functioning) to 5 (a 5-point decline in functioning).

Measures of social support and social networks.—Measures of both structural and functional aspects of social networks were included as predictors of impairment. Structural measures included marital status (married vs not married) and number of social ties, other than the spouse. Functional measures included emotional support and instrumental support. These constructs were measured separately for the respondent's spouse, children, and friends/relatives, and the three scores were averaged to create a single score for each type of functional support. Emotional support was measured based on the reported frequency with which the respondent's social network members "will listen when you have a problem" and make the respondent "feel loved and cared for." Instrumental support was measured based on the reported frequency with which network members "help with daily tasks" and "provide information." As previously reported (Seeman, Charpentier et al., 1994), these measures exhibit adequate test–retest reliability.

Covariates.—To control for confounding, variables found to be associated with social support and/or health status in previous studies were evaluated as potential covariates. Correlation analyses were conducted to determine which of these variables were associated significantly with the dependent variable, and these variables were retained for inclusion in subsequent multiple regression analyses.

Demographic variables included age, gender, ethnicity (White vs Black), education (high school graduate vs less than high school), and income (less than $10,000/year, over $10,000/year, or unknown). The education variable was dichotomized because its distribution was skewed. For income, the "unknown" category was included because a substantial proportion of the respondents (9%) either refused to provide income information or said they did not know their income. Rather than excluding these respondents from the analysis, we created dummy variables for income less than $10,000/year and income missing.

Baseline physical and psychological health status variables were included as covariates because older adults in poor health typically require and receive higher levels of social support (Wilcox, Kasl, & Berkman, 1994) and are at higher risk of functional decline (Seeman et al., 1995). These included a physical performance measure derived from tests of balance, gait, chair stands, foot taps, and manual ability (described in detail by Seeman, Charpentier, et al., 1994) and number of prevalent chronic conditions at baseline. Depressive symptoms were measured with the depression subscale of the Hopkins Symptom Checklist (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974).

Health behaviors such as alcohol use, smoking, and physical activity also were included as covariates. Smoking was expressed in pack-years. Levels of physical activity were assessed based on self-reported frequency of current leisure- and work-related activity. Each activity mentioned was classified as light, moderate, or strenuous based on intensity codes (described by Seeman et al., 1995). Summary scales were derived by multiplying the frequency of activity (5 categories, ranging from never to 3+ times/week) by the intensity and summing over all activities. To assess alcohol use, respondents were asked how many days in the past month they had consumed beer, wine, or liquor, and how many drinks they had at a time. These responses were used to create an estimate of the amount of ethyl alcohol consumed in the past month (Armor, Polich, & Stambul, 1975).

Analysis

The model-building process involved several steps. First, correlations were computed between the dependent variable (change in Nagi impairment) and each hypothesized covariate (demographic and health status variables). The covariates that were significantly correlated with change in Nagi impairment were included along with the four social support/social network variables in a multiple regression model predicting change in Nagi impairment, to determine the effects of social support/social networks after controlling for the covariates. Finally, to determine whether the effects of the social support/social network

variables were moderated by gender, income, or physical health status, interaction terms were added to the model. There were 12 interaction terms, representing the 4 social support/social network variables crossed with the 3 potential moderators.

Results

Table 1 shows the baseline demographic characteristics of the 340 men and 510 women who were alive and had complete data in 1995. The mean age of the respondents was 74.2 years (standard deviation = 2.7 years). The mean change in Nagi impairment was 0.82 impairments (standard deviation = 1.36 impairments).

Several variables differed significantly by gender. The women in the sample were older than the men (t = 2.37, $p < .05$), were more likely to have income less than $10,000 per year (chi square = 95.09, $p < .001$), were less likely to be married (chi square = 142.46, $p < .001$), smoked less (t = 8.00, $p < .0005$), drank less alcohol (t = 7.56, $p < .0005$), had less physical activity (t = 4.38, $p < .0005$), had lower physical performance scores (t = 10.42, $p < .0005$), had higher emotional support (t = 3.11, $p < .005$), had fewer social ties (t = 3.61, $p < .0005$), and showed larger changes in Nagi impairment (t = 4.42, $p < .0005$). The other variables in the model did not differ significantly by gender.

The correlations between each hypothesized predictor variable and functional decline are shown in Table 2. Several of the hypothesized covariates were correlated significantly with functional decline. These included age, gender, income, baseline chronic conditions, alcohol use, physical activity, physical performance, and depressive symptoms. These variables were retained for inclusion in the multiple regression described below. In addition, the correlations between the social support/social network variables and functional decline were assessed. Marital status was correlated significantly with functional decline, and the correlation between emotional support and functional decline approached statistical significance (p = .0798).

Table 3 shows the results of the multiple regression analyses predicting change in Nagi impairment. In this model, the effects of each covariate and social support/social network variable are controlled for the effects of the other variables. Only those covariates found to be significantly correlated with change in Nagi impairment were retained for inclusion in the multiple regression model. Interaction terms were added to the model, as described in the Methods section, to evaluate the potential moderating influences of gender, income, and baseline physical functioning.

Social support/social networks.—The only social support/social network variable significantly associated with functional decline was number of social ties at baseline, which was associated with less functional decline. The main effects of the other social support/social network variables were not associated significantly with functional decline, after controlling for the other variables.

Some of the social support/social network variables were intercorrelated. However, these associations were only modest, so multicollinearity is not a problem. Instrumental support was correlated positively with emotional support (r = .34, $p < .0005$), marital status (r = .10, $p < .005$), and number of social ties (r = .22, $p < .0005$). Emotional support also was correlated positively with number of social ties (r = .19, $p < .0005$).

Although marital status was associated significantly with functional decline in the correlation analyses, additional stepwise analyses (not shown) indicated that it became nonsignificant after depressive symptoms, income, and age were added to the model. Number of social ties was not associated significantly with functional decline in the correlation analyses, but it became significant after controlling for income, depressive symptoms, age, physical activity, and emotional support.

Table 1. Demographic Characteristics of Respondents at Baseline (1988)

	n	Percent
Gender		
Male	340	40
Female	510	60
Age		
70–72	281	33
73–75	282	33
76–80	287	34
Ethnicity		
White	700	82
Other	146	17
Missing	4	0
Education		
<High school	433	51
High school +	417	49
Income		
<$10,000	341	40
$10,000+	433	51
Missing	76	9
Marital status		
Married	399	47
Not maried	450	53
Missing	1	0
Change in Nagi score 1998–1995		
–1	59	7
0	432	51
1	145	17
2	94	11
3	66	8
4	42	5
5	12	1
Instrumental support		
0–1	70	8
1.1–2	399	47
2.1–3	238	28
Missing	6	1
Emotional support		
0–1	14	2
1.1–2	169	20
2.1–3	662	78
Missing	5	1
Number of social ties		
0–5	177	21
6–10	326	38
11–15	218	26
16+	127	15
Missing	2	0

Covariates.—Several of the covariates were associated significantly with functional decline. These included older age, lower physical activity, lower physical performance, and higher levels of depressive symptoms.

Table 2. Correlations Between Hypothisized Covariates and Change in Nagi Impairment Scores

Variable	Correlation	*p* value
Hypothesized Covariates		
Age	.122	.0003
Female gender	.140	.0001
Black ethnicity	–.024	.4828
High school education	–.039	.2517
Income over $10,000	–.148	.0001
Income missing	–.012	.7208
Baseline chronic conditions	.071	.0396
Smoking	–.019	.5882
Alcohol use	–.103	.0027
Physical activity	–.116	.0007
Physical performance	–.131	.0001
Depressive symptoms	.127	.0001
Social Support / Social Network Variables		
Instrumental support	–.020	.5669
Emotional support	–.060	.0798
Married	–.126	.0002
Number of social ties	–.031	.3738

Table 3. Predictors of Change in Nagi Impairment

Variable	*b*	SE	*t* value	*p* value
Covariates				
Age	.041	.018	2.34	.0196
Female gender	–.443	.539	–0.82	.4109
Income over $10,000	–.560	.523	–1.07	.2839
Baseline chronic conditions	.077	.052	1.48	.1391
Alcohol use	–.008	.006	–1.40	.1614
Physical activity	–.003	.002	–2.19	.0291
Physical performance	–1.103	.530	–2.08	.0378
Depressive symptoms	.046	.015	3.15	.0017
Social Support / Social Networks				
Instrumental support	–.233	.555	–0.42	.6741
Emotional support	–.547	.765	–0.72	.4748
Married	–.175	.797	–0.22	.8263
Number of social ties	–.235	.070	–3.34	.0009
Interactions				
Female × Instrumental	.154	.154	1.00	.3184
Female × Emotional	–.099	.216	–0.46	.6464
Female × Married	.279	.226	1.23	.2189
Female × Social Ties	.044	.021	2.09	.0372
Income × Instrumental	.145	.142	1.02	.3095
Income × Emotional	.034	.206	0.17	.8683
Income × Married	–.125	.211	–0.59	.5543
Income × Social Ties	.011	.020	.054	.5872
Physical perf × Instrumental	–.023	.149	–0.15	.8774
Physical perf × Emotional	.184	.213	0.86	.3874
Physical perf × Married	–.100	.214	–0.47	.6416
Physical perf × Social Ties	.058	.109	3.11	.0019

Note: Unstandardized regression coefficients.

Interactions.—Two of the 12 interaction terms, both involving the number of social ties, were significant. The interaction between gender and number of social ties ($p < .05$) is shown in Figure 1. Overall, respondents with larger numbers of social ties at baseline reported less functional decline. As shown in Figure 1, the association between number of social ties and functional decline was stronger for men than for women. In other words, although social ties were beneficial for respondents of both genders, they had a stronger protective effect for men than for women. The largest gender differences in functional decline were observed at the highest levels of social ties.

The interaction between baseline physical performance and number of social ties ($p < .005$) is shown in Figure 2. Although baseline physical performance was analyzed as a continuous variable in the regression analyses, it is shown as a dichotomous variable to simplify the illustration. This interaction indicates that the association between number of social ties at baseline and subsequent functional decline was stronger for individuals who were below the mean on baseline physical performance. Social ties were protective regardless of baseline physical performance, but they were especially protective for respondents with low levels of baseline physical performance.

Because the analyses focused on changes in Nagi impairment, they did not include the 273 respondents who died before the 1995 follow-up interview. To confirm the effects with a less restricted sample, we ran a similar analysis on the entire baseline sample, using mortality as the dependent variable. The results of this analysis were consistent with the analyses of Nagi impairment (data not shown).

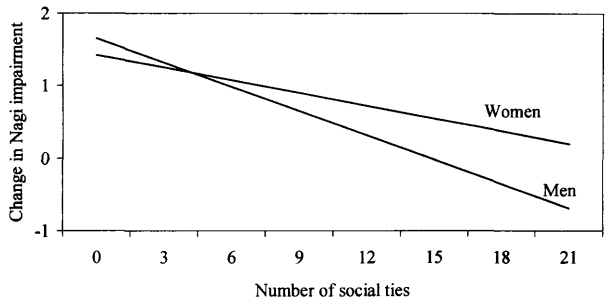

Figure 1. Change in Nagi impairment, according to gender and number of social ties.

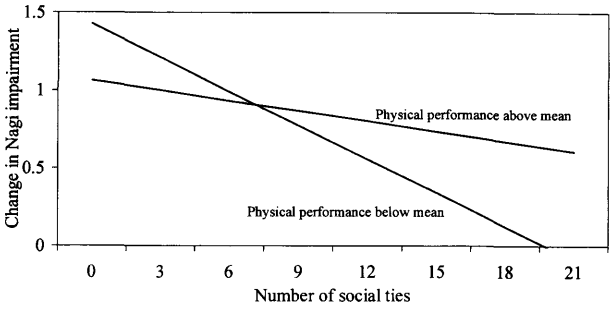

Figure 2. Change in Nagi impairment, according to baseline physical performance and number of social ties.

Discussion

These results indicate that the effects of social ties on the risk of functional decline in elderly persons are moderated by gender and baseline physical performance. Specifically, social ties had a stronger protective effect for men and for respondents with low levels of baseline physical performance.

Our finding that social support/social networks had a stronger effect on functional status for men than for women is consistent with other research findings for other health outcomes. A number of prospective studies have reported stronger effects for social support and/or social networks with respect to cardiovascular and all-cause mortality for men (Berkman et al., 1993; House et al., 1982; see also Seeman, 1996 for review). In particular, the harmful effect of widowhood on cardiovascular morbidity and mortality has been shown to be stronger among men than among women (Berkman et al., 1993). Because older men who are widowed or socially isolated are at high risk for functional decline and mortality, this high-risk group should be a target for health promotion interventions. Studies also are needed to determine what causes elderly men to become socially isolated, and how this social isolation and its associated harmful health effects can be prevented.

The stronger protective effect of social ties among respondents with low levels of baseline physical performance also has important implications for interventions to promote successful aging. Social ties appear to be most important for elderly people with more limited physical ability. This suggests that interventions to increase social support, such as arranging group activities for elderly people or pairing them with "buddies" in the community, may be especially powerful for those elderly people who already have some physical impairment or activity limitations. However, because of their restricted mobility, these older adults may pose the greatest challenge for health promotion programs and services. Greater efforts are needed to implement social activities that are accessible and can be enjoyed by people with physical impairments.

We had hypothesized that income also would moderate the effects of social support/social networks on functional decline. However, the moderating effects of income were not significant. Although higher income was associated with less functional decline in the correlational analysis, the main effect of income became nonsignificant in the multiple regression model, and none of the interaction terms involving income were significant. This suggests that the associations between income and functional status found in other studies (Berkman & Gurland, 1998) may be explained in part by differences in social support and social networks, and that social support may be a mediator, rather than a moderator, of the association between income and health status among elderly persons. Elderly people with higher incomes, for example, may be more able to remain integrated within a social network, because they are able to afford transportation and activities.

The significant interactions found in this study indicate that the beneficial effects of social variables are not equally strong for all elderly people. Although many previous studies have examined only the main effects of social variables, the present results indicate that the benefits of social variables may differ for men and women, and they may differ according to an individual's level of physical functioning. If studies evaluate only the main effects of social variables on health, they may fail to detect important subgroup differences in the effects of social support and social networks. Health promotion interventions for elderly people should focus on those elderly people who are most at risk of suffering harmful health effects as a result of social isolation. The results of this study suggest that men and people with physical impairments may be especially in need of interventions to enhance social support and social networks.

Limitations

Because this is a study of an initially high-functioning cohort, the generalizability of these findings may be limited. While this study suggests that social ties are more protective for people with lower levels of physical performance, all respondents in this study did in fact have relatively high levels of physical functioning, as evidenced by their lack of impairment in ADLs. This study does not clarify what the effects of social ties would be for elderly people with more severe functional limitations, because the initial selection criteria guaranteed that these individuals were not represented in the baseline cohort. Nevertheless, the significant moderating effect of physical performance found in this study indicates that even modest differences in physical performance within a high-functioning sample were associated with differential effects of social ties. One might hypothesize that the variation in effects would be even stronger in a cohort that included more severely impaired respondents.

Another possible limitation is that the data used in this study are based on respondents' self-reports of their physical functioning and social networks. Although attempts were made to control for variables that may confound the relationship between social variables and physical functioning (e.g., depressive symptoms, health behaviors, baseline health status), other variables not included in these analyses may have biased the accuracy of respondents' self-reports. Potential confounding variables that have been associated with both social networks and health outcomes include personality factors such as cynical hostility (Everson et al., 1997) and health behaviors other than those measured here (Lauver, Nabholz, Scott, & Tak, 1997).

Despite these limitations, these data provide important information about the effects of social support and social networks on physical functioning in elderly persons. More specifically, they highlight the fact that previously observed main effects might obscure important population variation in the effects of social ties and social support on health outcomes. As shown in these analyses, factors such as gender and baseline physical performance appear to moderate social network effects. Greater attention needs to be given to describing and understanding the complex interaction between social networks and individual characteristics if we are to gain the requisite understanding to design effective interventions to promote more successful aging.

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