Journal of Gerontology: SOCIAL SCIENCES
1999, Vol. 54B, No. 3, S162–S172

Social Networks and Disability Transitions Across Eight Intervals of Yearly Data in the New Haven EPESE

Carlos F. Mendes de Leon,[1] Thomas A. Glass,[2] Laurel A. Beckett,[1]
Teresa E. Seeman,[3] Denis A. Evans,[1] and Lisa F. Berkman[2]

[1]Rush Institute for Healthy Aging, Rush-Presbyterian-St. Luke's Medical Center, Chicago.
[2]Department of Health and Social Behavior, Harvard School of Public Health, Boston.
[3]Division of Geriatrics, University of California at Los Angeles School of Medicine.

Objectives. There is considerable evidence that social networks are strongly related to survival and other health outcomes. However, findings regarding the effect of social networks on disability outcomes have been inconsistent. This study examines this relationship with respect to the risk of developing disability and recovering from disability.

Methods. Data come from a community-based sample of the New Haven population aged 65 years and older, with nine annual interviews conducted between 1982 and 1991. Disability was measured by a 6-item index of activities of daily living (ADL), and a 3-item Rosow-Breslau index, with disability defined as impairment in one or more tasks on each measure. Social network variables were constructed for each of four domains of ties: children, relatives, friends, and a confidant, and a summary measure of total social networks. A Markov model was used to estimate one-year disability transitions averaged across all 8 intervals, after controlling for sociodemographic and health-related variables.

Results. Total social networks was associated with a significantly reduced risk of developing ADL disability ($\beta = -0.009$, $p < .01$), and a significantly increased likelihood of ADL recovery ($\beta = 0.017$, $p < .01$). Emotional and instrumental support did not affect the protective effect of social networks against disability, but partially accounted for their effect on enhanced recovery. Network variables related to relatives and friends were significantly associated with disability and recovery risks, but those related to children or a confidant were not. The associations with disability transitions as measured by the Rosow-Breslau index were generally smaller and nonsignificant.

Discussion. The findings lend further support for the role of social relationships in important health outcomes in old age. They suggest that being "embedded" in a social network of relatives and friends reduces risk for ADL disability, and enhances recovery from ADL disability.

THE beneficial influence of social interactions on our health and functioning has been an influential theme in social, gerontologic, and epidemiologic research. A considerable amount of evidence has accumulated to substantiate the claim that the quantity and nature of our social relations have a measurable influence on a variety of health outcomes. Findings from studies in the general population have been remarkably consistent in demonstrating a protective effect of social network ties with regard to various adverse health outcomes, especially mortality (Berkman, 1995; House, Landis, & Umberson, 1988). These benefits appear to persist into late life. Among the elderly, quantitative or qualitative aspects of social ties have been found to be related to mortality (Seeman, Kaplan, Knudsen, Cohen, & Guralnik, 1987; Seeman et al., 1993; Welin, Larsson, Svardsudd, Tibblin, & Tibblin, 1992) and well-being (Bowling & Faquhar, 1991; Dean, Kolody, & Wood, 1990; Oxman, Berkman, Kasl, Freeman, & Barrett, 1992). They have also been shown to improve survival and recovery following acute medical conditions (Berkman, Leo-Summers, & Horwitz, 1992; Glass, Matchar, Belyea, & Feussner, 1993; Jenkins, Stanton, & Jono, 1994; Ruberman, Weinblatt, Goldberg, & Chaudhary, 1984; Wilcox, Kasl, & Berkman, 1994; Williams et al., 1992) and reduced risk of institutionalization (Cohen, Tell, & Wallack, 1986; Freedman, 1996; Salive, Collins, Foley, & George, 1993). In this study, we examine the degree to which social networks are related to disability, a critical measure of overall health status in the elderly.

Disability serves as a measure of a person's diminished capacity or inability to perform basic self-care tasks that are usually required for independent living in the community (Parmalee, Thuras, Katz, & Lawton, 1995). Prevalence estimates of disability range from about 10 percent among the 65–74 year-old, to about 50 percent or higher in persons aged 85 years and older (Beckett et al., 1996; Kunkel & Appelbaum, 1992; Manton, Corder, & Stallard, 1997). Although the age-specific prevalence may be decreasing slightly (Manton, Corder, & Stallard, 1993; Manton et al., 1997), demographic trends are expected to cause the actual number of disabled, older Americans to increase well into the next century (U.S. Senate Committee on Aging, 1991). Disability is thought to result from the chronic effects of multiple morbidities incurred throughout life, which manifest as declining physical and/or cognitive health (Fried & Guralnik, 1997; Lawrence & Jette, 1996). Lifestyle factors, such as smoking and physical inactivity, are also thought to contribute to functional decline, either by causing disease, or through physiologic changes which have not yet manifested as clinical disease (Fried & Guralnik, 1997). Though disability is often precipitated by impaired physical or cognitive health, many other factors are believed to be involved in the disablement process, as well. In fact, theoretical models

of the disablement process explicitly recognize the role of the psychosocial and physical environment, positing that disability results from the complex interplay between declining biological health and these environmental influences (Pope & Tarlov, 1991; Verbrugge & Jette, 1994).

In reviewing the literature on psychosocial influences and disability, it is important to keep in mind that disablement may not necessarily follow a process of gradual decline. Instead, it often evolves in periods of deterioration in function, and partial or complete recovery from episodes of disability (Manton et al., 1993; Wolinsky, Stump, Callahan, & Johnson, 1996). Previous reports from the Established Populations for the Epidemiologic Studies of the Elderly (EPESE) study and the Longitudinal Study of Aging (LSOA) suggest that transitions between various states of disability, in the direction of both developing (more severe) disability and recovering from disability, are fairly common in community-dwelling older adults (Beckett et al., 1996; Rudberg, Parzen, Leonard, & Cassel, 1996). For example, data from the EPESE study indicate that among older persons aged 65 years and over, on average, about 10% will develop (new or recurrent) disability in Activities of Daily Living (ADL) every year, and about 20–25% will recover from an episode of ADL each year (Mendes de Leon et al., 1997). Psychosocial characteristics may therefore be hypothesized to influence this process in one of two ways; either by preventing or slowing down decline in function, or by enabling recovery from a disabled state. The distinction between decline in function and recovery from disability is important, because different psychosocial processes may account for the hypothesized salutary effects of social ties on disability outcomes.

Although the effect of social network ties on mortality is well established, whether they provide any benefit regarding the risk of developing disability in community-dwelling older individuals remains unclear. Results from the Alameda County Study suggest that persons with more extensive social ties show less decline in physical function than persons with fewer ties (Kaplan, Strawbridge, Camacho, & Cohen, 1993; Strawbridge, Cohen, Shema, & Kaplan, 1996). In contrast, findings from the MacArthur Studies of Successful Aging (Berkman et al., 1993; Seeman et al., 1995) and from the Longitudinal Study of Aging (LSOA; Harris, Kovar, Suzman, Kleinman, & Feldman, 1989; Mor et al., 1989) have failed to find such a protective effect on physical function, even though another LSOA analysis did report a positive association between social contacts and ADL disability (Boult, Kane, Louis, Boult, & McCaffrey, 1994). Much of this research, however, has been hampered by the use of crude and nonspecific measures of social network ties, and, for the most part, has failed to differentiate between different types of social ties (Glass, Mendes de Leon, Seeman, & Berkman, 1997). For example, summary measures of social networks have often combined information on specific ties (i.e., with friends and relatives with broader indicators of social integration, such as church attendance and group participation). Such measures are less useful in determining whether specific types of social interactions differ in terms of the health benefits they might confer. This may be important for disability outcomes because recent evidence suggests that ties with children appear to increase risk for disability (Seeman, Bruce, & McAvay, 1996). Other ties, such as those with friends and relatives, are perhaps more likely to reduce risk for decline in function, given their contribution to improved survival (Seeman et al., 1987, 1993).

When considering the long-term impact on the disablement process, it may be important not only to distinguish between types of social ties, but also the resources that are thought to emanate from social relationships, especially social support. Many studies have shown a positive effect of social support on enhanced recovery from specific illnesses (e.g., Glass et al., 1993; Jenkins et al., 1994; Wilcox et al., 1994;). Thus, social relationships may reduce risk of functional decline because they provide supportive resources. These resources may be brought to bear during acute illness episodes, or other events that challenge functional status, in order to prevent further decline or to enhance functional recovery (Argyle, 1992; Glass et al., 1997). At the same time, recent evidence suggests that not all forms of social support may be beneficial; whereas most recovery studies have focused primarily on emotional support, some studies have reported that instrumental support may actually increase risk for disability (Glass & Maddox, 1992; Hays, Saunders, Flint, Kaplan, & Blazer, 1997; Seeman et al., 1996).

In sum, the objective of the present study is to conduct a longitudinal analysis of the relationship between social network ties and disability in community-dwelling elderly persons. In a previous study, we used a structural equations modeling approach to characterize social relationships among elderly persons, resulting in a set of measures which organize social ties in terms of role-specific relationships, including ties with children, with relatives, with friends, and with a confidant (Glass et al., 1997). In this study, we will examine the association of each of these types of ties with the risk of developing disability and recovery from disability. In addition, we will examine the degree to which the effect of each type of tie on disability and recovery is mediated by emotional or instrumental support.

Methods

Sample.—Data for this analysis come from the New Haven site of the Established Populations for the Epidemiologic Studies of the Elderly (EPESE) project, one of four sites funded by the National Institute on Aging, and the only site with extensive information on social network ties. In order to generate a representative sample of the noninstitutionalized New Haven population aged 65 years and older, a 2-stage, stratified probability sample was obtained covering three housing strata: public housing for the elderly (age- and income-restricted), private housing for the elderly (age-restricted), and general community housing. The rate at which respondents were drawn into the sample varied by housing stratum and included an oversampling of men (Cornoni-Huntley et al., 1993). All persons within a household who met the age criteria were eligible. The response rate for the combined strata was 82%. The baseline sample consisted of 1,169 men and 1,643 women, for a total of 2,812 subjects.

Data collection and measures.—Baseline data collection took place during in-home, face-to-face interviews, conducted in 1982. These interviews covered various aspects pertaining to the subjects' sociodemographic, psychosocial, and health-related characteristics. Assessment during follow-up consisted of yearly interviews, including in-home interviews in 1985 and 1988, and brief telephone interviews in the intervening years

(1983, 1984, 1986, 1987), as well as in the two years (1989, 1990) following the last in-home interview. The last interview (1990) extended into 1991. The telephone interviews included assessment of disability status, but not of social network ties. Thus, including baseline, a total of nine waves of data were available on the outcome variable of disability.

Baseline sociodemographic variables used in the analyses included age (coded in single years), sex, marital status (married vs nonmarried), education (number of years of schooling completed), and income. Income was categorized into two dummy variables (<$5,000/year for low income; $5,000–$9,999/year for middle income). In order to retain subjects who failed to report income (13%), a separate dummy variable was created for missing values. The high income level (≥$10,000/year) served as the referent group. In the analysis, adjustment for income means the inclusion of all three dummy variables in the model.

Three overall indices were created to measure physical and cognitive health status. For physical health, we used information on relative weight and chronic conditions. Relative weight was assessed by body mass index (BMI), and then divided into approximate tertiles to create dummy variables for low (<23 kg/m^2), middle (23–27 kg/m^2), and high (>27 kg/m^2) BMI. As for income, a dummy variable for missing BMI values was created to permit inclusion of subjects with missing values (6%). Prevalent chronic conditions were measured by self-reported information on whether the subject was ever diagnosed with any of the following seven conditions: myocardial infarction, high blood pressure, stroke, cancer, diabetes, hip fracture, or arthritis. A summary measure of chronic conditions was created by summing the number of prevalent conditions. A separate analysis revealed that this summary measure provided a more stringent control for chronic conditions than when the effect of each condition was modeled individually. Cognitive performance was assessed by the 10-item Short Portable Mental Status Questionnaire (SPMSQ; Pfeiffer, 1975). "Don't knows" and refusals were coded as incorrect responses, and poor cognitive performance was defined as >3 incorrect responses (Fillenbaum, 1980).

Disability status.—For the purpose of this analysis, we selected two related but complementary measures of disability to obtain a relatively broad characterization of the disablement process. The first measure is derived from the Katz Activities of Daily Living (ADL) scale (Branch, Katz, Kniepmann, & Papsidero, 1984), and includes the following six tasks: bathing, dressing, eating, using the toilet, walking across a small room, and transferring from bed to chair. Consistent with previous studies (Beckett et al., 1996; Manton et al., 1993), task-specific disability is defined as a self- or proxy-report of presently needing help from a person, special equipment or device, or being unable to perform the activity. The second measure is derived from the work of Rosow and Breslau (1966), and includes three items measuring the ability (without help) to do heavy work around the house, to walk up and down the stairs, and to walk half a mile .

Commonly used models of disability all recognize that the disablement process evolves across a spectrum from no functional impairment to the inability to independently perform basic social roles and self-care functions (Nagi, 1976; WHO, 1980). The WHO model has so far adhered to a relatively broad definition of disability, whereas the Nagi model has drawn a more specific distinction between functional limitations and disability (see Verbrugge & Jette, 1994). The Katz ADL index most closely reflects the "end-stage" of this process, and would be considered a measure of disability in both models. The Rosow-Breslau measure places more emphasis on mobility-related tasks, and more closely matches the concept of functional limitations in the Nagi model. Functional limitations are generally thought to precede ADL disability, and to represent an earlier stage of the disablement process (Jette, Assmann, Rooks, Harris, & Crawford, 1998; Verbrugge & Jette, 1994).

A central aspect of this article is to model the disability process as a function of transitions into and out of a state of disability. As described later, a Markov (transition) model provides a suitable strategy to consider both types of transitions simultaneously. It also accounts for missing data due to death or gaps in the yearly interviews. Because this model is limited to the use of binary outcome variables, we defined disability in each measure as having an impairment in at least one of the individual tasks. This definition is consistent with the use of dichotomous disability measures in other studies (e.g., Beckett et al., 1996; Boult et al., 1994; Kunkel & Applebaum, 1992; Seeman et al., 1996). Transition into a state of disability (development of disability) indicates a report of disability in a measure following a report of no disability in the preceding interview. Similarly, transition out of a state of disability (recovery) is a report of no disability following a report of disability in the preceding interview. Subjects with missing values on one or more of the items (per measure) at baseline or during any of the follow-up interviews were set to missing, unless one of the nonmissing items indicated disability, in which case they were coded as disabled.

Social network ties and social support.—The New Haven EPESE baseline interview collected detailed information on the quantity and structure of social network ties. In a previous analysis, we used a confirmatory factor analysis to construct a measurement model to yield scales for four separate domains of ties: ties with children, ties with other relatives, ties with friends, and ties with a confidant (Glass et al., 1997). Each scale combined information on the number of ties with frequent visual contact, frequent nonvisual contact, and the geographic proximity of ties. The children ties variable also included information on (emotional) closeness and reciprocity in terms of help given and received. The interscale correlations were generally low (r < .10), except for the correlation between the friends and relatives scale (r = .33). To examine the effect of having multiple social relationships, we constructed a total social network scale by adding the scores for each of the domain-specific scales into a summary score.

Social support was measured by the following series of items relating to emotional support (talking over problems or helping with difficult decisions) and instrumental support (help with daily tasks like grocery shopping, house cleaning, etc.). First, each subject was asked whether they had anyone to provide each type of support; and if so, the number of persons that provided support during the past year. The "number of sources" of support variables were recoded to 0, 1, or ≥2. Subjects indicating no need for either emotional (15%) or instrumental (15%) support were coded as having 0 sources of support, though separate dummy variables were included in all analyses for the "no need of support" category.

Statistical analysis.—Descriptive statistics were calculated in SUDAAN (Shah, Barnwell, & Biegler, 1996) in order to account for the complex sampling design. The longitudinal effect of each of the social network scales on disability and recovery risks was computed using a Markov model (Muenz & Rubinstein, 1985). In essence, the model estimates one-year transition probabilities, which represent the average of the observed transition probabilities across all eight intervals (spanning nine waves of data). To that end, the data were first organized by state of disability (disabled or not disabled) at the beginning of each of the yearly intervals. The data were then pooled across subjects and across those intervals for which a subsequent interview was available, providing information on follow-up status. Two separate models were computed for transitions into and out of a state of disability using all intervals with information on disability status at the end of the interval. Transition probabilities are calculated conditional upon surviving an interval, while two additional models are computed simultaneously to estimate the risk of nonsurvival during each interval from either a disabled or a nondisabled state. Transition probabilities across intervals are estimated by a logistic link function, assuming that successive years were independent and calculating the likelihood for transition probabilities across gaps in intervals due to missing (disability) data iteratively. The New Haven sample is based on a 2-stage (housing stratum and sex) stratified sampling design, and weighted likelihood equations are solved to obtain pseudo maximum likelihood estimates, consistent under this sampling design. In addition, each person is considered a separate cluster to account for the within-person correlation of repeated measurements of disability status. This Markov model has been used in previous analyses of disability data in the EPESE data sets (Beckett et al., 1996; Mendes de Leon et al., 1997), and its current version is described in more detail elsewhere (Beckett, Brock, Scherr, & Mendes de Leon, 1993).

A series of models was computed for each social network variable. First, we calculated the effect of each network variable on disability and recovery risks after adjusting for age only. Next, we investigated whether social network variables were independently predictive of disability transitions by adding the sociodemographic and health-related control variables identified from the literature and from our own previous analyses of these data. Finally, we determined the degree to which social support might account for the effect of social network variables on disability transitions. Although this is usually accomplished by adding these variables to the fully adjusted models, this procedure led to problems in the convergence of the Markov models due to sparse or empty cells in various combinations of covariates in the model. We therefore elected to examine the effect of these potential "mechanisms" in the age-adjusted models, rather than the fully adjusted models, especially since the estimated effect of social network variables did not change appreciably between the two. We also examined a number of interaction effects for the social network variables, in particular with age and sex, but found no consistent evidence for differential effects by either variable.

Results

Of the original 2,812 subjects at baseline, complete data were available on 2,607 (93 %) subjects in analyses involving the total social network variable and ADL disability transitions. After pooling data across subjects and years of follow-up, there were a total of 11,678 intervals that were started from a nondisabled state; of these, 1,201 (10.3 %) ended in a disabled state at the end of the interval. Similarly, of the 2,614 intervals that started from a disabled state, 588 (22.5 %) ended in recovery (no disability) at the end of the interval. A total of 1,225 subjects (47%) died during the 10-year follow-up period. The number of subjects available for the analysis of each of the domain-specific network variables was slightly greater than for the total social network variable, due to the smaller number of missing values. For the Rosow-Breslau disability analysis, 2,593 (92%) provided complete data, of whom 1,217 (47%) died during follow-up. Of the 6,998 pooled intervals that started from a nondisabled state, 1,851 (26.5%) resulted in disability at the following interview. Of the 6,720 intervals that started from a disabled state, 1,311 (19.5%) were followed by a report of no disability (recovery) at the subsequent interview. Again, a slightly greater number of subjects were available for each of the domain-specific network variables. A small number of subjects ($n = 15$) with complete data received proxy interviews at baseline, and omission of these subjects from the analyses produced the same results as presented later.

Characteristics of the sample have been described in detail in previous reports (Berkman et al., 1986; Mendes de Leon et al., 1997). Briefly, the mean age at baseline of this cohort was almost 74 years old (range 65–99); 36% were male; 15% were black, and 42% were married. The average educational attainment was 9.4 years of schooling completed, and 33% had an annual income less than $5,000 (in 1982 dollars). As shown in Table 1, social network variables were generally positively and significantly related to both emotional and instrumental social support. Of the role-specific network variables, the confidant and children network variables showed the strongest associations with social support, whereas the friends network variable appeared to have the weakest association with either type of support.

The first series of Markov models was aimed at examining the associations of each of the social network variables with ADL disability and recovery (see left column, Table 2). The total social networks variable was significantly associated with a reduced risk of becoming disabled ($b = -0.010$, $p < .001$) as well as an increased likelihood of recovering from disability ($b = 0.014$, $p < .01$). Of the four domain-specific, social network measures, only two were significantly associated with disability outcomes after adjustment for age. Relatives networks and friends networks each reduced the risk of becoming disabled ($b = -0.031$, $p < .001$, and $b = -0.014$, $p < .05$ respectively) and increased the likelihood of recovery from disability ($b = 0.027$, $p < .01$, and $b = 0.028$, $p < .05$ respectively). Additional adjustment for sociodemographic and health-related variables had little effect on the relationship of social network variables to changes in disability status (see Table 2). Most associations remained largely unchanged in these models, with the exception of the friends network variable, which was reduced to a nonsignificant level ($b = -0.010$, $p = .11$) in the fully adjusted model for disability risk.

To illustrate the effect size associated with each social network variable, odds ratios were computed based on the results of the fully adjusted models, comparing transition risks due to a difference of one standard deviation in scores on each scale (see right column, Table 2). An increase of 1 standard deviation (standard unit) on the total Social Network variable is associated with a 16% reduction in odds of developing disability (OR = 0.84, 95% CI 0.75–0.94), after adjustment for all other vari-

Table 1. Baseline Association of Social Network Variables with Social Support[a]

Network Variables	Total Sample M	(SD)[b]	range	Emotional Support[c] 0 29%	1 57%	≥2 14%	Instrumental Support[c] 0 24%	1 48%	≥2 28%
Total Network	35.8	(20.5)	0–85	31.8	36.3***	42.0***	32.2	34.5***	41.4***
Children	10.6	(10.9)	0–25	10.1	10.2	13.5***	9.0	9.9***	13.3***
Relatives	6.2	(7.2)	0–24	5.6	6.2	7.6***	5.9	5.9	7.1*
Friends	9.1	(7.7)	0–31	8.1	9.4	10.1*	8.8	8.9	9.9*
Confidant	9.7	(6.0)	0–15	7.9	10.4***	10.7***	8.4	9.7***	11.0***

[a]All proportions, means, and statistical tests are adjusted for the complex sampling design.
[b]Means (standard deviations).
[c]For each Social Support variable, 0 sources of support is referent category, and statistical significance levels are adjusted for the "No Need for Support" category (see Methods).
*$p < .05$; ** $p < .01$; ***$p < .001$.

Table 2. The Association of Social Network Variables with Development of ADL Disability[a] and Recovery from ADL Disability: The New Haven EPESE 1982–1991 (N=2,630)

Network Variables	Age-adjusted model β[c]	(SE)	Fully adjusted model[b] β	(SE)	OR[d]	(95% CI)
Total Social Network:						
Disability	-0.010***	(.003)	-0.009**	(.003)	0.84	(0.75–0.94)
Recovery	0.014**	(.005)	0.017**	(.005)	1.41	(1.14–1.74)
Children Network:						
Disability	-0.001	(.008)	-0.004	(.007)	0.96	(0.82–1.12)
Recovery	0.010	(.011)	0.011	(.010)	1.12	(0.91–1.39)
Relatives Network:						
Disability	-0.031***	(.009)	-0.027**	(.009)	0.82	(0.77–0.93)
Recovery	0.027**	(.011)	0.029**	(.011)	1.25	(1.09–1.43)
Friends Network:						
Disability	-0.014*	(.006)	-0.010	(.007)	0.92	(0.84–1.02)
Recovery	0.028*	(.012)	0.031*	(.013)	1.28	(1.05–1.54)
Confidant Network:						
Disability	-0.009	(.008)	-0.008	(.007)	0.95	(0.88–1.04)
Recovery	-0.002	(.011)	0.001	(.014)	1.00	(0.83–1.20)

[a]Defined as ≥1 limitation in Activities of Daily Living (ADL).
[b]Model adjusted for age, sex, race, marital status, education, income, body mass index, cognitive performance, and chronic conditions.
[c]logistic regression coefficients (standard errors).
[d]Odds ratio (95% confidence interval), per increase of 1 standard deviation.
*$p < .05$; **$p < .01$; ***$p < .001$.

ables. The same standard unit increase is also associated with a 41% increase in odds of recovering from disability (OR=1.41, 95% CI 1.14–1.74). A standard unit increase on the Relatives Network variable is associated with an 18% reduction in odds (OR=0.82, 95% CI 0.77–0.93) of developing disability, and a 25% increase in odds of recovering from disability (OR=1.25, 95% CI 1.09–1.43). For the Friends Network variable, a standard unit increase on the scale is associated with a nonsignificant 8% reduced odds of developing disability (OR=0.92, 95% CI 0.84–1.02), and a 28% increase in odds of recovering from disability (OR=1.28, 95% CI 1.05–1.54).

The second series of Markov models addressed analyzed disability transitions based on the Rosow-Breslau measure of disability. Associations between the social network variables and Rosow-Breslau disability and recovery were generally much weaker compared with ADL disability, and none of the associations reached statistical significance (see Table 3).

The final step of the analysis was aimed at assessing the degree to which the effect of social networks on ADL disability transitions was mediated by emotional or instrumental social support. This analysis was restricted to the ADL measure of disability, as this was the only disability measure significantly affected by social networks. Transition models were computed first with each type of support added singly, and then jointly, in order to examine both the separate and combined effects of emotional and instrumental support on the association of social network ties with disability outcomes. With regard to development of disability, neither emotional nor instrumental support reduced the protective effect of total social networks (see Table 4). In fact, the association became slightly stronger in the models including instrumental support, due to the fact that total social networks was positively related to instrumental support, and instrumental support itself increased risk for development of disability. Compared with having no instrumental support,

Table 3. The Association of Social Network Variables with Developing and Recovering from Rosow-Breslau Disability[a]: The New Haven EPESE 1982–1991 (*N*=2,630)

	Age-adjusted model		Fully adjusted model[b]			
Network Variables	β[c]	(*SE*)	β	(*SE*)	OR[d]	(95% CI)
Total Social Network:						
Disability	-0.004	(.003)	-0.004	(.004)	0.92	(0.79–1.07)
Recovery	0.004	(.004)	0.002	(.004)	1.04	(0.89–1.21)
Children Network:						
Disability	0.006	(.006)	0.003	(.006)	1.03	(0.91–1.17)
Recovery	-0.002	(.006)	-0.003	(.006)	0.97	(0.85–1.11)
Relatives Network:						
Disability	-0.012	(.008)	-0.011	(.009)	0.92	(0.81–1.04)
Recovery	0.006	(.007)	-0.002	(.008)	0.98	(0.88–1.10)
Friends Network:						
Disability	-0.007	(.006)	-0.003	(.007)	0.98	(0.88–1.09)
Recovery	0.008	(.008)	0.006	(.008)	1.05	(0.93–1.18)
Confidant Network:						
Disability	-0.011	(.009)	-0.016	(.010)	0.91	(0.81–1.02)
Recovery	0.011	(.011)	0.012	(.011)	1.07	(0.94–1.23)

[a]Defined as ≥1 limitation in the Rosow-Breslau disability scale.
[b]Model adjusted for age, sex, race, marital status, education, income, body mass index, cognitive performance, and chronic conditions.
[c]Logistic regression coefficients (standard errors).
[d]Odds ratio (95% confidence interval), per increase of 1 standard deviation.

Table 4. The Effect of Emotional and Instrumental Support on the Association of Total Social Network Ties with ADL Disability Development and Recovery: The New Haven EPESE 1982–1991 (*N*=2,593)

	Development of Disability							
	OR	(95% CI)[a]	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Age	1.10	(1.08–1.11)	1.10	(1.08–1.11)	1.09	(1.08–1.11)	1.09	(1.08–1.11)
Total Social Network Ties	0.82[b]	(0.74–0.91)	0.82	(0.73–0.92)	0.76	(0.68–0.85)	0.76	(0.67–0.86)
Emotional Support:								
0			1.00				1.00	
1			1.11	(0.81–1.54)			1.01	(0.75–1.38)
2			0.87	(0.69–1.10)			0.79	(0.61–1.04)
Instrumental Support:								
0					1.00		1.00	
1					1.85	(1.38–2.50)	1.85	(1.40–2.44)
2					1.80	(1.33–2.44)	1.88	(1.39–2.56)
	Recovery from Disability							
Age	0.96	(0.94–0.98)	0.96	(0.94–0.98)	0.96	(0.94–0.98)	0.96	(0.94–0.98)
Total Social Network Ties	1.33[b]	(1.07–1.65)	1.30	(1.03–1.65)	1.24	(0.98–1.56)	1.23	(0.96–1.57)
Emotional Support:								
0			1.00				1.00	
1			1.23	(0.85–1.77)			1.25	(0.81–1.92)
2			1.05	(0.59–1.89)			0.96	(0.52–1.77)
Instrumental Support:								
0					1.00		1.00	
1					0.97	(0.52–1.79)	0.87	(0.43–1.76)
2					1.35	(0.68–2.69)	1.26	(0.58–2.71)

[a]Confidence interval.
[b]Odds ratios for Total Social Network Ties represent the difference in odds per standard unit increase.

having one source (OR = 1.85, 95% CI 1.38–2.50), or two or more sources (OR = 1.80, 95% CI 1.33–2.44) were both significantly predictive of future development of disability, after adjustment for age and total social networks. Emotional support was not significantly associated with development of ADL disability, although there was a suggestion of a small protective effect due to having two or more sources of emotional support (OR = 0.79; $p = .09$), after adjustment for age, total social networks, and instrumental support.

Turning to the models for recovery from ADL disability, the protective effect of social networks seemed to be partly mediated by both instrumental and emotional support. After adjusting for both types of support, the effect of total social networks was reduced from a significant association (OR= 1.33, 95% CI 1.07–1.65) to a nonsignificant level (OR= 1.23, 95% CI 0.96–1.57). The number of sources of either type of support showed somewhat inconsistent and nonsignificant associations with recovery (see Table 4). The "no need for support" dummy variables for each type of support generally were not significantly related to disability transitions (data not shown), with the exception of "no need for emotional support," which increased the odds of recovery from disability (OR = 1.67, 95% CI 1.29–2.72). Results for the relatives and friends network variables were similar to those for the total social network variable.

Discussion

There is solid evidence that social relationships have a beneficial influence on survival, even if the exact mechanisms by which they do so remain unclear. One way of further investigating this relationship is by considering an intermediate endpoint in the continuum between good health and death. Disability serves this function well, as a common endpoint of various disease processes that affect aging persons. At the same time, it is clear that disability is not exclusively determined by biological processes, but is also subject to various psychosocial and environmental influences (Pope & Tarlov, 1991; Verbrugge & Jette, 1994). The present analysis therefore was aimed at examining the relation between social network ties and changes in disability status in a representative sample of community-dwelling older persons. Overall, our findings suggest that having more extensive social ties and interactions reduces the risk of developing ADL disability, and increases recovery from ADL disability. We also found that this protective effect varied by type of role-specific relationships, and that emotional and instrumental support accounted for part of the beneficial effects of social network ties on recovery from ADL disability, but not on development of ADL disability. However, measures of social network ties showed smaller and nonsignificant associations with the Rosow-Breslau index of disability.

An important difference with previous gerontologic research on social relations and disability is our measures of social network ties. Other studies have often relied on either single-item indicators (Boult et al., 1994; Harris et al., 1989; Mor et al., 1989; Seeman et al., 1996), which have more limited validity, or on summary indices, which define social network ties more broadly by including indicators of social activities such as participation in groups and church attendance (Kaplan et al., 1993; Strawbridge et al., 1996). Social activities such as these typically require a certain minimum level of physical and/or cognitive health, which may confound the association between these activities and health outcomes. This confound is often difficult to adjust for adequately, especially in the absence of detailed measures of severity of previously diagnosed conditions, which plagues most large-scale epidemiologic studies. By using only basic structural characteristics (e.g., the number of frequent contacts and proximity of contacts) for our measures of social networks, we hoped to minimize this confound, and consequently offer a more rigorous test of the impact of social network ties on disability transitions. At the same time, we recognize that the distinction between social contacts and social activities is somewhat arbitrary. For example, having visual contacts with a friend or relative is not only a measure of one's social network, but also implies social activity.

Our measures were based on the notion that structural characteristics of social relationships are role-specific (i.e., cluster by type of relationship), and that each characteristic conveys some unique information on the nature of that relationship (Glass et al., 1997). Thus, although the measures may lack a simple interpretation in terms of, for example, total size of network, they do provide a comprehensive, and psychometrically tested characterization of an older person's social relationships. They are perhaps best interpreted as a measure of "embeddedness" in role-specific social relationships, with embedded-ness being a function of not just number of frequent visual contacts, but also of nonvisual contacts and geographical proximity.

Another important strength of this study was the availability of multiple waves of yearly information on disability status during follow-up, which enabled us to characterize functional change with much more precision than in most previous studies. A single-state ("two-wave") analysis is restricted to modeling only "first onset" disability, and assumes that each episode of disability is irreversible, and will be identified as an "incident case" at the end of follow-up. This assumption is problematic given the nature of the disablement process, especially when there is a lengthy interval between sequential assessments. Instead, our annual data allowed us to account for episodes of disability from which subjects recovered before the end of follow-up, and at which time they again become at risk for a recurrent episode of disability. Similarly, our data allowed us to simultaneously examine the inverse transition, recovery from disability, which also may occur more than once during a follow-up of relatively long duration, as was the case in our study. Similar approaches to modeling disability transitions have been used in several other recent studies (Anderson, James, Miller, Worley, & Longino, 1998; Rudberg et al., 1996); however, to our knowledge, this is the first time that this analytic approach has been used to examine social network and support variables in relation to disability transitions.

In spite of the clear strengths of the analytic methods used in this study, it also has several shortcomings. First, Markov transition models assume that transition probabilities are stable across time (intervals). This assumption may not necessarily hold for disability outcomes in longitudinal research of elderly populations, as disability rates are likely to increase, and recovery rates decrease with increasing age. Actual (weighted) annual transition rates ranged from 7.1%–14.1% for ADL disability, and from 11.1%–37.4% for ADL recovery across yearly intervals. However, the more extreme transition rates were confined mostly to the first and last follow-up intervals. Transition rates during the intervening intervals showed fluctuations within a relatively narrow range

(<6%). Essentially the same results were obtained when the main analyses were recomputed after omission of the first and last (9th) interview data, suggesting that our findings are relatively robust against minor departures from the stability assumption.

A second assumption of these types of models is that transitions are assumed to be "memory-less," meaning that transition probabilities are assumed to be independent of previous disability states. Although this assumption may not be entirely met (Anderson et al., 1998), we were unable to account for disability history, because our analytic program was not designed to model time-varying covariates. The degree to which this may have affected the present findings is unclear. However, this disadvantage may be partially offset by the Markov program's ability, in contrast to other recently used multistate transition models (Anderson et al., 1998; Rudberg et al., 1996), to account for gaps in disability data due to missing interviews. This is important because these gaps may not occur at random, and are potentially related to disability status. Another limitation due to the program is that we were unable to account for changes in social network variables during follow-up. However, previous studies suggest that network size tends to be fairly stable in older adults (Field & Minkler, 1988; Stoller & Pugliesi, 1988), and is relatively immune to changes in health (Penninx, 1996). Our own analysis of this cohort also indicates substantial stability in social networks across a period of 3 years (Glass, Mendes de Leon, & Berkman, 1995), which suggests that change in social networks may have provided relatively little additional information on disability transitions.

In order to simultaneously address development of and recovery from disability, we had to use relatively crude indicators of disability changes, being defined as transitions between having no limitations, and having one or more limitations on each scale. As a result, our findings only pertain to development of ADL disability from a *previously disability-free* status, and to *complete recovery* from any previous state of disability, and do not address other changes in disability status (e.g., from "some" to "more severe" disability). It should be noted, however, that this definition is likely to have captured the majority of disability transitions, as most such transitions originate from a previously disability-free state (see e.g, Rudberg et al., 1996), simply due to the fact that the large majority of community-dwelling elderly persons (usually about 85–90%) report no ADL disability at any given moment. Our definition is also consistent with previous studies (Beckett et al., 1996; Boult et al., 1994; Seeman et al., 1996), and allowed us to make use of the Markov modeling procedure, which we feel offers several important advantages for the analysis of change in disability status when compared with other analytic models.

Our findings are generally consistent with those from several previous studies of the role of social ties in disability (Hays et al., 1997; Kaplan et al., 1993; Seeman et al., 1996; Strawbridge et al., 1996). For example, data from the Alameda County study suggest that social integration and more extensive personal ties reduce the risk of developing disability (Kaplan et al., 1993; Strawbridge et al., 1996). Results from both the LSOA (Boult et al., 1994) and the MacArthur Studies of Successful Aging (Seeman et al., 1996) suggest that the beneficial effect of social ties against developing disability may be confined to ties with friends or relatives. In both these studies, disability was defined on the basis of performing self-care (ADL) functions. Our own findings provide further evidence for a relationship between specific social ties and this type of disability. Although the present findings suggest that social ties affect both development of disability and recovery from disability, they also indicate that this effect does not necessarily generalize to the entire spectrum of the disablement process.

As mentioned previously, one of the main concerns in research of social relationships and health outcomes is that maintaining these relationships typically requires a certain degree of physical and cognitive capacity. The effect of our network measures on disability transitions proved to be largely unaffected by major indicators of concurrent physical and cognitive health, suggesting that our strategy of focusing on structural characteristics of social relationships was relatively successful in minimizing the confound due to health status. We next considered the possibility that social relationships would be associated with a more active lifestyle, which itself is predictive of development of disability (Simonsick et al., 1993). However, correlations between a 4-item physical activity measure and social networks variables were generally small (Pearson's r were ≤.10, data not shown), suggesting that the effect was not due to higher levels of physical activity among those reporting more extended social networks. Depressed mood has also been found to be related to disability (Bruce, Seeman, Merrill, & Blazer, 1994; Guccione et al., 1994), and is usually inversely associated with social relationships. Again, correlations between depression (as measured by the CES–D) and our network variables were fairly modest, the largest being $r = -.18$ for the total network variable (data not shown), and adding this variable to the models including social networks and both types of social support did not change the results. Although we cannot entirely exclude the possibility that the observed effects for the social network variables were affected by unmeasured heterogeneity in physical or mental health, they do seem to be independent of the major known determinants of ADL disability.

As House and colleagues have pointed out previously (1988), there are a variety of pathways through which social relationships may affect health outcomes, ranging from behavioral and psychological mechanisms to physiological processes. In this analysis, we examined one mechanism in more detail, social support, given its well-established role in recovery from specific diseases (Berkman, 1995). Even though we recognize the limitations of our single-item measures of social support, we found generally strong associations between social network ties and availability of emotional and instrumental support. There was little evidence, however, that either type of support accounted for the protective effect of social networks on development of ADL disability. We also observed that although emotional support was not significantly associated with disability risks, instrumental support actually increased the risk of developing ADL disability. This effect is consistent with those of several other studies (Hays et al., 1997; Seeman et al., 1996), and may be due to increased reporting of instrumental support among those at imminent risk of developing ADL disability. Alternatively, greater availability or use of instrumental support might also foster greater dependence, and thus increase risk for ADL disability.

In contrast, emotional and instrumental support appear to account for a considerable part of the beneficial effect of social networks on recovery from ADL disability. This suggests that older persons who are more embedded in their social relationships, especially with relatives and friends, are able to mobilize

those contacts for social support during episodes of ADL disability, which, in turn, appears to enhance their ability to recover from the disabled state. This finding is perhaps even more surprising given that availability of support was reported, for the most part, years before the actual disability episodes. Social support assessed more proximate to the time of disability might have accounted for a greater proportion of the apparent benefit of those ties for recovery. Even so, our findings are consistent with those from a recent study that found that more extensive social networks before open heart surgery are associated with perceived social support one month after surgery, which, in turn, predicted better functional recovery six months after surgery (Oxman & Hull, 1997). Overall, our results provide further evidence for the role of social support in recovery from disease, which has been observed in many previous studies (Glass et al., 1993; Jenkins et al., 1994; Wilcox et al., 1994), and extend the importance of social relationships to recovery from ADL disability in general, rather than just disability following specific acute medical conditions.

Because social support did not explain the increased risk of developing ADL disability due to social networks, other explanations may be inferred from the observation that the association was largely restricted to relationships with relatives and with friends. For example, embedded-ness in a larger network of relatives and friends may provide more opportunity to perform meaningful social roles, which has shown to positively influence various health outcomes, including disability (Adelmann, 1994a). One way in which these social roles, or meaningful social relationships in general, might bring about better health outcomes is by promoting certain motivational characteristics or coping strategies, such as sense of control and self-efficacy (Adelmann, 1994b). Such characteristics have been shown to enable older persons to ward off or slow down the disabling consequences of declines in physical health (Mendes de Leon, Seeman, Baker, Richardson, & Tinetti, 1996; Rodin, 1989). In fact, Social Cognitive Theory, from which the concept of self-efficacy is derived, explicitly recognizes the importance of the social environment in shaping and reinforcing self-efficacy, which, in turn, determines the degree of confidence persons have in their ability to successfully perform specific behaviors (Bandura, 1986). Social embedded-ness may also provide less tangible benefits, such as a sense of meaning and coherence in an older person's life (Antonovsky, 1979). While it is mostly unclear how a sense of meaning or purpose in life might translate into concrete health benefits, it perhaps serves to enhance what has been called "generalized (host) resistance," a concept which refers to a person's ability to resist or overcome health hazards (Berkman, 1995; House et al., 1988). Recent research has actually begun to elucidate a number of immune and neuroendocrine responses that provide a link between the quantity and quality of social relationships with specific physiological processes (Seeman, Berkman, Blazer, & Rowe, 1994; Uchino, Cacioppo, & Kiecolt-Glaser, 1996).

The finding that ties with children and a confidant appear to confer little benefit with respect to disability transitions was somewhat unexpected. As noted earlier, the children ties variable included additional indicators for closeness and reciprocity that were not available for the other domain-specific network variables. However, the findings did not change when we reconstructed the children variable using the same set of indicators as the other network variables. One reason for the equivocal effect of children network ties may be that these ties are typically less discretionary (Adams & Bliezner, 1989; Larson, Mannell, & Zuzanek, 1986), and may therefore be associated with both benefits and strains. Consequently, they may provide less unequivocal psychological reinforcement, compared with relationships with friends and more distant relatives (Antonucci, 1990). An alternative explanation may be that older persons draw closer to children or a confidant when anticipating a decline in health and the resulting need for assistance with self-care tasks. This "closing ranks" phenomenon in times of declining health might offset any benefits that accrue from these intimate ties. This is consistent with the observation that older persons tend to turn first to a spouse or children for basic self-care needs before seeking assistance from more distant relatives or friends (Stoller & Pugliesi, 1988). It is also congruent with our observation that children and confidant network ties were the most strongly related to the availability of instrumental support, which, in turn, was associated with an increased risk of disability.

Our findings indicate that the beneficial effect of certain social ties does not appear to affect all aspects of the disability process equally, as the associations with the Rosow-Breslau measure of disability were smaller, and did not attain statistical significance. This finding was somewhat unexpected, given the usually strong associations between these two measures of disability. One reason may be that the tasks assessed by the Rosow-Breslau index (walking stairs, walking half a mile, doing heavy household tasks) tend to be physically more demanding than basic self-care tasks, and, therefore, may be more directly affected by underlying physical disease processes, such as cardiovascular, musculoskeletal, and neurological conditions. On the other hand, disability in self-care functions not only arises from the physical and mental limitations imposed by the various chronic disease processes that affect aging persons, but also reflects the psychological and socioenvironmental adaptation to these limitations (Verbrugge & Jette, 1994). Because the ability to perform basic self-care tasks is normally critical for maintaining independence and meaningful social role functioning, there is a mutual interest to both the individual and the people in his or her immediate social environment to preserve this ability for as long as possible. Few studies to date have directly compared different aspects of the full spectrum of the disability process in relation to social relationships, and future research may well want to take account of the various stages of disability when investigating the specific role of the social environment in this process.

In recent years, a profile of the psychosocial influences in the disablement process has begun to emerge. Some of these influences, especially negative mood states such as depression and anxiety, may accelerate decline in functioning and impair recovery (Bruce et al., 1994; Guccione et al., 1994; Tinetti, Inouye, Gill, & Doucette, 1995). Other characteristics, including self-efficacy and mastery, serve to slow down or halt functional decline (Mendes de Leon et al., 1996; Rodin, 1989; Seeman, Rodin, & Albert, 1993). The present research corroborates the role of another important psychosocial influence in the disablement process: the extent and nature of social relationships. It suggests that being "embedded" in a network of social relationships, especially with friends and relatives, provides long-term protection against ADL disability, either by reducing risk of developing disability, or promoting recovery from disability.

ACKNOWLEDGMENTS

This study was supported by grants R29-AG-10170 (FIRST Award) and R01-AG-11042, and contract N01-AG-02105, all from the National Institute on Aging.

Address correspondence to Dr. Carlos F. Mendes de Leon, Rush Institute for Healthy Aging, Rush-Presbyterian-St. Luke's Medical Center, 1645 W. Jackson Blvd, Suite 675, Chicago, IL 60612. E-mail: cmendes@rush.edu

REFERENCES

Adams, R., & Bliezner, R. (1989). *Perspectives on later life friendships.* Beverly Hills, CA: Sage.

Adelmann, P.K. (1994a). Multiple roles and physical health among older adults: Gender and ethnic comparisons. *Research on Aging, 16,* 142–166.

Adelmann, P.K. (1994b). Multiple roles and psychological well-being in a national sample of older adults. *Journal of Gerontology: Social Sciences, 49,* S277–S285.

Anderson, R.T., James, M.K., Miller, M.E., Worley, A.S., & Longino, C.F. (1998). The timing of change: Patterns in transitions in functional status among elderly persons. *Journal of Gerontology: Social Sciences, 53B,* S17–S27.

Antonovsky, A. (1979). *Health, stress, and coping.* San Francisco, CA: Jossey-Bass.

Antonucci T. (1990). Social supports and social relationships. In R.H. Binstock & L.K. George (Eds.), *Handbook of aging and the social sciences* (3rd ed.). San Diego, CA: Academic Press.

Argyle, M. (1992). Benefits produced by supportive social relationships. In H.O.F. Veiel & U. Baumann (Eds.), *The meaning and measurement of social support* (pp. 13–32). New York: Hemisphere.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Beckett, L.A., Brock, D.B., Lemke, J.H., Mendes de Leon, C.F., Guralnik, J.M., Fillenbaum, G.G., Branch, L.G., Wetle, T.T., & Evans, D.A. (1996). Analysis of change in self-reported physical function among older persons in four population studies. *American Journal of Epidemiology, 143,* 766–778.

Beckett, L.A., Brock, D.B., Scherr, P.A., & Mendes de Leon, C.F. (1993). Markov models for longitudinal data from complex models. *Proceedings of the American Statistical Association Survey Research Methods Section,* 921–925.

Berkman, L.F. (1995). The role of social relations in health promotion. *Psychosomatic Medicine, 57,* 245–254.

Berkman, L.F., Berkman, C.S., Kasl, S.V., Freeman, D.H.Jr., Leo, L., Ostfeld, A.M., Cornoni-Huntley, J., & Brody, J.A. (1986). Depressive symptoms in relation to physical health and functioning in the elderly. *American Journal of Epidemiology, 124,* 372–388.

Berkman, L.F., Leo-Summers, L., & Horwitz, R.I. (1992). Emotional support and survival after myocardial infarction. *Annals of Internal Medicine, 117,* 1003–1009.

Berkman, L.F., Seeman, T.E., Albert, M., Blazer, D., Kahn, R., Mohs, R., Finch, C., Schneider, E., Cotman, C., McClearn, G., Nesselroade, J., Featherman, D., Garmezy, N., McKhann, G., Brim, G., Prager, D., & Rowe, J. (1993). High, usual, and impaired functioning in community-dwelling older men and women: Findings from the MacArthur Foundation Research Network on Successful Aging. *Journal of Clinical Epidemiology, 46,* 1129–1140.

Boult, C., Kane, R.L., Louis, T.A., Boult, L., & McCaffrey, D. (1994). Chronic conditions that lead to functional limitation in the elderly. *Journal of Gerontology: Medical Sciences, 49,* M28–M36.

Bowling, A., & Faquhar, M. (1991). Associations with social networks, social support, health status and psychiatric morbidity in three samples of elderly people. *Social Psychiatry and Psychiatric Epidemiology, 216,* 115–126.

Branch, L.G., Katz, S., Kniepmann, K., & Papsidero, J.A. (1984). A prospective study of functional status among community elders. *American Journal of Public Health, 74,* 266–268.

Bruce, M.L., Seeman, T.E, Merrill, S.S., & Blazer, D.G. (1994). The impact of depressive symptomatology on physical disability: MacArthur Studies of Successful Aging. *American Journal of Public Health, 84,* 1796–1799.

Cohen, M., Tell, E., & Wallack, S. (1986). Client-related risk factors of nursing home entry among elderly adults. *Journal of Gerontology, 41,* 785–792.

Cornoni-Huntley, J., Ostfeld, A.M., Taylor, J.O., Lallace, R.B., Blazer, D.G., Berkman, L.F., Evans, D.A., Kohout, F.J., Lemke, J.H., Scherr, P.A., & Korper, S.P. (1993). Established populations for epidemiologic studies of the elderly: Study design and methodology. *Aging Clinical and Experimental Research, 5,* 27–37.

Dean, A., Kolody, B., & Wood, P. (1990). Effects of social support from various sources on depression in elderly persons. *Journal of Health and Social Behavior, 31,* 148–161.

Field, D., & Minkler, M. (1988). Continuity and change in social support between young-old and old-old or very-old age. *Journal of Gerontology: Psychological Sciences, 43,* P100–P106.

Fillenbaum, G.G. (1980). Comparison of 2 brief tests of organic brain impairment, the MSQ and the SPMSQ. *Journal of the American Geriatrics Society, 28,* 381–384.

Freedman, V.A. (1996). Family structure and the risk of nursing home admission. *Journal of Gerontology: Social Sciences, 51,* S61–S69.

Fried, LP., & Guralnik, J.M. (1997). Disability in older adults: Evidence regarding significance, etiology, and risk. *Journal of the American Geriatrics Society, 45,* 92–100.

Glass, T.A., & Maddox, G.L. (1992). The quality and quantity of social support: Stroke recovery as a psychosocial transition. *Social Science and Medicine, 34,* 1249–1261.

Glass, T.A., Matchar, D.B., Belyea, M., & Feussner, J.R. (1993). Impact of social support on outcome in first stroke. *Stroke, 24,* 64–70.

Glass, T.A., Mendes de Leon, C.F., & Berkman, L.F. (1995). *Risk of social isolation: Prospective evidence from the New Haven EPESE.* Paper presented at the 48th Annual Meeting of The Gerontological Society of America, Los Angeles, CA.

Glass, T.A., Mendes de Leon, C.F., Seeman, T.E., & Berkman, L.F. (1997). Beyond single indicators of social networks: A LISREL analysis of social ties among the elderly. *Social Science and Medicine, 44,* 1503–1517.

Guccione, A.A., Felson, D.T., Anderson, J.J., Anthony, J.M., Zhang, Y., Wilson, P.W.F., Kelly-Hayes, M., Wolf, P.A., Kreger, B.E., & Kannel, W.B. (1994). The effects of specific medical conditions on the functional limitations of elders in the Framingham Study. *American Journal of Public Health, 84,* 351–358.

Harris, T., Kovar, M.G., Suzman, R., Kleinman J.C., & Feldman, J.J. (1989). Longitudinal study of physical ability in the oldest-old. *American Journal of Public Health, 79,* 698–702.

Hays, J.C., Saunders, W.B., Flint, E.P., Kaplan, B.H., & Blazer, D.G. (1997). Social support and depression as risk factors for loss of physical function in late life. *Aging and Mental Health, 1,* 209–220.

House, J.S., Landis, K.R., & Umberson, D. (1988). Social relationships and health. *Science, 241,* 540–545.

Jenkins, C.D., Stanton, B.A., & Jono, R.T. (1994). Quantifying and predicting recovery after heart surgery. *Psychosomatic Medicine, 56,* 203–212.

Jette, A.M., Assmann, S.F., Rooks, D., Harris, B.A., & Crawford, S. (1998). Interrelationships among disablement concepts. *Journal of Gerontology: Medical Sciences, 53A,* M395–M404.

Kaplan, G.A., Strawbridge, W.J., Camacho, T., & Cohen, R.D. (1993). Factors associated with change in physical functioning in the elderly: A six year prospective study. *Journal of Aging and Health, 5,* 140–153.

Kunkel, S.R, & Applebaum, R.A. (1992). Estimating the prevalence of long-term disability for an aging society. *Journal of Gerontology: Social Sciences, 47,* S253–S260.

Larson, R., Mannell, R., & Zuzanek, J. (1986). Daily well-being of older adults with friends and family. *Psychology and Aging, 2,* 117–126.

Lawrence, R.H., & Jette, A.M. (1996). Disentangling the disablement process. *Journal of Gerontology: Social Sciences, 51B,* S173–S182.

Manton, K.G., Corder, L., & Stallard, E. (1993). Estimates of change in chronic disability and institutional incidence and prevalence rates in the U.S. elderly population from 1982, 1984, and 1989 National Long-Term Care Survey. *Journal of Gerontology: Social Sciences, 48,* S153–S166.

Manton, K.G., Corder, L., & Stallard, E. (1997). Chronic disability trends in elderly United States populations: 1982–1994. *Proceedings of the National Academy of Sciences, 94,* 2593–2598.

Mendes de Leon, C.F., Beckett, L.A., Fillenbaum, G.G., Brock, D.B., Branch, L.G., Evans, D.A., & Berkman, L.F. (1997). Black-white differences in risk of becoming disabled and recovering from disability in old age: A longitudinal analysis of two EPESE populations. *American Journal of Epidemiology, 145,* 488–497.

Mendes de Leon, C.F., Seeman, T.E., Baker, D.I., Richardson, E.D., & Tinetti, M.E. (1996). Self-efficacy, physical decline, and change in functioning in community-living elders: A prospective study. *Journal of Gerontology: Social Sciences, 51B,* S183–S190.

Mor, V., Murphy, J., Masterson-Allen, S., Willey, C., Razmpour, A., Jackson, M.E., Greer, D., & Katz, S. (1989). Risk of functional decline among well elders. *Journal of Clinical Epidemiology, 42,* 895–904.

Muenz, L., & Rubinstein, L. (1985). Markov models for covariate dependence of binary sequences. *Biometrics, 41,* 91–101.

Nagi, S.Z. (1976). An epidemiology of disability among adults in the United States. *Milbank Memorial Fund Quarterly/Health and Society, 54,* 439–467.

Oxman, T.E., Berkman, L.F., Kasl, S., Freeman, D.H., & Barrett, J. (1992). Social support and depressive symptoms in the elderly. *American Journal of Epidemiology, 135,* 356–368.

Oxman, T.E., & Hull, J.G. (1997). Social support, depression, and activities of daily living in older heart surgery patients. *Journal of Gerontology: Psychological Sciences, 52B,* P1–P14.

Parmalee, P.A., Thuras, P.D., Katz, J.R., & Lawton, M.P. (1995). Validation of the cumulative illness rating scale in a geriatric residential population. *Journal of the American Geriatrics Society, 43,* 130–137.

Penninx, B.W.J.H. (1996). *Social support in elderly people with chronic diseases. Does it really help?* Ph.D. Dissertation, Free University of Amsterdam.

Pfeiffer, E. (1975). A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. *Journal of the American Geriatrics Society, 23,* 433–441.

Pope, A.M., & Tarlov, A.R. (1991). *Disability in America: Toward a national agenda for prevention.* Washington, DC: National Academy Press.

Rodin, J. (1989). Sense of control: Potentials for intervention. *Annals of the American Academy of Psychological and Social Sciences, 503,* 29–42.

Rosow, I., & Breslau, N. (1966). A Guttman health scale for the aged. *Journal of Gerontology, 21,* 556–559.

Ruberman, W., Weinblatt, E., Goldberg, J.D., & Chaudhary, B.S. (1984). Psychosocial influences on mortality after myocardial infarction. *New England Journal of Medicine, 311,* 552–559.

Rudberg, M.A., Parzen, M.I., Leonard, L.A., & Cassel, C.K. (1996). Functional limitation pathways and transitions in community-dwelling older persons. *The Gerontologist, 36,* 430–440.

Salive, M.E., Collins, K.S., Foley, D.J., & George, L.K. (1993). Predictors of nursing home admission in a biracial population. *American Journal of Public Health, 83,* 1765–1767.

Seeman, T.E., Berkman, L.F, Blazer, D.G., & Rowe, J.W. (1994). Social ties and support as modifiers of neuroendocrine function. *Annals of Behavioral Medicine, 16,* 95–106.

Seeman, T.E., Berkman, L.F., Charpertier, P.A., Blazer, D.G., Albert, M.S., & Tinetti, M.E. (1995). Behavioral and psychosocial predictors of physical performance: MacArthur Studies of Successful Aging. *Journal of Gerontology: Medical Sciences, 50A,* M177–M184.

Seeman, T.E., Berkman, L.F., Kohout, F., Lacroix, A., Glynn, R., & Blazer, D. (1993). Intercommunity variations in the association between social ties and mortality in the elderly: A comparative analysis of three communities. *Annals of Epidemiology, 3,* 325–335.

Seeman, T.E., Bruce, M.L., & McAvay, G.J. (1996). Social network characteristics and onset of ADL disability: MacArthur Studies of Successful Aging. *Journal of Gerontology: Social Sciences, 51B,* S191–S200.

Seeman, T.E., Kaplan, G.A., Knudsen, L., Cohen, R., & Guralnik, J. (1987). Social ties and mortality in the Alameda County Study. *American Journal of Epidemiology, 126,* 714–723.

Seeman, T.E., Rodin, J., & Albert, M. (1993). Self-efficacy and cognitive performance in high-functioning older individuals. *Journal of Aging and Health, 5,* 455–474.

Shah, B.V., Barnwell, B.G., & Biegler, G.S. (1996). SUDAAN's survey data analysis software, release 7.0. Research Triangle Park, NC: Research Triangle Institute.

Simonsick, E.M., Lafferty, M.E., Phillips, C.L., Mendes de Leon, C.F., Kasl, S.V., Seeman, T.E., Fillenbaum, G.G., Hebert, P., & Lemke, J.H. (1993). Risk due to inactivity in physically capable older adults. *American Journal of Public Health, 83,* 1443–1450.

Stoller, E.P., & Pugliesi, K.L. (1988). Informal networks of community-based elders. *Research on Aging, 10,* 499–516.

Strawbridge, W.J., Cohen, R.D., Shema, S.J., & Kaplan, G.A. (1996). Successful Aging: Predictors and associated activities. *American Journal of Epidemiology, 144,* 135–141.

Tinetti M.E., Inouye, S.K., Gill, T.M., & Doucette, J.T. (1995). Shared risk factors for falls, incontinence, and functional depedence. Unifying the approach to geriatric syndromes. *Journal of the American Medical Association, 273,* 1348–1353.

Uchino, B.N., Cacioppo, J.T., & Kiecolt-Glaser, J.K. (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119,* 488–531.

U.S. Senate Committee on Aging. (1991). Aging America—trends and projections (no. FcoA 91-28001). Washington, DC: U.S. Department of Health and Human Services.

Verbrugge, L.M., & Jette, A.M. (1994). The disablement process. *Social Science and Medicine, 38,* 1–14.

Welin, L., Larsson, B., Svardsudd, K., Tibblin, B., & Tibblin, G. (1992). Social network and activities in relation to mortality from cardiovascular diseases, cancer and other causes: A 12-year follow-up of the study of men born in 1913 and 1923. *Journal of Epidemiology and Community Health, 46,* 127–132.

WHO. (1980). *International Classification of Impairments, Disabilities, and Handicaps.* Geneva, Switzerland: World Health Organization.

Wilcox, V.L., Kasl, S., & Berkman, L.F. (1994). Social support and physical disability in older people after hospitalization: A prospective study. *Health Psychology, 13,* 170–179.

Williams, R.B., Barefoot, J.C., Califf, R.M., Haney, T.L., Saunders, W.B., Pryor, D.B., Hlatky, M.A., Siegler, I.C., & Mark, D.B. (1992). Prognostic importance of social and economic resources among medically treated patients with angiographically documented coronary artery disease. *Journal of the American Medical Association, 267,* 520–524.

Wolinsky, F.D., Stump, T.E., Callahan, C.M., & Johnson, R.T. (1996). Consistency and change in functional status among older adults over time. *Journal of Aging and Health, 8,* 155–182.

Received June 1, 1998
Accepted January 5, 1999