Published in final edited form as:

Int J Geriatr Psychiatry. 2008 September ; 23(9): 972–978. doi:10.1002/gps.2023.

Influence of social network characteristics on cognition and functional status with aging

Ariel Frank Green, MPH¹, George Rebok, PhD², and Constantine G. Lyketsos, MD, MHS³

¹*Johns Hopkins University School of Medicine and Bloomberg School of Public Health, Baltimore, MD, USA*

²*Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA*

³*Department of Psychiatry, Johns Hopkins Bayview and Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, MD, USA*

Abstract

Objective—To determine whether more frequent engagement in larger social networks, and more emotional support protect against cognitive and functional decline with aging.

Methods—We examined the influence of social networks on cognition and instrumental activities of daily living (IADLs) over a median interval of 10.9 years. Data were from the Baltimore follow-up of the Epidemiologic Catchment Area (ECA) study, a community-based sample of adults in eastern Baltimore. 874 participants completed cognitive testing at both the third and fourth study waves (1993–1996 and 2003–2004) on the Mini-Mental State Examination (MMSE) and a delayed word recall task. Functional status at both waves was self-reported on the Lawton-Brody IADL scale. Social network characteristics, assessed at the third study wave, included network size, frequency of contact, and emotional support.

Results—In cross-sectional analyses at wave 3, larger networks were associated with higher MMSE and better delayed recall scores. This association persisted after adjustment for covariates. More emotional support was associated with better functional status, before and after adjustment. By contrast, social networks were not longitudinally associated with cognitive change, with two counter-intuitive exceptions: *more* frequent contact and *more* emotional support were associated with worse delayed recall and IADL scores after adjustment.

Conclusions—There was no evidence of a longitudinal association between social networks and cognition or IADLs, although a clear cross-sectional association exists. Together, these findings suggest the emergence of social isolation in individuals declining in cognition and functioning, rather than a protective effect of social networks.

Keywords

Cognitive impairment; cognitive function; instrumental activities of daily living; social networks

INTRODUCTION

Research has suggested that social interaction protects against cognitive decline. The aging of the population makes this an important issue. Thirty-one million Americans will live alone in 2010 – a 40% increase since 1980 (Cacioppo, Hawkey 2003). Two longitudinal studies found that limited social contacts were associated with increased risk of cognitive decline or dementia

(Bassuk, Glass & Berkman 1999, Fratiglioni et al. 2000). Others found no evidence that larger networks predicted better maintenance of cognition after 7 years (Glei et al. 2005). Seeman et al. found that neither social ties nor group participation affected cognition after 7.5 years (Seeman et al. 2001).

Most studies have had short follow-up or used assessments insensitive to the detection of milder cognitive impairment. Subsequently, the reverse causality question remains unanswered: is limited social contact a risk factor for cognitive decline, or a prodromal feature? Here we expand on earlier work from the Baltimore ECA that suggested more interpersonal activity and emotional support were cross-sectionally associated with better cognitive performance, while larger social networks predicted lower odds of cognitive decline over 12 years (Holtzman et al. 2004). We hypothesized that larger networks, more frequent contact, and more emotional support would correlate with better maintenance of cognition and function over the subsequent decade. Evidence of such an association would lead to enhanced efforts to keep people engaged as they age.

METHODS

Study population

Data were from the Baltimore ECA follow-up study, described in detail elsewhere (Eaton et al. 1997). Probability sampling was used to identify 3,481 adults aged ≥ 18 in eastern Baltimore interviewed at wave 1 (1981). Wave 2 was conducted one year later. Of the original participants, 1,920 were re-interviewed at wave 3 (1993–1996), and 1,071 at wave 4 (2004–2005). The Johns Hopkins Bloomberg School of Public Health Committee on Human Research approved the study. To facilitate examination of change over the decade, only respondents with cognitive scores at waves 3 and 4 were included in the present analysis ($n=874$ persons).

Exposure assessment: social networks

We assessed network size, frequency of interaction, emotional support, and a composite social network measure. Network size constituted (1) the number of relatives outside the home and (2) the number of friends/neighbors with whom the respondent communicated by telephone or visits during the past six months. Response choices were 0, 1, 2–3, 4–5, 6–10, and ≥ 11 . Within each domain (i.e., family or friends), these responses were assigned scores of 0–5 (i.e., 0=0, 1=1, 2–3=2, etc.) and the two domains were summed (range 0–10).

Frequency of interaction was assessed by asking how often respondents talked on the phone/visited with (1) relatives outside the home and (2) friends. Choices were “never,” “less than once a month,” “about once a month,” “a few times a month,” “a few times a week,” and “most every day.” These were scored 0–5, within each domain, and the two domains were summed (range 0–10).

Emotional support was assessed by asking: (1) How much does your (husband/wife/partner) really care about you? (2) How much can you rely on your (husband/wife/partner) for help with a serious problem? And, (3) How much can you relax and be yourself around your (husband/wife/partner)? Choices were “not at all,” “a little,” “some,” or “a lot” (scored 0–3). The three items were repeated for other relatives and for friends, and summed (range 0–27). 365 unmarried respondents lacked data for the items relating to emotional support from a spouse/partner, so we multiplied their emotional support scores by 1.5.

Network size, frequency of contact and emotional support were only moderately correlated (pairwise correlation coefficients 0.27–0.36, $p<0.001$), so a composite social network measure was created by adding the scores for these variables (range 0–47).

Outcome assessment: cognition and functional status

At waves 3 and 4, we assessed total MMSE score (range 0–30) and delayed recall. A validated, widely used screening instrument for global cognitive impairment, the MMSE was administered using standard procedures at all study waves (Folstein, Folstein & McHugh 1975).

A delayed recall task was administered at waves 3 and 4 (Cornoni-Huntley et al. 1993). Impairment in delayed recall is a sensitive indicator of dementia. Participants listened to 20 common words then recalled them in any order. After 20 minutes, they recalled the same list again. The total number of correct words recalled after the delay was scored.

Functional status was assessed on six items from the Lawton-Brody Instrumental Activities of Daily Living (IADL) (Lawton, Brody 1969): ability to use a telephone, prepare meals, clean the house, and manage finances (each scored 0–2, with lower scores indicating more disability). Additionally, respondents were asked about their ability to shop for groceries and use public transportation (each scored 0–3, with lower scores indicating more disability). Scores for each task were summed (range 0–14). These items were re-scaled from the original survey so that higher scores would correspond with better functional status.

Covariates

The following variables were included in adjusted analyses as potential confounders. They had cross-sectional associations at wave 3 ($p \leq 0.01$) with social networks, cognition, or IADLs, and/or were established risk factors for cognitive decline: race, sex, age, education, past year household income, depressive symptomatology, lifetime alcohol use disorder, ability to perform activities of daily living (ADLs) and cerebrovascular disease (CVD).

Depressive symptomatology was assessed at wave 3 by asking respondents to rate feelings of unhappiness, depression, worthlessness, and hopelessness over the past few weeks (Goldberg, Hillier 1979). Each of these questions was scored 0–3 (“not at all,” “no more than usual,” “more than usual,” or “much more than usual”) and summed for an overall dysphoria measure. Participants were considered to have CVD risk factors at wave 3 if they reported having ever been diagnosed with diabetes, “heart trouble,” stroke, or hypertension.

The presence of lifetime alcohol use disorder at wave 3 was assessed using *Diagnostic and Statistical Manual of Mental Disorders criteria* (American Psychiatric Association 1987). Physical disability was ascertained through self-reported difficulty with ADLs including eating, transferring from bed, toileting, dressing, bathing (Katz et al. 1963), carrying a bag of groceries, picking up a shoe from the floor, reaching, and grasping. Each item was scored 0–2, with lower scores indicating more disability, and the nine measures were summed (range 0–18). As with IADLs, these items were re-scaled from the original survey so that high scores would correspond with better functional status.

Statistical analyses

We compared at wave 1 all participants included in these analyses to those who were not (because of loss to follow-up or missing cognitive data at wave 3 or 4) on sociodemographic and health measures. We used t-tests for continuous variables and chi-square tests for categorical ones. To examine longitudinal associations between social networks and cognition, we used univariate and multiple linear regression. The dependent variable was an individual change score for MMSE, delayed recall or IADLs (wave 3 minus wave 4). We initially used dummy variables to represent quintiles of each social network measure. There were no significant departures from linearity, so social network variables were modeled continuously to maximize use of available data. Coefficients represent the magnitude of change in MMSE,

delayed recall and IADLs over 10.9 years, associated with a 1-point increase in social network measures. Positive coefficients reflect greater cognitive and functional decline. Analyses were performed using Stata 9.2 (Stata Corporation, College Station, TX).

RESULTS

Assessed and nonassessed cases

874 participants who provided data on MMSE and delayed recall at waves 3 and 4 comprised the study population. Compared with those who were lost to follow-up or had missing cognitive data, the assessed participants were younger at wave 1 and had more education, higher income, and higher MMSE scores ($p \leq 0.01$; Table 1).

At wave 3, the average age of participants included in this analysis was 47.3 years (Table 2). Only 3 participants had no contact with relatives or friends outside the home during the previous 6 months.

Cross-sectional analyses

Larger social networks were cross-sectionally associated with higher MMSE scores at wave 3 (Table 3), even after adjustment ($p = 0.019$). Emotional support and the composite social network measure were positively associated with MMSE before adjustment ($p \leq 0.025$). MMSE was not associated with frequency of social contact.

Larger social networks were cross-sectionally associated with better delayed recall before and after adjustment ($p = 0.014$). Additionally, emotional support, and the composite social network measure, were positively associated with delayed recall before adjustment ($p \leq 0.0001$). Delayed recall was not associated with frequency of contact.

Greater levels of emotional support were cross-sectionally associated with less IADL impairment before and after adjustment ($p = 0.044$). IADLs were not associated with any other social network measures at wave 3.

Longitudinal analyses

Our primary goal was to examine whether social networks were longitudinally associated with cognition. In general, we did not find significant associations between baseline social network factors and change in MMSE (Table 4), delayed recall (Table 5), or IADLs (Table 6). There were two counter-intuitive exceptions: after adjustment for sociodemographic variables, participants with *more* frequent contacts at baseline exhibited greater decline in delayed recall between waves 3 and 4 ($p = 0.042$). This association became marginally non-significant after inclusion of health factors ($p = 0.057$). Additionally, individuals with *more* emotional support at baseline exhibited greater decline in IADLs after adjustment ($p = 0.003$).

DISCUSSION

We investigated associations between social networks and cognition in a community-based cohort over 10.9 years. While a clear cross-sectional association existed at baseline, there was no evidence that social contact conferred protection against later cognitive decline. If anything, individuals with more frequent contacts and better emotional support at baseline had greater decline, after adjustment. Together, these data suggest that social network changes may be the consequence rather than the cause of cognitive decline, although this conclusion is premature based on these results alone.

One explanation for these findings is that quality of social engagement is more important than quantity. We did not examine the nature and complexity of interactions. Effortful mental activities such as crossword puzzles may prevent cognitive deterioration (Verghese et al. 2003), perhaps by increasing the number of neocortical synapses and improving neuronal networking (Orrell, Sahakian 1995), but findings concerning social networks are mixed. This may reflect that one can be surrounded by others but not engaged, particularly for individuals on the cusp of mental decline. For example, one study found that activities requiring creativity and initiative, such as gardening and traveling, reduced the risk of incident dementia within 3 years. Less cognitively demanding activities such as visiting friends and watching television were not protective (Fabrigoule et al. 1995).

The longitudinal results contradict earlier findings from the Baltimore ECA that suggested an association between larger network size and better cognition (Holtzman et al. 2004). This may be because the earlier analysis used data from the first 12 years, while we restricted our sample to respondents who remained in the study for two decades. This subgroup of survivors differed significantly from individuals lost to follow-up. The present analysis also included many younger participants, potentially masking any effect of social networks on cognition. A future study focusing on older persons, who are likely to experience greater cognitive change during the follow-up period than younger individuals, might reveal a longitudinal association between frequency of social contact, emotional support, and cognition.

Our findings concur with other negative studies (Glei et al. 2005, Seeman et al. 2001). Previous investigations reporting a positive association had short follow-up (Fratiglioni et al. 2000) or used cognitive instruments unable to detect mild deficits. Thus, respondents may have been misclassified as cognitively intact when their social withdrawal resulted from emerging mental decline (Bassuk, Glass & Berkman 1999). We attempted to clarify this issue by using delayed recall, a highly sensitive measure of cognitive dysfunction, and following participants for 10.9 years.

Another possible explanation for our results is the limited variability of social network characteristics in the study population, which reduced the likelihood of detecting an association. Lastly, social networks may primarily affect aspects of cognition that the MMSE and delayed recall task do not assess well, such as executive functioning.

This study has many strengths, including a large, population-based sample, many person-years of follow-up, and the use of two different cognitive assessments, including a sensitive delayed recall task. The major limitation was the use of “survivor” data.

Our results provide no evidence that social network characteristics prevent cognitive decline. Additional longitudinal studies can clarify whether specific aspects of social participation, such as interactive mentally stimulating activities, are beneficial. Conclusive evidence of an association would support the creation of social interventions for aging individuals.

Key points:

1. A longitudinal study shows that social networks do not protect against cognitive and functional decline with aging.
2. However, a clear cross-sectional association exists between social network size and cognitive function.
3. This suggests that changes in social network characteristics may be the consequence, rather than the cause, of cognitive and functional decline.

ACKNOWLEDGEMENT

We thank Ronald E. Holtzman, PhD and Linda Fried, MD, MPH for helpful discussions.

Supported by: The NIH Predoctoral Clinical Research Training Program (5 T32 RR023523), grant R01-MH47447 for the Baltimore ECA follow-up, and the Johns Hopkins Alzheimer's Disease Research Center (PO1-AGO5146).

REFERENCES

- American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. Vol. Rev. 3rd ed.. Washington DC: 1987.
- Bassuk SS, Glass TA, Berkman LF. Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine* 1999;vol. 131(no 3):165–173. [PubMed: 10428732]
- Cacioppo JT, Hawkley LC. Social isolation and health, with an emphasis on underlying mechanisms. *Perspectives in Biology and Medicine* 2003;vol. 46(no 3 Suppl):S39–S52. [PubMed: 14563073]
- Cornoni-Huntley J, Ostfeld AM, Taylor JO, Wallace RB, Blazer D, Berkman LF, Evans DA, Kohout FJ, Lemke JH, Scherr PA. Established populations for epidemiologic studies of the elderly: study design and methodology. *Aging (Milan, Italy)* 1993;vol. 5(no 1):27–37.
- Eaton WW, Anthony JC, Gallo J, Cai G, Tien A, Romanoski A, Lyketsos C, Chen LS. Natural history of Diagnostic Interview Schedule/DSM-IV major depression. The Baltimore Epidemiologic Catchment Area follow-up. *Archives of General Psychiatry* 1997;vol. 54(no 11):993–999. [PubMed: 9366655]
- Fabrigoule C, Letenneur L, Dartigues JF, Zarrouk M, Commenges D, Barberger-Gateau P. Social and leisure activities and risk of dementia: a prospective longitudinal study. *Journal of the American Geriatrics Society* 1995;vol. 43(no 5):485–490. [PubMed: 7730528]
- Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research* 1975;vol. 12(no 3):189–198. [PubMed: 1202204]
- Fratiglioni L, Wang HX, Ericsson K, Maytan M, Winblad B. Influence of social network on occurrence of dementia: a community-based longitudinal study. *Lancet* 2000;vol. 355(no 9212):1315–1319. [PubMed: 10776744]
- Glei DA, Landau DA, Goldman N, Chuang YL, Rodriguez G, Weinstein M. Participating in social activities helps preserve cognitive function: an analysis of a longitudinal, population-based study of the elderly. *International Journal of Epidemiology* 2005;vol. 34(no 4):864–871. [PubMed: 15764689]
- Goldberg DP, Hillier VF. A scaled version of the General Health Questionnaire. *Psychological Medicine* 1979;vol. 9(no 1):139–145. [PubMed: 424481]
- Holtzman RE, Rebok GW, Saczynski JS, Kouzis AC, Wilcox Doyle K, Eaton WW. Social network characteristics and cognition in middle-aged and older adults. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences* 2004;vol. 59(no 6):278–284.
- Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The index of ADL: A standardized measure of biological and psychosocial function. *JAMA: The Journal of the American Medical Association* 1963;vol. 185:914–919. [PubMed: 14044222]
- Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *The Gerontologist* 1969;vol. 9(no 3):179–186. [PubMed: 5349366]
- Orrell M, Sahakian B. Education and dementia. *BMJ (Clinical research ed.)* 1995;vol. 310(no 6985):951–952.
- Seeman TE, Lusignolo TM, Albert M, Berkman L. Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur studies of successful aging. *Health Psychology* 2001;vol. 20(no 4):243–255. [PubMed: 11515736]
- Vergheze J, Lipton RB, Katz MJ, Hall CB, Derby CA, Kuslansky G, Ambrose AF, Sliwinski M, Buschke H. Leisure activities and the risk of dementia in the elderly. *The New England Journal of Medicine* 2003;vol. 348(no 25):2508–2516. [PubMed: 12815136]

Table 1
Characteristics of assessed and nonassessed participants at wave 1

Covariates	Nonassessed sample ¹ (n=2,607) N (%)	Assessed sample ² (n=874) N (%)	p-value
Mean age (SD)	52.2 (20.1)	34.7 (12.0)	1×10 ⁻⁴
Gender			0.52
Female	1,609 (61.7)	550 (62.9)	
Male	998 (38.3)	324 (37.1)	
Race			0.11
Black	860 (33.0)	322 (36.8)	
White	1,667 (63.9)	526 (60.2)	
Other	80 (3.07)	26 (2.97)	
Marital Status			1×10 ⁻⁴
Married	1,093 (41.9)	381 (43.6)	
Widowed	527 (20.2)	43 (4.93)	
Separated/divorced	472 (18.1)	171 (19.6)	
Never married	515 (19.8)	278 (31.8)	
Education			1×10 ⁻⁴
0–8 years	879 (33.7)	74 (8.47)	
9–11 years	619 (23.8)	162 (18.5)	
12 years or GED	715 (27.4)	385 (44.1)	
13–15 years	246 (9.44)	155 (17.7)	
≥ 16 years	147 (5.64)	98 (11.2)	
Household income			1×10 ⁻⁴
≤ \$12,499	1,254 (48.1)	285 (34.9)	
\$12,500–\$24,499	622 (23.9)	328 (40.2)	
\$25,000–\$49,999	280 (10.7)	183 (22.4)	
≥\$50,000	20 (0.77)	21 (2.57)	
Missing	431 (16.53)	57 (6.52)	
Mean IADL, 0–14 (SD)	13.2 (2.35)	13.9 (0.65)	1×10 ⁻⁴
Mean ADL, 0–18 (SD)	17.4 (1.89)	17.9 (0.76)	1×10 ⁻⁴
Mean MMSE, 0–30 (SD)	27.4 (3.37)	28.9 (1.50)	1×10 ⁻⁴
Mean delayed recall, 0–20 (SD)	-- ³	--	--
Cerebrovascular disease/risk	1,170 (47.1)	227 (26.2)	1×10 ⁻⁴
Alcohol use disorder	-- ⁴	--	--
Mean dysphoria, 0–9 (SD)	1.29 (1.50)	1.14 (1.39)	0.01
Mean social network size, 0–10 (SD)	6.04 (2.39)	6.57 (2.24)	1×10 ⁻⁴
Mean frequency of contact, 0–10 (SD)	-- ⁵	--	--
Mean emotional support, 0–27(SD)	-- ⁶	--	--
Mean composite social network, 0–47 (SD)	-- ⁷	--	--

¹ Includes those lost to follow-up after wave 1 or missing MMSE or delayed recall scores at waves 3 or 4.

²Includes respondents with MMSE and delayed recall scores available at waves 3 and 4.

³Delayed recall was not assessed at wave 1.

⁴Not available.

^{5,6,7}Frequency of contact and emotional support were not assessed at wave 1. As a result, the composite measure of social network characteristics could not be calculated.

Table 2

Characteristics of assessed participants at wave 3

Covariates	N (%)
Mean age (SD)	47.3 (12.0)
Gender	
Female	550 (62.9)
Male	324 (37.1)
Race	
Black	322 (36.8)
White	526 (60.2)
Other	26 (2.97)
Marital Status	
Married	457 (52.3)
Widowed	94 (10.8)
Separated/divorced	186 (21.3)
Never married	137 (15.7)
Education	
0–8 years	72 (8.24)
9–11 years	139 (15.9)
12 years or GED	329 (37.6)
13–15 years	192 (22.0)
≥ 16 years	142 (16.3)
Household income	
≤ \$12,499	133 (15.2)
\$12,500–\$24,499	159 (18.2)
\$25,000–\$49,999	258 (29.5)
≥\$50,000	228 (26.1)
Missing	96 (11.0)
Mean IADL, 0–14 (SD)	13.8 (1.01)
Mean ADL, 0–18 (SD)	17.7 (1.12)
Mean MMSE, 0–30 (SD)	28.7 (1.82)
Mean delayed recall, 0–20 (SD)	6.17 (2.70)
Cerebrovascular disease/risk	348 (39.8)
Alcohol use disorder	58 (6.64)
Mean dysphoria, 0–9 (SD)	0.95 (1.32)
Mean social network size, 0–10 (SD)	6.18 (2.09)
Mean frequency of contact, 0–10 (SD)	7.34 (1.78)
Mean emotional support, 0–27(SD)	24.5 (3.17)
Mean composite social network, 0–47 (SD)	38.4 (4.97)

Table 3

Associations between social network characteristics and cognitive and functional status at wave 3

Outcome	β (95% CI)	Adjusted ³ p-value
MMSE ¹	0.066 (0.011, 0.121)	0.019
Delayed recall ¹	0.113 (0.023, 0.203)	0.014
IADLs ²	0.018 (0.000, 0.035)	0.044

¹ Coefficient reflects the effect of a 1-point increase in social network size on MMSE or delayed recall.

² Coefficient reflects the effect of a 1-point increase in emotional support on IADLs.

³ Adjusted for age at wave 3, sex, race, education, household income, CVD or risk, depressive symptoms, lifetime alcohol abuse or dependence, and ADL disability.

Table 4
Associations between wave 3 social network characteristics and change in MMSE (Δ MMSE)

Variable	Model 1 ^{1, 2}		Model 2 ³		Model 3 ⁴	
	β (95% CI)	p-	β (95% CI)	p-	β (95% CI)	p-
Network size	0.048 (−0.012, 0.108)	0.117	0.038 (−0.025, 0.102)	0.236	0.028 (−0.037, 0.093)	0.403
Frequency of contact	−0.008 (−0.080, 0.064)	0.826	0.017 (−0.057, 0.092)	0.647	0.002 (−0.073, 0.078)	0.950
Emotional support	0.018 (−0.022, 0.059)	0.372	0.014 (−0.028, 0.055)	0.523	−0.004 (−0.047, 0.040)	0.862
Composite social network	0.014 (−0.012, 0.040)	0.279	0.015 (−0.011, 0.042)	0.259	0.005 (−0.023, 0.033)	0.721

¹ Positive coefficients reflect greater decline in MMSE between waves 3 and 4.
² Unadjusted.
³ Adjusted for age, sex, race, education and household income.
⁴ Adjusted for above plus CVD or risk, depressive symptoms, lifetime alcohol abuse or dependence, and ADL disability.

Table 5
Associations between wave 3 social network characteristics and change in delayed recall (Δ delayed recall)

Variable	Model 1 ^{1,2}		Model 2 ³		Model 3 ⁴	
	β (95% CI)	p-	β (95% CI)	p-	β (95% CI)	p-
Network size	0.008 (− 0.084, 0.100)	0.867	0.027 (− 0.074, 0.129)	0.597	0.022 (− 0.083, 0.128)	0.678
Frequency of contact	0.094 (− 0.016, 0.204)	0.094	0.124 (0.004, 0.243)	0.042	0.119 (− 0.003, 0.241)	0.057
Emotional support	−0.001 (− 0.064, 0.062)	0.977	0.018 (− 0.050, 0.087)	0.602	0.010 (− 0.062, 0.082)	0.787
Composite social network	0.005 (− 0.036, 0.045)	0.817	0.018 (− 0.026, 0.062)	0.420	0.013 (− 0.034, 0.059)	0.595

¹ Positive coefficients reflect greater decline in delayed recall score between waves 3 and 4.
² Unadjusted.
³ Adjusted for age, sex, race, education and household income.
⁴ Adjusted for above plus CVD or risk, depressive symptoms, lifetime alcohol abuse or dependence, and ADL disability.

Table 6
Associations between wave 3 social network characteristics and change in IADL (Δ IADL)

Variable	Model 1 ^{1, 2}		Model 2 ³		Model 3 ⁴	
	β (95% CI)	p-	β (95% CI)	p-	β (95% CI)	p-
Network size	-0.034 (-0.095, 0.027)	0.277	-0.003 (-0.063, 0.058)	0.932	0.023 (-0.038, 0.084)	0.468
Frequency of contact	0.004 (-0.069, 0.077)	0.916	-0.022 (-0.093, 0.049)	0.540	0.016 (-0.087, 0.055)	0.659
Emotional support	0.036 (-0.005, 0.077)	0.088	0.045 (0.005, 0.086)	0.028	0.063 (0.022, 0.105)	0.003
Composite social network	0.006 (-0.020, 0.033)	0.635	0.011 (-0.015, 0.037)	0.421	0.021 (-0.005, 0.048)	0.118

¹ Positive coefficients reflect greater decline in IADL score between waves 3 and 4.

² Unadjusted.

³ Adjusted for age, sex, race, education and household income.

⁴ Adjusted for above plus CVD or risk, depressive symptoms, lifetime alcohol abuse or dependence, and ADL disability.