

Social Networks, Social Integration, and Social Engagement Determine Cognitive Decline in Community-Dwelling Spanish Older Adults

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Objectives. To examine the influence of social networks and social engagement on cognitive decline in a population-based cohort of elderly people, and to assess gender differences in the effect of social relations on cognition.

Methods. A longitudinal study of community-dwelling people over 65 was carried out. Cognitive function (orientation and memory) in 1997 and cognitive decline (absent, mild, and severe) over 4 years (1993–1997) were assessed using an instrument previously validated for populations with a low level of education. The effect of social networks, social integration, and social engagement with friends, children, and relatives on cognitive function and cognitive decline was estimated by multiple linear and logistic regressions after adjusting for age, sex, education, depressive symptoms, systolic and diastolic blood pressure, and functional status.

Results. Poor social connections, infrequent participation in social activities, and social disengagement predict the risk of cognitive decline in elderly individuals. The probability of cognitive decline was lower for both men and women with a high frequency of visual contact with relatives and community social integration. Engagement with friends seemed to be protective for cognitive decline in women but not in men.

Discussion. This longitudinal study indicates that few social ties, poor integration, and social disengagement are risk factors for cognitive decline among community-dwelling elderly persons. The nature of the ties that influence cognition may vary in men and women.

RESEARCH over the past decades has demonstrated that social relations, including social networks, social integration, and social engagement, impact significantly on the mental and physical health of elderly people (Berkman & Syme, 1979; Berkman, Glass, Brissette, & Seeman, 2000; Seeman, 2000). However, the study of the influence of social relations on human cognitive decline is recent. A few longitudinal studies of community-dwelling older people have indicated that the probability of cognitive decline and dementia is higher in individuals who are isolated, have poor social networks and support, and are not very physically active (Balfour, Masaki, & Launer, 2001; Bassuk, Glass, & Berkman, 1999; Covinski, Barnes, Lui, Nevitt, & Yaffe, 2001; Fabrigoule et al., 1995; Fratiglioni, Wang, Ericson, Maytan, & Winblad, 2000; Seeman, Albert, Lusignolo, & Berkman, 2001).

Berkman and colleagues (2000) have proposed a cascading causal process beginning with the macrosocial to psychobiological processes by which social relationships influence health. We have adopted this model to explore the relations between social integration and cognitive aging. Social networks are embedded in a larger social and cultural milieu in which upstream forces (political economy, social stratification, gender roles) condition network structure. Moving downstream we argue with Berkman and colleagues that social networks affect social and interpersonal behavior. Networks operate at the behavioral level through primary pathways, including social

engagement and the flow of social support. These microsocial and behavioral processes influence more proximal pathways to cognitive aging, such as depression, direct physiological responses to stress, and life habits that increase the probability of developing health conditions that lead to cognitive decline. This model allows for definition of concepts such as social integration, social networks, and social support. Social integration is defined as involvement with ties spanning the range from intimate to extended. Social networks are defined by their structure (number of ties, proximity of ties) and function (frequency of contact, reciprocity). Networks can be further classified into subnetworks according to the nature or role specificity of the tie (friends, relatives, children, couple). We argue that both the structural characteristics of the network and the nature of the ties may have important and separate effects on cognitive aging, as proposed by Glass and colleagues to explain the relationship between social integration and health status (Glass, Mendes de Leon, Seeman, & Berkman, 1997).

We also argue that social integration is beneficial for maintaining cognitive function, yet the nature of beneficial social relationships may vary in men and women. We followed the hypothesis formulated by Taylor and colleagues (2000) based on evidence of sex differences in the neurobiology of stress responses and in patterns of affiliation under stress. The fight or flight response may stem from an androgenic response to threat, activated in part by testosterone.

Animal studies suggest that, in females, the neuro-endocrine system favors an affiliative response to stress—rather than a fight or flight response. This literature indicates that whereas males may respond to stress by “fighting” or “fleeing,” females tend to respond in dyadic fashion (e.g., by bonding with other females or with their young). The “tend and befriend” pattern may be maintained not only by sex-linked endocrine responses to stress but also through social roles. Hence the nature of social networks and support associated with the maintenance of cognitive function may differ among men and women.

Anthropological and survey studies indicate that men and women do tend to behave differently under stress. Men tend to form larger groups than women, and male groups are often organized around defined purposes or tasks. Although men invest in a large number of social relationships, many of these relationships emphasize hierarchy over intimate bonding (Baumeister & Sommer, 1997).

In this article, data from a longitudinal study of community-dwelling people over age 65 have been analyzed to examine two hypotheses: (a) Older men and women with poor social networks, little social integration, and little social engagement are at high risk of cognitive decline, independent of established risk factors, namely, age, level of education, depression, blood pressure, and functional limitations and (b) the nature of the social relationships associated with the maintenance of cognitive function differ by sex in older adults. More specifically, emotional ties with peers would be stronger predictors of sustained cognitive function for women than for men; and formal roles in families and other social organizations would be stronger predictors of sustained cognitive function for men than for women.

METHODS

Participants

The study population was a stratified random sample ($n = 1,540$) of community-dwelling people over 65 living in Leganés, a suburban municipality located 8 km outside Madrid, Spain (Zunzunegui, Béland, & Gutierrez-Cuadra, 2001). The sample is representative of the elderly people in Leganés whose age, sex, marital status, and education resemble those of the Spanish elderly population as a whole. Data were collected in 1993, through two home interviews and a medical exam. Response rate was 83% ($n = 1,284$) in the first interview and 91% ($n = 1,165$) in the second interview, which included the medical exam. Because clinical diagnosis of dementia at baseline was not carried out, 99 subjects with severe cognitive deficit (5 or more errors in an 8-item version of the Short Portable Mental Status Questionnaire) were excluded from the analysis for this study. In addition, 102 subjects with visual impairments (unable to see 23-point characters) were also excluded because they were likely to experience difficulties in the visual memory test. Therefore, the sample used in this study includes 964 elderly people. In 1997, the subjects were re-interviewed and reexamined.

Measurements

Cognitive performance was measured during home interviews using a scale that included several items on orientation

and memory, excerpted from the Short Portable Mental Status Questionnaire (Pfeiffer, 1975), the Barcelona Test (Peña-Casanova et al., 1997), and the EPESE short story recall (Coroni-Huntley, Brock, Ostfeld, Taylor, & Wallace, 1986). This scale was developed to assess cognitive function in elderly populations with low levels of formal education, for which available tests have a strong education bias (Zunzunegui, Gutierrez-Cuadra, Béland, del Ser, & Wolfson, 2000). Two dependent variables were considered: a continuous, almost normally distributed score in 1997, and a categorical measurement defined over the distribution of cognitive change between 1993 and 1997 (cognitive score in 1997 – cognitive score in 1993). The change score distribution had a mean of -1 and a standard deviation of -7 , and the following arbitrary categorization of change was established: a change score within one standard deviation below the mean (-2 to -7) was considered as “mild decline,” a change score larger than one standard deviation below the mean was considered as “severe decline” (scores between -8 and -23), and finally, change scores on and over the mean (-1 to 12) were considered as “normal.” A severe decline was found in 11.0% of the cohort, a mild decline in 20.6%, and no decline or improvement in 68.4%.

The study entitled *Envejecer en Leganés* was designed to assess the role of social networks and support in maintaining health and function in a aging Spanish population. Three dimensions of social relations were examined in the survey: social networks, social integration, and social engagement. The number of monthly visual contacts and telephone contacts with friends and relatives (other than children) was ascertained via several questions from the MacArthur Healthy Aging Questionnaire (Seeman, Berkman, Blazer, & Rowe, 1994), and three variables were obtained. Only half of the sample (48%) reported having one or more friends (1 to 60) and a dichotomous variable was considered: has or does not have friends. Monthly visual and telephone contacts with relatives ranged from 0 to 35 (means of 6.21 and 5.60, respectively) and both variables were divided into three categories for descriptive analysis: no contacts, one to three, and more than three, but were truncated to 15 monthly contacts (95th percentile of the distribution) and introduced as continuous in the multivariate analyses. We did not evaluate social networks involving children in the same way that we assessed networks involving friends and other extended family, because more than half of our subjects live with their children, most of them live within walking distance of their children and see them at least weekly, and 93% of the sample population have children. Therefore, frequent contact with children is almost universal and governed by social norms. Instead, we only considered active social engagement (parental role providing help to children, playing an important role and being useful) with children, because this involvement may require more mobilization of cognitive function.

Three dichotomous markers of social integration were recorded at baseline: (a) membership in a community association, (b) at least monthly attendance of religious services, and (c) visits to the community center for elderly people (social center with recreational activities). A composite social integration index was constructed with the addition of the three indicators (score range = 0 to 3).

Social engagement with children, relatives, and friends was assessed via four choice questions (three for type of social tie: children, relatives, and friends) taken from the MacArthur Healthy Aging Study (Seeman et al., 1994). Their wording is as follows: How often do you feel you help your children (family/friends)? How often do you feel useful to your children (family/friends)? How often do you feel that you play an important role in your children's (family's/friends') lives? Factor analysis indicated the existence of a single factor referring to the self-perceived usefulness to others. The Cronbach's alpha reliability coefficient was 0.64 for children, 0.68 for family, and 0.71 for friends. Items were recorded as -2 (never), -1 (sometimes), 1 (frequently), and 2 (always). Individuals stating that they had no family or friends were assigned the value of 0 on the corresponding variable. Items were added to produce one score for children, one for family, and one for friends. For descriptive analyses the social engagement score was categorized as low (-6 to -1), medium (0), and high (1 to 6). For multivariate analyses the score was introduced as a continuous variable.

The following potential confounders of the association between social relations and cognitive decline were included in the analyses: age, education, depressive symptoms, systolic and diastolic blood pressure, and functional limitations. Age and education have previously been found to be associated with cognitive decline in our population (Alvarado, Zunzunegui, del Ser, & Béland, in press), and several studies have shown that social relations decrease with age and are more rare for people with lower level of education (Glass et al., 1997; Turner & Marino, 1994). Because the level of formal education in this population is low, subjects were classified according to being illiterate (12%), with no formal schooling but able to read and write (33%), with incomplete primary school (35%), and having completed primary school (4 years of schooling for this age cohort). Systolic and diastolic blood pressure were determined by the average of two measurements following the procedures of the Hypertension Detection and Follow-up Study. Depressive symptomatology was measured using the Spanish version of the Center for Epidemiology Studies Depression Scale (Moscicki, Locke, & Rae, 1989). Four questions regarding the performance of actions requiring mobility and effort were asked to assess functional limitations of the upper and lower extremities (Coroni-Huntley et al., 1986; Nagi, 1976). Subjects received a score ranging from one to three according to their ability to perform all four actions without difficulty, experiencing some difficulty but able to perform the four actions, and unable to perform at least one action.

Statistical Analysis

A comparison between the baseline population and those who continued in the study after 4 years was carried out to assess possible selection bias. Bivariate analyses were performed to examine differences in the distributions among those who completed the follow-up and those who were lost to follow-up due to change of residence, refusal, or death. Differences between women and men in each variable were also recorded.

Analysis was carried out in four phases: 1. Eleven multiple linear regressions of the continuous cognitive score in 1997 on social networks, social integration, and social engagement were

carried out, one regression for each independent variable. Linear regressions were performed, controlling for age (as continuous variable), baseline 1993 cognitive function, and level of education.

2. A sequential hierarchical multiple regression was fitted according to the conceptual framework (Berkman et al., 2000). In a first step, age, education, cognitive function in 1993, and sex were entered as antecedent or exogenous variables. Variables concerning networks were entered; then we added the integration index and engagement with relatives, friends, and children. Correlations between the 11 indicators of social relations were moderate and varied between -0.27 and 0.45. Lastly, depression, systolic and diastolic blood pressure, and functional limitations were entered as potentially confounding variables because they are risk factors for cognitive decline and they may influence the likelihood of social interactions. Finally, gender differences were tested through inclusion of interaction terms suggested by the results of the 11 regressions of the previous analysis. All models were adjusted by 1993 baseline cognitive function, age, sex, and level of education.

3. The risk of severe decline in cognitive function was estimated by comparing those who had experienced severe decline with those who had not. Again, 11 binary logistic regressions were fitted controlling for age and level of education, separated for men and women.

4. An ordinal logistic regression was performed with the three-category measures of decline ("no decline," "mild," and "severe decline") as dependent variables to identify clinically relevant predictors of change. The strategy of inclusion of variables in the model was the same explained above: first age, sex, and education; second, the network and the integration index; and third, engagement with relatives, children, and friends. Depression, systolic and diastolic blood pressure, and functional limitations were included in the final model as potential confounders.

RESULTS

Followed and Lost Cases

Nine hundred sixty-four subjects (83% of the total sample) provided complete data on cognitive function and had good visual function in 1993, and they constitute the base population for this study. After 4 years, 15.7% had died ($n = 152$), 2.1% had been institutionalised ($n = 20$), 17.4% refused to participate ($n = 159$), 7.8% were lost due to change of residence ($n = 76$), and 57.7% ($n = 557$) were retested. Compared with the 1993 study population, those who completed the follow-up were similar in marital status, social networks, social integration, and social engagement characteristics (Table 1). However, poor social networks, social integration, and social engagement were significantly associated with mortality. The probability of death was higher for men with less visual contacts with relatives (odds ratio [OR] = 1.05, 90% confidence interval [CI] = 1.01 to 1.10) and for women who participated infrequently in social activities (OR = 1.49, 90%CI = 1.17 to 1.92), had infrequent social engagement with friends (OR = 1.15, 90%CI = 1.02 to 1.28), and infrequent engagement with relatives (OR = 1.11, 90%CI = 1.03 to 1.19).

Table 1. Gender-Specific Characteristics—Social Networks, Social Integration, and Social Engagement—of the Analytic Sample in 1993: Aging in Leganés, Spain, 1993–1997

Characteristic	Analytic Sample						Baseline % (N = 964)
	Women (n = 264)		Men (n = 293)		Women and Men Combined (n = 557)		
	No.	%	No.	%	No.	%	
Social Networks							
Has friends (yes)	127	39.2	138	59.2	265	47.6	49.6
Telephone contacts with friends (yes)	86	26.5	57	24.6	143	25.7	23.2
Number of relatives seen at least monthly							
0	24	7.4	12	5.2	36	6.5	6.2
1–3	88	27.1	57	24.6	145	26	27.2
≥3	213	65.5	163	70.3	376	67.5	66.6
Number of relatives contacted by telephone at least monthly*							
0	38	11.8	52	22.3	90	16.2	21.5
1–3	88	27.3	45	19.3	133	24.0	7.2
≥3	196	60.9	136	58.4	332	59.8	71.3
Social Integration							
Group membership (yes)*	94	29.5	127	55.5	221	40.3	44.6
Attends religious services (yes)*	202	62.2	75	32.2	277	49.6	47.1
Attends old age center activities (yes)*	73	22.5	128	54.9	201	36.1	38.3
Social index*							
0	69	30.2	66	23.7	135	27.5	30.2
1	105	37.8	77	26.7	182	33.2	34.9
2	57	20.0	99	33.6	156	25.7	23.2
3	33	12.0	51	15.9	84	13.6	11.7
Social Engagement							
Social engagement with children							
Low	27	12.1	35	11.3	62	11.7	14.9
Medium	31	11.4	27	8.7	58	10.3	27.5
High	199	76.5	227	80.0	426	78.0	57.6
Social engagement with friends*							
Low	42	13.2	44	19.7	86	15.9	51.5
Medium	192	60.6	89	39.9	281	52.0	17.6
High	83	26.2	90	40.4	173	32.0	31.3
Social engagement with relatives							
Low	104	33.5	59	26.7	163	30.7	5.2
Medium	11	3.5	10	4.5	21	4.0	32.3
High	195	62.9	152	68.8	347	65.3	62.5

Note: Percentages given are from weighted data.

*Women and men differ significantly over level of covariate, $p < .05$.

Sociodemographic Characteristics

Living alone was not frequent (9.8%). Contacts with relatives were more frequent than contacts with friends. Although 68% of the subjects had contacted three or more relatives in the last month, only 48% reported having friends.

Only 8.6% of this sample had not been engaged in any of the four social activities included in the index of social integration. High engagement with relatives and children was more frequent than high engagement with friends (Table 1). Several significant differences were found between men and women. Men were more likely to be married whereas women were more likely to live alone or with family. Women reported less extensive networks than men, that is, fewer social contacts with friends and extended family and fewer social activities over the past month. Only attendance of religious services occurred more frequently among women than men. Engagement with children and relatives occurred as frequently for men as for women, but women tended to be less engaged with friends. There were more women reporting cardiovascular morbidity (51.0%), high depressive symptomatology (40.5%), and functional limitations (22.7%), than men (36.0%, $p < .001$; 12.0%, $p < .001$; 8.0%, $p < .001$, respectively). There were no significant gender differences with respect to frequency of cognitive decline: 10.5% of women had severe and 24.6% mild decline, whereas 12.9% of men showed severe and 18.5% mild decline.

Table 2 shows the results of the total and gender-specific multiple linear regressions of 1997 cognitive function on each variable of social relations, controlling for age, baseline cognition value in 1993, and education. Visual contacts with relatives, participating as a member of a group, attending religious services, attending old age center, and the social integration index were positively related to cognitive score in 1997 both in men and in women. Having friends and social engagement with friends was associated with cognitive function in women but not in men; this was formally tested in the model including all subjects ($p = .09$; bottom two lines of Table 2).

The final multiple regression analyses results are shown in Table 3. The frequency of visual contacts with relatives and the social integration index are positively associated with cognitive function both for men and women, whereas engagement with friends is significantly associated with good cognitive function in women and the interaction between engagement with friends and sex is significant at $p = .06$. In addition, among men depressive symptoms are significantly associated with poorer cognitive function ($p = .03$).

Table 4 shows the results of the logistic regressions of severe cognitive decline for men and women separately. First, a higher social integration index and a high frequency of visual family contacts were associated with a low probability of severe cognitive decline 4 years later for both genders. Equations for both sexes separately seem to indicate that friends are stronger negative predictors for women and social engagement with children in men is also a negative predictor of cognitive decline. Table 5 shows the results of fitting an ordinal logistic regression equation. Here, the dependent variable was cognitive decline with three levels: no decline, mild decline, and severe decline. The number of relatives seen at least monthly and the social integration index are significant predictors of cognitive decline for both sexes. Among women, engagement with friends predicts lower probability of cognitive decline. Neither engagement with relatives or children was related to decline in this final model. Depression is associated with decline in men but not in women.

Table 2. Gender-Specific Multiple Linear Regressions Coefficients for Cognitive Function in 1997: Aging in Leganés, Spain

Variable	Total		Women		Men	
	Coeff.	SD	Coeff.	SD	Coeff.	SD
Social Networks						
Has friends (yes vs. no)	0.52	0.54	1.96	0.70	-0.23	0.88
Number of relatives seen at least monthly	0.16	0.06	0.18	0.09	0.22	0.10
Number of relatives contacted by telephone at least monthly	0.08	0.06	0.15	0.08	0.006	0.09
Social Integration						
Group membership (yes vs. no)	1.54	0.54	1.70	0.80	2.20	0.78
Attends religious services (yes vs. no)	1.80	0.53	2.00	0.77	1.50	0.82
Attends old age center activities (yes vs. no)	1.17	0.54	1.60	0.85	1.68	0.76
Social integration index (for every activity increase)	1.00	0.26	1.18	0.35	0.99	0.41
Social Engagement						
Social engagement with children	0.11	0.09	0.05	0.13	0.20	0.13
Social engagement with relatives	0.08	0.08	0.12	0.10	0.05	0.11
Social engagement with friends (main effects)	0.18	0.13	0.53	0.16	0.16	0.13
Sex	0.52	0.58				
Sex \times Social Engagement With Friends interaction term	0.36	0.21				

Note: Values are adjusted by age as continuous variable, cognitive function in 1993, and level of education. Coeff. = Coefficient.

DISCUSSION

This study confirmed the results of other longitudinal studies (Bassuk et al., 1999; Fratiglioni et al., 2000), indicating that elderly individuals with poor social connections and social disengagement are at increased risk of cognitive decline and/or dementia. Three main results have been obtained in our study. First, several areas of social relations—social networks, social integration, and social engagement—are associated with cognitive decline controlling for age, baseline cognitive function, education, cardiovascular morbidity, depression, and functional limitations. Second, formal participation in social activities (church, social center for elderly people, group membership, park) has protective effects against cognitive decline. Third, the influence of social relations on cognitive function is to some extent different for every gender. Engagement with friends was protective in women but not in men.

Our findings are in agreement with one previous report (Bassuk et al., 1999). That study used a composite index of social networks and social integration, based on six indicators: presence of spouse, visual and nonvisual contacts with friends and relatives, attendance at places of worship, membership in other groups, and regular participation in social activities. The follow-up period was 12 years (4 measurements). At 3 years, those who had no social ties were at increased risk of cognitive decline after adjusting for age, education, and morbidity conditions. Contrary to our results, this study did not find

Table 3. Final Multiple Regression Model of Cognitive Function in 1997 on Risk Factors in 1993

Variable	Women		Men		Total	
	Coeff.	SD	Coeff.	SD	Coeff.	SD
Constant	23.0	6.44	40.30	8.12	30.15	5.01
Social integration index	1.00	0.35	0.78	0.42	0.87	0.27
Number of relatives seen at least monthly	0.15	0.09	0.19	0.10	0.16	0.06
Sex (Women vs. men)					-0.14	0.95
Social engagement with friends	0.52	0.15	0.09	0.15	0.10	0.14
Interaction term social engagement with friends and sex					0.42	0.21
Depressive symptoms	-0.04	0.03	-0.20	0.08	-0.04	0.03
Interaction depressive symptoms and sex					-0.17	0.08
Systolic blood pressure	-0.03	0.02	-0.02	0.03	-0.03	0.02
Diastolic blood pressure	0.04	0.04	-0.02	0.04	0.03	0.03
Functional limitations	0.37	0.56	0.17	0.73	0.29	0.44
Age	-0.30	0.05	-0.43	0.07	-0.35	0.04
Level of education	0.50	0.39	0.21	0.47	0.40	0.30
Baseline 1993 cognitive function	0.78	0.11	0.63	0.14	0.71	0.09
Multiple R^2	0.37		0.37		0.43	

Note: Coeff. = Coefficient.

a distinct effect for each dimension of social networks or in the social integration measurements. Moreover, the effect of social networks on cognitive decline was not evaluated separately for men and women; therefore, we are not able to compare our gender-specific results with them.

Other observations in noninstitutionalized elderly cohorts have demonstrated associations between social networks, social integration, and incidence of dementia. Using a community-based cohort, Fratiglioni and colleagues (2000) showed that those living alone or without any close social ties were 1.5 times more likely to develop dementia after 3 years of follow-up. In the Honolulu Asia Aging Study, Balfour and colleagues (2001) reported that a higher rate of social engagement and participation in productive activities (helping others, paid work, volunteer work) might reduce the risk of dementia among older adults. In contrast, the PAQUID Study (Fabrigoule et al., 1995) showed that active participation in leisure activities (gardening, travelling, and knitting) predicted lower risk of dementia, whereas group memberships and participation in social activities were not related to the incidence of dementia after 3 years of follow-up, when baseline cognitive performance was controlled. The authors argued that leisure activities demand more attention and control than social ties and social participation and have more powerful effect on delaying dementia. However, the structural and role-specific models of social networks were not clearly defined in their study. A recent study of the MacArthur Successful Aging population older than 70 (Seeman et al., 2001) reported better cognitive function in 7 years of follow-up in those having a high frequency of emotional support. Neither the number of social ties (children, friend, and relatives) nor group participation predicted cognitive decline in this population. Gender interactions with social relations variables were not significant, therefore, analysis was presented for both sexes together.

Table 4. Logistic Regression: Gender-Specific Odds Ratio (OR)
Predicting Severe Cognitive Decline 1993–1997:
Aging in Leganés, Spain

Variable	Women		Men	
	OR	95% CI	OR	95% CI
Social Networks				
Has friends (yes vs. no)	0.44	(0.15, 1.29)	1.29	(0.60, 2.79)
Number of relatives seen at least monthly	0.94	(0.83, 1.08)	0.91	(0.83, 1.08)
Number of relatives contacted by telephone at least monthly	0.93	(0.91, 1.06)	0.98	(0.91, 1.06)
Social Integration				
Group membership (no vs. yes)	1.66	(0.52, 5.30)	2.92	(1.35, 6.36)
Attends old age social center (no vs. yes)	2.09	(0.57, 7.66)	1.42	(0.68, 2.97)
Attends religious services (no vs. yes)	2.48	(0.97, 6.31)	2.44	(0.98, 6.06)
Social integration index (for each additional activity)	0.73	(0.47, 1.13)	0.68	(0.45, 1.04)
Social Engagement				
Social engagement with children	1.12	(0.95, 1.33)	0.88	(0.78, 1.00)
Social engagement with friends	0.77	(0.59, 1.00)	0.93	(0.81, 1.07)
Social engagement with relatives	0.98	(0.85, 1.12)	0.93	(0.84, 1.03)

Notes: Values are adjusted by age as continuous variable and level of education. OR = odds ratio; CI = confidence interval.

We have chosen to analyze the effect of social relations on cognitive function separately by gender for two reasons: the gender-specific social context of elderly people and the evidence regarding a differential effect of social relations on health for women and men. First, there has been a marked separation of social roles by gender in Spanish society (as in virtually every society), with specific values and cultural norms about social behavior and networks. Women's social role in Spain in this older age cohort has been rather restricted to domestic life, whereas men's role is centered on kinship. Some studies have demonstrated gender-specific associations between social relations and health for men and women (Berkman & Syme, 1979; Fuhrer, Standsfeld, Chemali, & Shipley, 1999; Glass et al., 1997; Moritz, Kasl, & Berkman, 1995; Unger, McAvay, Bruce, Berkman, & Seeman, 1999). Our results indicate that social networks, social integration, and social engagement operate in similar ways in both sexes, although the nature of the relations that matter vary by gender. For women, friends appear to play a more significant role. Our data suggest that social relations outside of the family circle are not frequent among women living with their spouse or with others; however, women living alone have more frequent social participation, contacts, and active engagement with friends and relatives. Conversely, among men, social contacts, integration, and engagement are not associated with living arrangements (data not shown). It may be that social engagement outside of the home environment is stimulating for women, whereas an active role as head of the household within one's own family and as

Table 5. Multinomial Ordinal Logistic Regression to Predict
Mild and Cognitive Decline: Leganés, Spain, 1993–1997

Variable	Coeff.	SE	p	95% CI
Threshold				
Severe decline	−8.263	1.490	<.001	(−11.183, −5.343)
Mild decline	−6.619	1.467	<.001	(−9.494, −3.743)
Social integration Activities	0.207	0.101	.040	(0.042, 0.436)
Number of relatives seen at least monthly	0.056	0.025	.028	(0.009, 0.405)
Engagement with friends	0.163	0.066	.013	(0.035, 0.292)
Interaction engagement with friends by gender	−0.202	0.086	.019	(−0.370, −0.033)
Depressive symptoms	−0.010	0.012	.409	(−0.034, 0.014)
Interaction depressive symptoms by gender	−0.055	0.028	.051	(−0.111, 0.0002)
Age	−0.103	0.014	<.001	(−0.132, −0.075)
Gender (women vs. men)	0.368	0.360	.307	(−0.338, 1.074)
Education	0.131	0.108	.228	(−0.082, 0.343)
Systolic blood pressure	−0.005	0.006	.390	(−0.017, 0.006)
Diastolic blood pressure	0.014	0.011	.197	(−0.008, 0.037)
Functional limitations	0.198	0.164	.229	(−0.125, 0.520)

Notes: Coeff. = Coefficient; CI = confidence interval.

member of the community is stimulating for men. Because our results on these gender-specific effects are not conclusive, further longitudinal research should explore these hypotheses.

There are several possible explanations of our findings about the impact of social networks on cognitive decline in elderly people. All of them are compatible with the data that we, and other previous authors, have obtained, and only more refined future research may determine the mechanisms underlying social impact on cognition. Cognitive reserve hypothesis, often used to explain the influence of variables such as education and occupation, on the risk of cognitive decline and dementia (Coffey, Saxton, Ratcliff, Bryan, & Lucke, 1999; Katzman, 1993; Reynolds, Johnston, Dodge, Dekosky, & Ganguli, 1999; Schofield, Mosesson, Stern, & Mayeux, 1995) may also account for our study's findings. Good social relations with friends and relatives, throughout the life course and especially in the late life, might produce continued mental stimulation and better cognitive strategies or increase neural growth and synaptic density—the “use-it-or-lose-it” hypothesis—delaying cognitive impairment or protecting against pathological processes. An alternative formulation of cognitive reserve hypothesis should be also considered. People who have a better neural structure, more resistant to late damage and cognitive decline, may be also more able to acquire and maintain social abilities and contacts, and the association between social networks and cognition in the old age could be not causal but a surrogate.

Alternatively, social networks could act on cognitive function through psychosocial pathways: the individual with more frequent contacts and integration has more opportunities for engagement with others (Berkman et al., 2000). Our study suggests that the effect of social networks on cognitive function may be partially explained by the social engagement index. Women with friends showed a better cognitive function in 1997, and the association increased when social engagement with friends replaced the dichotomous variable “has/does not have friends” in the equation. Social engagement may protect

against cognitive decline through effects on positive emotional and cognitive states such as self-esteem, social competence, and adequate mood (Berger, Fratiglioni, Forsell, Winblad, & Backman, 1999; Devanand et al., 1996). Moreover, social engagement produces an independent effect. Women with a positive perception of their helpfulness and usefulness, and who felt they played an important role with friends, showed less cognitive decline. Among men social engagement with children showed a protective effect but this association lost significance in the final multivariate equation. In fact, social engagement could also provide opportunities for mobilization of cognitive functions and operate as an antidote to minor stress (Berkman et al., 2000; Stansfeld, 1999). Physiological mechanisms related to stress theory could also partially explain our results. Stress may favor neurodegenerative processes, especially in the hippocampus, which plays a crucial role in the memory process (McEwen, 1998; O'Brien, Ames, & Schweitzer, 1993). Furthermore, the hippocampus regulates the stress response and acts to inhibit the response of the HPA axis to stress. Frequent social contacts and high rates of social integration and social engagement could dampen or moderate the effect of stress on the activation of the hypothalamic-pituitary adrenal axis of the central nervous system; therefore, social relations may reduce brain damage and the effects of aging (Berkman et al., 2000).

Some authors have stated that associations of social networks and social integration with cognitive function could be artifactual. Firstly, low rates of participation in social activities and lower frequency of visual contacts could be a prodromal feature of or a reaction to incipient dementia, rather than a risk factor for cognitive decline. Secondly, measures of social contacts and participation, which require a minimum level of functional and cognitive capacity, could be confounded by functional limitations. Thirdly, measures that rely on self-reports of perceived engagement could be confounded by mental decline (Glass et al., 1997). However, we excluded cases with very low cognitive scores at baseline. Furthermore, we found that participants with low cognitive scores at baseline tended to either die or move out of the study area (Alvarado et al., in press). Only 15 people completed the follow-up, scoring less than 18 points on the cognitive test at baseline, and our results did not change when we repeated the analysis excluding those subjects. We showed that the association of social contacts and the index of integration with cognitive decline remained after adjustment for functional limitations. Depressive symptoms were associated with severe decline only among men but they did not confound the association between social relationships and cognitive function because the coefficients of the social variables remained unchanged.

This study has both methodological strengths and limitations. Its strengths include the following. The study was based on a prospective design with social variables measured at baseline and cognitive change and decline measured after 4 years of follow-up. Social relations measurements were based on a theoretical model that proved to be valid for elderly individuals (Berkman et al., 2000), capturing three dimensions of network structure (frequency of contacts, integration, and engagement) and the role-specificity of each of them. Previous research indicates that these three dimensions, as well as the type of social relation, have a differential impact on health

outcomes (Seeman, Kaplan, Knudsen, Cohen, & Guralnik, 1987; Seeman & Berkman, 1988; Stansfeld, 1999), and this study shows similar effects on cognitive function in elderly individuals. Cognitive function was assessed using an instrument, validated for a population with low levels of education, that has proven construct validity (Zunzunegui et al., 2000). Finally we used two dependent variables: a cross-sectional cognitive score as a continuous variable and a categorical description of cognitive decline over 4 years. Our analysis, using both multiple linear and logistic regressions, has produced consistent results.

We will now discuss some limitations. Firstly, the attrition of our baseline sample due to mortality and change of residence was rather high, that is, 24%. However, there were no significant differences between those who refused to continue in the study and those who completed the exams, whereas those who died or moved out of the area during the follow-up period had lower cognitive performance at baseline, according to expectations. In addition, mortality was higher among those with infrequent social contacts and a low rate of social engagement, especially in women—variables that were related to cognitive decline in our study. As attrition was higher in those with the worst baseline performance, reported associations of cognitive decline with social relations may be underestimated in this study. Secondly, the small sample size of our study limits the ability to explore interactions in the multivariate models and obtain more precise estimates of the magnitude of the effects. Thirdly, with our 4-year follow-up, we cannot determine whether the observed effect of social relations on cognitive function is the result of a lifelong cumulative exposure or the result of an abrupt change from a previous extensive network to a more limited one. Previous studies examining the effect of social networks on mortality have reported that the availability of a good social network is a better predictor of survival than the changes in such a network. Other authors agree with the fact that social networks are stable in old age (Antonucci & Akiyama, 1987).

In conclusion, we have provided evidence that social integration, frequent contact with family and friends, and playing an important role with significant others have beneficial effects in maintaining cognitive function in later life.

ACKNOWLEDGMENTS

This research was supported by the Fondo de investigaciones sanitarias of Spain (Contract No. 97/0467), a grant of the Community of Madrid (8.7/2/1997), and the Fundación La Caixa.

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Received February 18, 2002

Accepted September 19, 2002

Decision Editor: Charles F. Longino, Jr., PhD