Published by Oxford University Press on behalf of the International Epidemiological Association
International Journal of Epidemiology 2005;**34**:864–871

Advance Access publication 11 March 2005
doi:10.1093/ije/dyi049

Participating in social activities helps preserve cognitive function: an analysis of a longitudinal, population-based study of the elderly

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Accepted 31 January 2005

Background This study examines how changes in cognition over time are related to participation in social activities and the extent of social networks.

Methods Data are drawn from a population-based, longitudinal study that began in 1989 among elderly Taiwanese. An over-dispersed Poisson model is used to regress the number of failed cognitive tasks (0–5) in 1996, 1999, and 2000 on prior measures of cognitive impairment, social activities, social networks, health status, and sociodemographic characteristics. The analysis sample comprises 2387 individuals, who contribute a total of 4603 observations across three survey intervals (1993–96, 1996–99, 1999–2000).

Results After adjusting for prior cognitive impairment, baseline health status, and sociodemographic factors, respondents who participated in one or two social activities failed 13% fewer cognitive tasks ($P < 0.01$) than those with no social activities; those who engaged in three or more activities failed 33% fewer cognitive tasks ($P < 0.001$). In contrast, none of the social network measures was related to cognitive impairment.

Conclusions Despite a social structure where elderly persons often live with their children and social interaction is likely to be more family-centered than in western countries, data from Taiwan suggest that participation in social activities outside the family may have a bigger impact on cognitive function than social contacts with family or non-relatives.

Keywords Cognitive impairment, cognitive function, social networks, social activity, social contact, Taiwan

Better social networks and greater participation in social activities are generally associated with lower risks of cognitive decline.[1–4] Previous research suggests that social networks may help preserve cognitive function by guarding against depression and the adverse effects of stress. Social activities may also protect cognitive function by providing stimulation.

Several studies have found cognitive impairment to be related to depressive symptoms, restricted activities of daily living (ADLs), and limitations on instrumental activities of daily living (IADLs).[5–8] Such health conditions may restrict or otherwise limit participation in social activities. Indeed, studies have reported that those in poor psychological and physical health have fewer social connections than their healthier counterparts.[1,9]

However, an observed cross-sectional association between social interaction and cognitive function does not demonstrate a causal link: if cognitive impairment leads to a reduction in social interaction, then correlation may be a result of reverse causality. Even with controls for health status, a cross-sectional study cannot establish the direction of causality. We focus here on longitudinal studies that have the potential to identify an independent effect of social interaction on cognitive decline.

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One such prospective study of 469 elderly non-demented subjects found that participation in cognitively stimulating leisure activities (e.g. playing board games) protected against the development of dementia.[4] Other studies have shown that social disengagement at baseline and unsatisfying contact with children were associated with greater risks of subsequent dementia or cognitive decline.[1–3] In addition to social networks and activities, marriage may be protective of cognitive function. Fratiglioni *et al*. found single persons at greater risk for dementia compared with their married counterparts.[2]

The present study uses longitudinal data from an elderly population in Taiwan to determine the effects of social networks and activities on changes in cognitive function. Most studies on this topic have been based on western populations. Taiwan provides an interesting context for exploring this question because the social structure differs from that of western countries: elderly people are more likely to reside with their children and social interaction is more family-centered.[10] Our analysis improves upon most previous research in several important ways: by using a national rather than a community sample, by including more than one wave of follow-up,[2–4] and by examining both social activities and social relationships in a multivariate model. Because these two aspects of the social environment are interrelated, the ability to control for their individual and joint effects allows one to gain insight into their relative contributions to the maintenance of cognitive function.

Methods

Data come from surveys conducted as part of the Study of Health and Living Status of the Elderly in Taiwan.[11] The first wave was conducted in 1989 with follow-up interviews in 1993, 1996, 1999, and 2000. The respondents were drawn from a random sample of Taiwanese—including the institutionalized population—who were aged ⩾60 in 1989 ($n = 4049$, 92% response rate). By the 1993 wave, 15% ($n = 590$) of the original cohort had died; 3155 respondents completed the interview (91% of survivors); and 8% ($n = 304$) were lost-to-follow-up (LFU). Interviews were completed with 2669 persons in 1996 and with 2310 persons in 1999, comprising 89% and 90%, respectively, of survivors from the original 1989 cohort (see Figure 1 for details). In 2000, a subsample of those interviewed in 1999 was selected randomly for the Social Environment and Biomarkers of Aging Study; 728 elderly respondents were interviewed (93% response rate).

Those lost to mortality were older, on average, and had higher mean cognitive impairment at the previous wave compared with those completing the interview (Table 1). Differences between those LFU and those completing the interview at a given wave were not significant with one exception: mean cognitive impairment in 1993 was lower for LFU in 1996 than for those completing the interview.

Since 1989, questionnaires have included and updated a broad spectrum of information including demographic characteristics, marital history, social networks and activities, and socioeconomic status. Although the specific wording of some questions changed over time, this analysis used indicators that were consistently worded or changed only modestly across waves. The variables used in the models are described below.

Cognitive impairment was measured based on five questions from the Short Portable Mental Status Questionnaire.[12] Respondents were asked to (i) state their current address, (ii) give their age in years, (iii) identify the date (month, day, and year), (iv) identify the weekday, and (v) subtract the number three from twenty a total of four consecutive times. We counted the number of incorrect answers to these five items (one point was assigned if any of the four subtractions was incorrect), resulting in a 5-point scale, where 0 represents no errors. The use of these questions as cognitive tests has been validated for Chinese equivalents of the MMSE[13–15] and for measures of cognitive function used in the Study of Asset and Health Dynamics Among the Oldest Old.[5,16,17]

Sex, age (adjusted for follow-up survey dates), and education were determined from answers to the 1989 questionnaire. The occupational status index reflects the prestige of the primary lifetime occupation of male respondents or female respondents' husbands (six women who never married were coded as missing and excluded from the analysis). This measure was developed for Taiwan based on earlier similar measures for the US and has a theoretical range of 55–76.[18] Respondents' dissatisfaction with their current economic situation was measured on a scale from one (very satisfied) to five (very unsatisfied).

Health measures comprised three indicators of functional status and a depressive symptoms score. Functional status was measured by separate counts of respondents' difficulties performing ADLs, IADLs, and basic mobility tasks. ADLs comprised bathing, dressing/undressing, eating, getting out of bed/standing up/sitting in a chair, moving about the house, and going to the toilet. IADLs comprised buying personal use items, managing money/paying bills, riding the bus or train alone, doing physical work around the house or environs, performing light tasks around the house, and making a phone call. Mobility tasks comprised standing continuously for 15 min, climbing stairs, walking 200–300 m, lifting or carrying 11–12 kg, squatting, reaching over one's head, grasping with one's fingers, and running or jogging 20–30 m. Depressive symptoms were measured using a 10-item version of the original 20-item Center for Epidemiologic Studies Depression Scale (CES-D),[19] whose measurement properties are well-established.[20] The 10-item scale generated a score ranging between 0 and 30. The shortened form of the CES-D has been shown to perform well in cross-cultural studies of elderly depression[21] including Chinese populations,[5,22,23] and to yield similar internal consistency, factor structure, and accuracy in detecting depressive symptoms as the full 20-item CES-D.[23–27]

The respondent's social network was realized as four variables describing social ties and frequency of contact with those ties. Marital status was entered as a dichotomous variable: married or not married (widowed, divorced, separated). The other three indicators were: (i) a count of the number of close relatives (children, sons-in-law, daughters-in-law, parents, parents-in-law, siblings, and grandchildren) who live with or who have at least weekly contact with the respondent; (ii) the number of other relatives (cousins, aunts, uncles) who have at least weekly contact with the respondent; and (iii) the number of friends and neighbours with whom the respondent maintains at least weekly contact.

Participation in social activities was included as a categorical variable: no activities, one or two activities, or three or more. Information was based on respondents' participation in the following nine activities: (i) playing games (chess, cards, or mahjong); (ii) socializing with friends/neighbours/relatives;

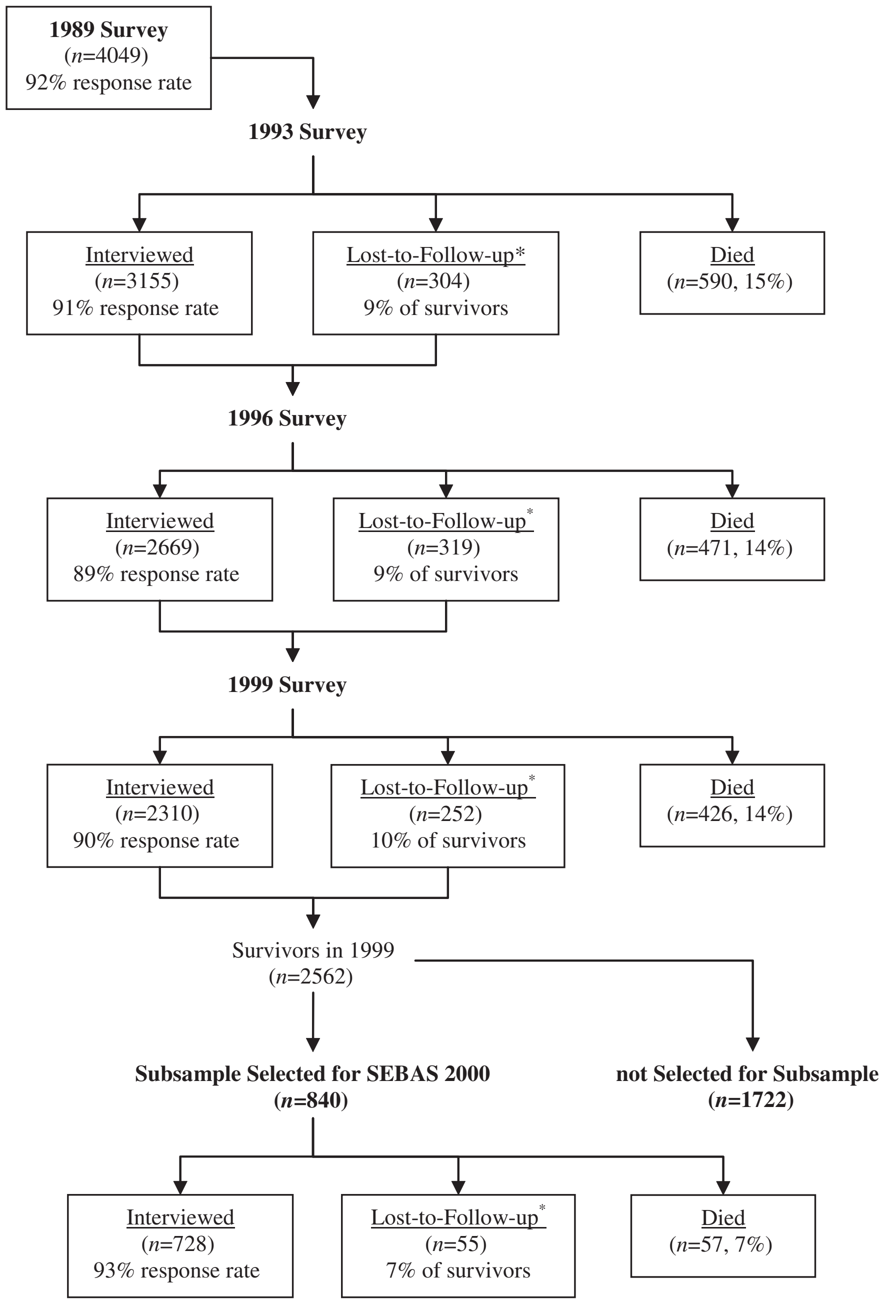

Figure 1 Attrition across survey waves, 1989–2000

*At each survey wave, efforts were made to contact and interview all respondents from the original 1989 cohort ($n = 4049$), even if they were lost-to-follow-up (LFU) in a previous wave. Thus, a person may be LFU in one survey wave, but interviewed in subsequent waves.

(iii) joining organized group activities; (iv) doing volunteer work; and participating in (v) religious groups; (vi) business associations; (vii) political groups; (viii) clan associations; and (ix) elderly organizations.

In order to exploit the longitudinal data, we modelled cognitive impairment at each wave (1996, 1999, and 2000) as a function of each respondent's level of cognitive impairment and characteristics at the previous survey date. Because the outcome represents a count of events, we estimated a Poisson model for the number of failed cognitive tasks. In addition to the lagged dependent variable, the model included measures (estimated at the prior survey date) of social activities and social networks, and controlled for demographic and socioeconomic characteristics, health factors, and survey year. Diagnostic analyses indicated that the data are over-dispersed, with the variance proportional to the mean. In such cases, the Poisson estimates remain consistent, but the standard errors tend to be under-estimated. We fitted the model using the 'glm' procedure in Stata version 7, with the distributional family Poisson.[28] In order to correct the standard errors, we set the scale parameter to the

Table 1 Attrition, response rates, and missing data for each survey wave

Survey year	(1) Deceased	(2) Lost-to-follow-up	(3) Interviewed	(4) Not interviewed in prior survey wave	(5) Missing cognitive score in current survey wave[c]	(6) Missing cognitive score in prior survey wave[c]	(7) Missing other covariates	(3) − (4 + 5 + 6 + 7) Remaining in the analysis
1996 (n)	471	319	2669	144	232	22	70	2201
Mean age in 1996	78.0[a]	73.7	73.8	73.6	78.3[b]	76.0	74.8[b]	73.2
Mean cognitive impairment in 1996	–	–	0.6 (n = 2419)[d]	0.6 (n = 126)[d]	–	0.9	0.8	0.6
Mean cognitive impairment in 1993	1.1[a] (n = 337)[d]	0.4[a] (n = 185)[d]	0.6 (n = 2441)[d]	–	1.3[b] (n = 170)[d]	–	1.0[b]	0.6
1999 (n)	426	252	2310	153	210	60	93	1794
Mean age in 1999	79.6[a]	76.4	76.3	76.2	80.3[b]	79.1[b]	77.1[b]	75.6
Mean cognitive impairment in 1999	–	–	0.7 (n = 2072)[d]	0.6 (n = 125)[d]	–	1.4[b]	1.0[b]	0.6
Mean cognitive impairment in 1996	1.0[a] (n = 296)[d]	0.5 (n = 113)[d]	0.6 (n = 2010)[d]	–	1.2[b] (n = 123)[d]	–	0.9[b]	0.5
2000 (n)	57	55	728	0	64	29	27	608
Mean age in 2000	79.3[a]	76.9	76.6	–	80.5[b]	78.4[b]	77.0	76.1
Mean cognitive impairment in 2000	–	–	0.7 (n = 664)[d]	–	–	1.8[b]	0.7	0.6
Mean cognitive impairment in 1999	1.1[a] (n = 36)[d]	1.0 (n = 39)[d]	0.6 (n = 670)[d]	–	1.6[b] (n = 35)[d]	–	0.7	0.5

[a] Mean differs significantly ($P < 0.05$) compared with those who completed the interview (column 3), based on *t*-test for columns 1 and 2 (vs column 3).
[b] Mean differs significantly ($P < 0.05$) compared with those remaining in the analysis (column 8), based on *t*-test for columns 4, 5, 6, and 7 (vs column 8).
[c] The vast majority of those missing data on cognition were not administered those items because the interview was completed by a proxy respondent. For example, among those missing cognition in 1996, 99% (229 of 232) were not asked these questions because a proxy completed the interview.
[d] Based on those respondents with a valid cognitive score for the year specified.

Pearson χ^2 statistic divided by the residual degrees of freedom as recommended by McCullagh and Nelder.[29]

By lagging the dependent variable as well as the measures of social environment, we controlled for unobserved heterogeneity between individuals and reduced the potential for reverse causality. For example, unobserved factors could cause both poor cognition and reduced social activity. By controlling for prior cognitive function, we accounted for any unobserved factors that may explain a correlation between social activity and cognitive function at baseline. In essence, the model tested the effects of social networks and activity (measured at the previous survey wave) on the change in cognitive function between survey waves.

Results

A total of 4603 observations comes from 2387 individuals who each contributed up to three observations to the analysis sample: 2201 for the 1993–96 interval, 1794 for 1996–99, and 608 for 1999–2000 (Table 1). Among observations excluded because the cognitive score was missing (Table 1, columns 5 and 6), the vast majority (96%, 593 of 617) were not administered those items because the interview was completed by a proxy respondent. Observations excluded because of missing data for other covariates (column 7) were older, on average, and had higher mean cognitive impairment at the 1993–99 waves compared with those included in the analysis.

Table 2 Descriptive statistics for covariates included in model

Variable	Mean or percentage	SD	Minimum	Maximum
Fixed covariates (individual respondents, *n* = 2387)				
Female	43.5%			
Highest level of education achieved by respondent				
Illiterate	37.3%			
Literate (but no formal schooling)	8.3%			
Primary school	33.8%			
Secondary school	20.6%			
Socioeconomic index	61.7	4.87	55.1	76.1
Time-varying covariates (observations, *n* = 4603)				
Age (in years)	71.8	5.2	64	94
Dissatisfaction with economic situation	2.6	0.9	1	5
Health factors				
Number of ADL difficulties				
None	96.5%			
One	1.1%			
Two or more	2.4%			
Number of IADL difficulties				
None	60.1%			
One	21.8%			
Two or more	18.1%			
Number of mobility limitations				
None	49.3%			
One	14.5%			
Two	11.1%			
Three or more	25.1%			
CES-D score	6.2	5.9	0	30
Participation in social activities				
Participation in 0 social activities	20.5%			
Participation in 1 or 2 social activities	60.3%			
Participation in ⩾3 social activities	19.2%			
Social network				
Currently married	64.1%			
Number of close relatives (children, sons-in-law/daughters-in-law, siblings, parents, parents-in-law, grandchildren) with at least weekly contact	9.6	6.5	0	46
Number of close friends/neighbours with at least weekly contact	4.9	6.3	0	70
Number of other relatives with at least weekly contact	2.4	4.7	0	61

Table 2 presents descriptive statistics for the variables used in the model. The distributions show an unusual predominance of men attributable to the influx of Mainlander Chinese soldiers following the Second World War. The vast majority of the population was either illiterate or had completed only a primary school education; only one-fifth had any schooling beyond the primary level. Fewer than 4% reported having any ADL limitations, but 40% reported at least one IADL limitation and more than half reported a mobility limitation. A significant minority (about one-fifth) reported no social activity, but most reported engaging in one or two activities. On average, respondents had regular contact with 10 close relatives, two other relatives, and five close friends and neighbours.

Results from the over-dispersed Poisson model indicate that those who engaged in social activities had lower risk of subsequent cognitive impairment, even after adjusting for prior cognitive impairment, health status, and sociodemographic factors (Table 3). Relative to those who reported no activities, respondents who participated in one or two social activities failed 13% fewer cognitive tasks ($e^{-0.14} = 0.87$, $P < 0.01$), while those who engaged in three or more activities failed 33% fewer cognitive tasks ($P < 0.001$). In contrast, none of the measures of social network was significantly related to cognitive decline.

As we would expect, those with prior cognitive impairment, IADL limitations, or mobility limitations had a higher rate of cognitive impairment at follow-up. Older age and being female were also significantly associated with greater cognitive impairment ($P < 0.001$), whereas higher education and socioeconomic index score were significantly associated with a lower rate of impairment ($P < 0.001$).

Table 3 Poisson model predicting the number of failed cognitive tasks in 1996, 1999, and 2000

	Coefficients (SEs)
Social activities	
Reference (Participation in no social activity)	–
Participation in 1 or 2 social activities	−0.14** (0.05)
Participation in 3 or more social activities	−0.40*** (0.08)
Social network	
Currently married	0.03 (0.05)
Number of close relatives with at least weekly contact	−0.001 (0.003)
Number of close friends/neighbours with at least weekly contact	0.01 (0.004)
Number of other relatives with at least weekly contact	−0.01 (0.01)
Control variables	
Number of failed cognitive tasks at prior survey	0.25*** (0.02)
Number of ADL difficulties	0.01 (0.02)
Number of IADL difficulties	0.05* (0.02)
Number of mobility limitations	0.05** (0.01)
CES-D score	0.002 (0.004)
Reference (1993 survey)	–
1996 survey	−0.002 (0.05)
1999 survey	−0.07 (0.07)
Age at prior survey	0.03*** (0.004)
Female	0.20*** (0.05)
Education	
Reference (Illiterate)	–
Literate but no formal schooling	−0.23** (0.08)
Primary school	−0.54*** (0.06)
Secondary school	−0.89*** (0.10)
Socioeconomic index	−0.03*** (0.01)
Dissatisfaction with economic situation	0.01 (0.03)
Constant	−1.15* (0.51)
Over-dispersion parameter	1.30
Number of observations	4603

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Discussion

We used multi-wave, longitudinal national data from an elderly Taiwanese cohort to examine the relationship over time between cognitive function and social networks and engagement. Previous studies have generally used community-based samples[2,3,30,31] and have typically been cross-sectional or limited to a single follow-up interview.[2,3,32,33] In contrast to most other research, which has been based on western cohorts, this analysis provides new insights into the extent to which previous findings can be generalized to a non-western population.

The results show that, even after adjusting for an extensive set of control variables, participation in social activities is significantly associated with reduced risk of cognitive impairment. The graded relationship between cognition and participation in social activities shows that the higher the level of participation, the greater the benefit. Yet, we find no evidence of a relationship between the participants' social networks and cognition. These findings suggest that the extent of participation in social activities may be a more important predictor of cognitive performance than various aspects of respondents' social networks.

Notably, one of the social network measures—ties with close relatives—included relatives with whom the respondent lives. If individuals with poor health and impaired cognitive function were more likely to live with relatives, this relationship could mask any potential benefits of such ties. In our sample, 70% lived with at least one close relative, and these respondents tended to have more IADL and mobility limitations than those who did not live with relatives. Our model included controls for physical and mental health status, which should account for this association. Nonetheless, we estimated an additional model (not shown) that included separate measures for close relatives with whom the respondent lived and for other close relatives with whom the respondent had regular contact. The results remain unchanged: neither variable was significantly related to cognitive impairment.

Our results complement two recent studies of elderly populations: a study in 2000[2] reporting that Swedish individuals with a poor or limited social network were at an increased risk of developing dementia over time (average 3 year follow-up), and a study in 2003[3] observing that poor social connections and infrequent participation in social activities predicted the risk of cognitive decline in elderly Spanish subjects. The former study[2] did not include data on participation in social activities, and thus could not distinguish between the risk of dementia in patients who had poor social networks from those with limited social participation. The latter[3] found that although both factors were important predictors of cognitive decline, participation in social activities was more protective against cognitive decline than maintaining contact with friends and relatives. Their results, like ours, suggest that activities are more important than the extent of social networks in maintaining cognitive function.

This analysis was designed to mitigate the problem of reverse causation. Using longitudinal data, we examined cognitive impairment (controlling for prior impairment) as a function of the social environment at the prior survey. We also adjusted for various indicators of physical and mental health status to reduce the likelihood that the observed relationship between social activity and cognition was spurious (i.e. simply due to poor health leading to both reduced social activity as well as cognitive decline). While this analytical strategy posed a stringent test, it cannot definitively establish causality. The generally accepted gold standard for establishing a causal effect is a randomized-controlled study. However, an experimental design is difficult or impossible to implement when the relevant treatment is a component of the social environment.

Another potential constraint of this study is that our measures of social networks are limited. Three of the four social network measures involve relatives (whereas only one variable measures social ties with non-relatives), but none of these takes into account the quality of the relationship.

Although this analysis covered a 7 year period, it was based on a series of combined shorter periods. The problem with measuring cognitive decline over longer periods of time is that there is greater risk of attrition due to mortality, especially for a sample of elderly persons. We did examine cognitive decline over a 6 year period (data not shown), and we found that those with lower cognitive function and fewer social activities in 1993 were more likely to die by 1999. Among survivors (74% of the sample), those who participated in one or two social activities had lower risk of cognitive decline than those with no social activity (3+ activities was not statistically significant). Thus, over a longer follow-up, the association between social activity and cognition was less apparent, but was attributable, at least in part, to the fact that those with the least social activity and the most cognitive impairment were more likely to die and thus could not be tested at follow-up.

Despite its limitations, this analysis builds upon and extends previous studies of cognitive function in elderly persons, offering convincing evidence of the benefits of social participation: engagement in social activities appears to be more important than the extent of one's social network in maintaining cognitive function. As in other East Asian countries, it remains quite common for elderly Taiwanese to live with their children. Although the social environment in Taiwan is much more family-centered than in western countries, we find no evidence that familial ties affect cognitive function.

Consistent with some previous studies, these results suggest that voluntary social interactions may have a greater impact on cognitive function than family or intimate ties. These findings may arise in part because social ties can impose demands or involve negative interaction. The results may also be specific to settings like Taiwan, where social support structures are generally strong and may not be measured adequately by the frequency of contact with specific types of individuals. These findings, if confirmed by other studies of both western and non-western populations, may help guide the development of programmes to keep elderly adults better engaged in activities to guard against cognitive decline.

Acknowledgements

This research was supported by the Behavioral and Social Research Program of the National Institute of Aging under grant numbers R01AG16790 and R01AG16661 and by the National Institute of Child Health and Development under grant number P30HD32030. We thank Christopher Seplaki for his assistance.

KEY MESSAGES

- Results from multi-wave, longitudinal data for a national sample of elderly Taiwanese show that participation in social activities is significantly associated with reduced risk of cognitive impairment, even after adjusting for prior measures of cognitive function, health status, and sociodemographic characteristics.
- Despite a social structure where elderly persons often live with their children and social interaction is likely to be more family-centered than in western countries, we find no evidence of a relationship between social contacts with family or non-relatives and cognition.
- Consistent with some previous studies, these results suggest that voluntary social interactions may have a greater impact on cognitive function than family or intimate ties.

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