American Journal of Epidemiology

Vol. 186, No. 7
DOI: 10.1093/aje/kwx142
Advance Access publication:
May 18, 2017

Original Contribution

Association of Social Support and Cognitive Aging Modified by Sex and Relationship Type: A Prospective Investigation in the English Longitudinal Study of Ageing

Jing Liao* and Shaun Scholes

* Correspondence to Dr. Jing Liao, School of Public Health, Sun Yat-sen University, No. 74 Zhongshan Second Road, Guangzhou 510080, People's Republic of China (e-mail: liaojing5@mail.sysu.edu.cn).

Initially submitted May 17, 2016; accepted for publication November 9, 2016.

We examined whether between-persons differences and within-person changes in levels of social support were associated with age-related cognitive decline and whether these associations varied by sex and by relationship type. Executive function and memory scores over 8 years (2002–2010) were analyzed by mixture models among 10,241 adults aged ≥50 years in the English Longitudinal Study of Ageing. Between-persons differences and within-person changes in positive social support and negative social support were independently associated with cognitive decline in different ways according to sex and relationship type. Among men, higher-than-average positive social support from a spouse/partner was associated with slower cognitive decline (for executive function, $\beta_{\text{person-mean}\times\text{time-in-study}} = 0.005$, 95% CI: 0.001, 0.010; for memory, $\beta_{\text{person-mean}\times\text{time-in-study}} = 0.006$, 95% CI: 0.000, 0.012); whereas high negative social support from all relationship types was associated with accelerated decline in executive function (for all relationships combined, $\beta_{\text{person-mean}\times\text{time-in-study}} = -0.005$, 95% CI: −0.008, −0.002). For women, higher-than-average positive social support from children ($\beta = 0.037$, 95% CI: 0.010, 0.064) and friends ($\beta = 0.115$, 95% CI: 0.081, 0.150)—but not from a spouse/partner ($\beta = -0.034$, 95% CI: −0.059, −0.009) or extended family ($\beta = -0.035$, 95% CI: −0.064, −0.006)—was associated with higher executive function. Associations between social support and age-related cognitive decline vary across different relationship types for men and women.

cognitive aging; longitudinal study; sex-specificity; social network; social support

Abbreviations: CI, confidence interval; ELSA, English Longitudinal Study of Ageing; PM, person-mean; WP, within-person.

Evidence suggests cognitive benefits of social relationships (1). Cognitive benefits, however, may be contingent upon the perceived quality of relationships—negative social support (but not positive social support) from significant others has been shown to be associated with accelerated rates of cognitive decline (2).

It is well known that men and women maintain social relationships differently, having different requirements and expectations of social support (3). Women have more extensive social networks than men, and women both benefit from and are burdened by providing and receiving social support from multiple sources (4, 5). Men maintain close relationships with fewer people, primarily their spouses or partners (4), and they receive most social support from intimate ties (6). Given that social relationships are formed by social partners with different degrees of closeness, the amount and type of social support transmitted may rely on the defined social ties (6, 7). Social support may be interpreted and handled in a manner specific to the source. Evidence also suggests that associations between social support and health vary by the source of support (8, 9).

Few epidemiologic studies have investigated associations between social support and cognitive function separately by sex and by relationship type. In previous studies, investigators have found that more social engagement, particularly with friends, was associated with better cognitive function (10) and lower cognitive decline (11, 12) for women only, while other studies did not report sex-specific associations (13, 14). To

our knowledge, potential variation in associations between social support and cognitive function across different relationship types have not been explored systematically. Furthermore, despite evidence that social support changes in later adulthood (15, 16), most studies have measured social support only at a single time point, hindering understanding of how changes in levels of social support influence age-related cognitive decline (17).

There is a lack of evidence addressing the ways social support and cognitive function are associated longitudinally and whether these associations differ by sex and by relationship type. To fill this gap, we explored the between-persons and within-person associations of social support and cognitive function in a representative sample of English adults aged 50 years or older over an 8-year period. Our objectives were to examine 1) whether between-persons differences and within-person changes in levels of positive social support and negative social support were associated with age-related change in cognitive function, and 2) whether these associations were modified by sex and by relationship type.

METHODS

English Longitudinal Study of Ageing

The English Longitudinal Study of Ageing (ELSA) is an ongoing study of community-based adults aged ≥50 years (18); 11,391 sample members (born before February 29, 1952) participated in wave 1 (2002–2003). Comparisons of the sociodemographic characteristics of wave 1 participants with the national census indicated that the sample was broadly representative of the noninstitutionalized English population (18). Participants are contacted every 2 years, and data collection consists of a face-to-face interview and self-completion questionnaire. Technical details of ELSA are reported elsewhere (19). The individual response rate at baseline was 67%, and 82% of wave 1 respondents participated in wave 2, 73% in wave 3, 74% in wave 4, and 78% in wave 5 (18). Our study was based on participants with at least 1 cognitive assessment from the first 5 waves. We excluded wave 1 participants with doctor-diagnosed Alzheimer or Parkinson disease, dementia, or serious memory impairment ($n = 126$), as well as participants with missing data on cognitive function ($n = 397$) or other covariates ($n = 627$), leaving an analytical sample of $n = 10{,}241$ (executive function) and $n = 10{,}336$ (memory). ELSA participants provided signed consent, and ethical approval was granted by the London Multicentre Research Ethics Committee.

Measurement of cognitive function

Each wave included an interviewer-administered cognitive battery, which assessed several processes essential to daily functioning that are considered sensitive to decline with aging. The present study examined composite scores of executive function and memory, as did previous ELSA analyses (20, 21). (Web Appendix 1, Web Table 1 and Web Figure 1, available at https://academic.oup.com/aje).

Executive function. The executive function index comprised verbal fluency and letter-cancellation tasks. For verbal fluency, participants were asked to name as many members of a specific category (animals) as they could in 60 seconds. For letter cancellation, participants were handed a page of randomly generated letters of the alphabet arranged in rows and columns, and were asked to cross out as many of the target letters (P and W) as possible within 60 seconds. These tasks formed 3 scales: verbal fluency (the number of animals named (range, 0–8)), letter cancellation (for speed processing: the number of letters reached (range, 0–7)), and visual search accuracy (the number of target letters missed (reverse recoded and categorized: range, 0–5)). These were summed into a composite score (range, 0–20).

Memory. The memory index comprised 3 tasks: time orientation, verbal learning (word-list learning), and prospective memory. These tasks formed 4 scales: time orientation (reporting the correct day, week, month, and year (range, 0–4)), verbal learning (2 scales: immediate and delayed recall for a list of 10 everyday words (both with a range of 0–10)), and prospective memory (remembering to carry out a task—write initials on a clipboard at a certain point during the battery after being instructed to do so earlier—range, 0–3)). These were summed into a composite score (range, 0–27).

Measurement of social support

Questions on social support covered 4 relationship types: spouse/partner, children, friends, and extended family members. Three questions addressed positive social support: 1) how much they understand the way you feel about things; 2) how much they can be relied on if you have a serious problem; and 3) how much you can open up to them to talk about worries. Responses ranged from "not at all" (scored 0) to "a lot" (3). Scores were summed for each relationship (range, 0–9) and summed into an overall score (range, 0–36). Three questions addressed negative social support: 1) how much they criticize you; 2) how much they let you down when you are counting on them; and 3) how much they get on your nerves. Responses were scored as described for positive social support. Participants without the relevant social ties were scored zero.

Covariates

Sex, age, socioeconomic status (highest educational attainment and wealth quintiles), and health factors assessed at wave 1 were treated as covariates. The number of mobility limitations (range, 0–6) was derived from reported difficulties with 6 basic activities of daily living tasks (22). The number of depressive symptoms (range, 0–8) was assessed using the 8-item Center for Epidemiologic Studies Depression Scale (CESD-8) (23).

Statistical analyses

To differentiate within-person and between-persons associations for social support, 2 variables were derived from a single time-varying variable (17). Between-persons associations were assessed using each participant's average score across waves, centered at the grand mean (hereafter referred to as the

person-mean (PM) variable). Within-person associations were assessed by subtracting each participant's wave-specific score from his or her average level (hereafter referred to as the within-person (WP) variable). Mixture models were used to estimate change in cognitive function scores as a function of time since baseline. The models contained level-1 (WP) and level-2 (PM) coefficients. WP coefficients describe variation in cognitive function scores as a function of change in each participant's usual level of social support; PM coefficients describe variation in cognitive function scores as a function of the difference between participants in their average level.

Our modelling strategy was chosen a priori to answer our principal research questions. First, to examine whether between-persons differences and within-person changes in levels of social support were associated with cognitive function, we fitted models containing PM and WP, their interaction with time (time-squared was nonsignificant), and their cross-level interaction. Interaction with time allowed the rate of change in cognitive function scores to covary with PM and WP levels. Cross-level interaction terms allowed the magnitude of WP associations to vary across PM levels. Second, to examine whether sex and relationship type modified the social support and cognitive function associations, we added the relevant interaction terms with sex, and we fitted relationship-specific models. Each model contained a random intercept and random slope and included adjustments for socioeconomic status, depression, and mobility limitations, plus their interaction with time. Wave 1 weights were used to ensure that the sample was representative of the community-dwelling English population aged ≥50 years at baseline. We assessed the impact of attrition bias on the robustness of our findings by repeating analyses on the subset of participants (n = 5,079) who took part in all 5 waves, using a weighting variable that has adjusted for attrition since wave 1. We also tested the extent to which retest effects would affect our results via further adjustment for the number of cognitive tests. Data was analyzed using Stata, version 13.1 (StataCorp LP, College Station, Texas). Statistical significance tests were based on 2-sided probability ($P <$ 0.05).

RESULTS

Sociodemographic characteristics and summary statistics for cognitive function and social support are shown according to study wave in Table 1. On average, there were small increases over time in cognitive function scores and in both positive social support and negative social support. Mean age at wave 1 was 64.6 years. Fewer than half of participants were male (46.7%), and over one-third had no formal educational qualifications (41.2%). The mean number of depressive symptoms and mobility limitations decreased slightly.

Social support and cognitive function

For the social support measures combined across all relationship types, Table 2 shows the multivariable-adjusted PM and WP coefficients, their interaction with time in study, and their cross-level interaction for executive function and memory. Participants with higher PM positive social support showed higher initial executive function (β = 0.017, 95% confidence interval (CI): 0.009, 0.026) and slower decline in memory (β = 0.004, 95% CI: 0.002, 0.006). WP positive social support was nonsignificantly associated with baseline memory scores, but a positive association became significant over time (β = 0.004, 95% CI: 0.001, 0.007), suggesting a more positive slope for participants with higher-than-usual level of positive social support. In contrast, higher WP negative social support was associated with higher memory scores (β = 0.018, 95% CI: 0.003, 0.033). This association was weaker for participants with higher PM negative social support, indicated by the cross-level interaction term (β = −0.002, 95% CI: −0.004, 0.000). Higher PM negative social support was associated with lower baseline memory scores (β = −0.029, 95% CI: −0.046, −0.012) but not with rate of change.

Cognitive function by sex and by relationship type

Sex-specific associations are presented in Web Table 2. Faster declines in executive function were observed for men

Table 1. Cognitive Function, Levels of Positive and Negative Social Support, and Demographic Characteristics for Participants Aged 50 Years or Older, According to Study Wave (n = 10,241), English Longitudinal Study of Ageing, 2002–2010

Characteristic	Wave 1 (n = 9,764)		Wave 2 (n = 7,437)		Wave 3 (n = 6,111)		Wave 4 (n = 5,010)		Wave 5 (n = 5,071)	
	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%	Mean (SD)	%
Executive function	9.9 (3.3)		10.1 (3.3)		10.2 (3.3)		10.4 (3.3)		10.4 (3.3)	
Memory	15.0 (4.2)		15.8 (4.2)		16.0 (4.3)		16.1 (4.2)		16.2 (4.2)	
Positive support	22.2 (7.0)		22.5 (6.7)		22.6 (6.7)		22.7 (6.5)		22.8 (6.6)	
Negative support	6.4 (4.3)		6.5 (4.1)		6.5 (4.0)		6.6 (4.0)		6.7 (4.0)	
Age, years	64.6 (10.2)		66.1 (9.7)		67.5 (9.3)		68.6 (8.8)		70.0 (8.3)	
Male sex		46.7		46.2		46.2		45.9		45.8
Low level of education		41.2		37.6		35.7		33.8		32.4
Lowest quintile of wealth		18.5		16.8		15.9		15.6		15.5
Depressive symptoms (CESD-8)	1.5 (1.9)		1.4 (1.9)		1.4 (1.8)		1.3 (1.8)		1.3 (1.8)	
Difficulty with activities of daily living	0.4 (0.9)		0.3 (0.9)		0.3 (0.8)		0.3 (0.8)		0.3 (0.7)	

Abbreviations: CESD-8, 8-item Center for Epidemiologic Studies Depression Scale; SD, standard deviation.

Table 2. Results From Linear Mixed Models of the Between-Persons and Within-Person Associations for Levels of Positive and Negative Social Support[a] and Cognitive Aging Trajectories (Executive Function and Memory), English Longitudinal Study of Ageing, 2002–2010

Time-Varying Support	Positive Support			Negative Support		
	β	95% CI	*P* Value	β	95% CI	*P* Value
Executive Function (n = 10,241)						
Between-persons						
PM	0.017	0.009, 0.026	<0.001	−0.006	−0.020, 0.009	0.436
PM × time slope	0.000	−0.001, 0.002	0.577	−0.002	−0.004, 0.000	0.089
Within-person						
WP	0.007	−0.004, 0.018	0.186	0.018	0.003, 0.033	0.022
WP × time slope	0.000	−0.002, 0.003	0.698	−0.003	−0.006, 0.000	0.068
Interaction						
PM × WP	0.000	−0.001, 0.001	0.581	−0.002	−0.004, 0.000	0.045
Memory (n = 10,336)						
Between-persons						
PM	0.007	−0.004, 0.017	0.209	−0.029	−0.046, −0.012	0.001
PM × time slope	0.004	0.002, 0.006	<0.001	0.000	−0.003, 0.003	0.928
Within-person						
WP	−0.004	−0.020, 0.011	0.568	0.012	−0.009, 0.034	0.260
WP × time slope	0.004	0.001, 0.007	0.020	−0.001	−0.006, 0.003	0.626
Interaction						
PM × WP	0.000	−0.001, 0.002	0.728	0.000	−0.004, 0.003	0.751

Abbreviations: CI, confidence interval; PM, person-mean; WP, within-person.

[a] Per 1-unit increase. Adjustments for time, time-squared, age, age-squared, sex, highest educational attainment, total wealth quintile, number of depressive symptoms, and number of mobility limitations (plus interactions with time in study).

with higher PM negative social support (β = −0.005, 95% CI: −0.008, −0.002) but not for women (β = 0.001, 95% CI: −0.002, 0.004; for interaction with sex, $P < 0.01$). Moderation by sex was also observed in the associations between higher WP negative social support and baseline executive function (P for interaction < 0.01) and rate of change (P for interaction < 0.05), showing a decline in scores for women (β = −0.006, 95% CI: −0.011, −0.002) but not for men (β = 0.001, 95% CI: −0.004, 0.006). Results for memory were similar for both sexes (for interaction with sex, $P > 0.05$).

The estimated associations between social support and cognitive function stratified by relationship type are shown in Table 3 (executive function) and Table 4 (memory). Web Appendix 2 presents the relationship-specific mean trajectories distinguished on the basis of profiles that differ by 1 unit according to differences between persons in average levels (PM = 0 and 1) and within-person change in their usual level (WP = 0 and 1) of social support, with all other covariates held constant.

Executive function. As shown in Table 3, among men, executive function scores varied by social support from a spouse/partner, showing higher initial levels (β = 0.037, 95% CI: 0.008, 0.066) and slower decline (β = 0.005, 95% CI: 0.001, 0.010) for participants with higher PM positive social support (Web Figure 2A) and lower PM negative social support (β = −0.012, 95% CI: −0.022, −0.002) (Web Figure 2C). Decline in executive function was faster among men with higher PM negative social support from children (β = −0.009, 95% CI: −0.018, 0.000), from extended family members (β = −0.009, 95% CI: −0.018, 0.000), and from friends (β = −0.017, 95% CI: −0.027, −0.006) (Web Figures 3C–5C). Among women, higher initial levels of executive function were associated with lower PM positive social support from a spouse/partner (β = −0.034, 95% CI: −0.059, −0.009) and from extended family members (β = −0.035, 95% CI: −0.064, −0.006). In contrast, higher initial levels of executive function were associated with higher PM positive social support from children (β = 0.037, 95% CI: 0.010, 0.064) and from friends (β = 0.115, 95% CI: 0.081, 0.150) (Web Figures 2B–5B). Women reporting higher WP negative social support from extended family members (β = 0.088, 95% CI: 0.041, 0.135) and from friends (β = 0.062, 95% CI: 0.008, 0.115) showed higher initial executive function scores, but higher WP negative social support from extended family members was also associated with faster decline (β = −0.013, 95% CI: −0.023, −0.004) (Web Figures 4D and 5D).

Memory. Among men, higher PM positive social support from a spouse/partner was associated with slower decline in memory scores (β = 0.006, 95% CI: 0.000, 0.012) (Web Figure 2E and Table 4). Men reporting higher PM negative social support from extended family members (β = −0.138, 95% CI: −0.201, −0.076) and from friends (β = −0.108, 95% CI: −0.185, −0.032) showed lower initial memory scores (Web Figures 4G and 5G). Among women, higher PM positive social support from a spouse/partner was associated with lower baseline scores (β = −0.063,

Table 3. Results From Linear Mixed Models of the Between-Persons and Within-Person Associations for Levels of Source-Specific Positive and Negative Social Support[a] and Executive Function, English Longitudinal Study of Ageing, 2002–2010

Time-Varying Support	Spouse/Partner			Children			Family Members			Friends		
	β	95% CI	*P* Value	β	95% CI	*P* Value	β	95% CI	*P* Value	β	95% CI	*P* Value
						Men						
Positive support												
PM	0.037	0.008, 0.066	0.011	0.059	0.030, 0.088	<0.001	−0.029	−0.061, 0.003	0.078	0.026	−0.011, 0.063	0.173
PM × time slope	0.005	0.001, 0.010	0.024	−0.001	−0.006, 0.003	0.634	−0.001	−0.006, 0.005	0.836	0.000	−0.006, 0.006	0.895
WP	0.053	0.002, 0.104	0.041	0.013	−0.040, 0.066	0.637	0.011	−0.025, 0.048	0.553	−0.022	−0.066, 0.023	0.335
WP × time slope	−0.004	−0.015, 0.007	0.490	−0.006	−0.018, 0.006	0.359	0.000	−0.008, 0.008	0.960	0.004	−0.006, 0.013	0.470
PM × WP	0.011	−0.003, 0.026	0.128	−0.017	−0.033, −0.001	0.038	0.007	−0.004, 0.019	0.226	0.006	−0.007, 0.020	0.366
Negative support												
PM	−0.013	−0.074, 0.048	0.670	0.037	−0.018, 0.092	0.192	−0.032	−0.086, 0.022	0.242	−0.034	−0.099, 0.031	0.306
PM × time slope	−0.012	−0.022, −0.002	0.018	−0.009	−0.018, 0.000	0.039	−0.009	−0.018, 0.000	0.043	−0.017	−0.027, −0.006	0.002
WP	0.011	−0.060, 0.082	0.761	−0.015	−0.075, 0.044	0.618	−0.015	−0.068, 0.038	0.571	−0.004	−0.062, 0.053	0.879
WP × time slope	0.000	−0.014, 0.014	0.978	0.001	−0.012, 0.013	0.913	0.002	−0.009, 0.013	0.719	−0.001	−0.013, 0.010	0.846
PM × WP	−0.011	−0.041, 0.018	0.456	0.008	−0.016, 0.032	0.498	−0.001	−0.020, 0.019	0.935	−0.001	−0.026, 0.024	0.945
						Women						
Positive support												
PM	−0.034	−0.059, −0.009	0.007	0.037	0.010, 0.064	0.007	−0.035	−0.064, −0.006	0.020	0.115	0.081, 0.150	<0.001
PM × time slope	−0.001	−0.005, 0.002	0.518	0.000	−0.004, 0.004	0.878	0.001	−0.004. 0.005	0.753	−0.003	−0.009, 0.002	0.276
WP	−0.005	−0.051, 0.042	0.837	0.030	−0.023, 0.084	0.263	0.015	−0.017, 0.047	0.368	0.001	−0.037, 0.039	0.952
WP × time slope	0.006	−0.003, 0.016	0.199	−0.003	−0.014, 0.008	0.594	−0.001	−0.008, 0.005	0.694	0.005	−0.003, 0.014	0.221
PM × WP	−0.001	−0.015, 0.013	0.860	−0.005	−0.022, 0.012	0.567	0.001	−0.010, 0.011	0.899	−0.006	−0.017, 0.006	0.338
Negative support												
PM	−0.029	−0.079, 0.021	0.252	−0.026	−0.077, 0.026	0.325	−0.046	−0.095, 0.002	0.063	−0.045	−0.107, 0.018	0.160
PM × time slope	0.006	−0.002, 0.013	0.132	0.000	−0.008, 0.008	0.979	0.005	−0.003, 0.013	0.220	0.006	−0.015, 0.004	0.275
WP	0.031	−0.032, 0.094	0.335	0.004	−0.052, 0.061	0.876	0.088	0.041, 0.135	<0.001	0.062	0.008, 0.115	0.024
WP × time slope	−0.011	−0.022, 0.000	0.059	−0.002	−0.013, 0.010	0.791	−0.013	−0.023, −0.004	0.007	−0.010	−0.021, 0.001	0.069
PM × WP	0.001	−0.021, 0.023	0.954	−0.010	−0.033, 0.012	0.374	−0.014	−0.031, 0.003	0.114	−0.002	−0.029, 0.025	0.903

Abbreviations: CI, confidence interval; PM, person-mean; WP, within-person.

[a] Per 1-unit increase. Adjustments for time, time-squared, age, age-squared, sex, highest educational attainment, total wealth quintile, number of depressive symptoms, and number of mobility limitations (plus interactions with time in study).

Table 4. Results From Linear Mixed Models of the Between-Persons and Within-Person Associations for Levels of Source-Specific Positive and Negative Social Support[a] and Memory, English Longitudinal Study of Aging, 2002–2010

Time-Varying Support	Spouse/Partner			Children			Family Members			Friends		
	β	95% CI	*P* Value	β	95% CI	*P* Value	β	95% CI	*P* Value	β	95% CI	*P* Value
						Men						
Positive support												
PM	0.015	−0.020, 0.049	0.406	0.033	−0.002, 0.068	0.065	−0.050	−0.090, −0.010	0.014	0.037	−0.008, 0.082	0.110
PM × time slope	0.006	0.000, 0.012	0.046	0.004	−0.002, 0.009	0.233	0.004	−0.003, 0.011	0.259	0.001	−0.007, 0.009	0.851
WP	−0.035	−0.106, 0.036	0.333	−0.009	−0.082, 0.064	0.810	−0.022	−0.072, 0.027	0.370	0.031	−0.028, 0.090	0.297
WP × time slope	0.007	−0.008, 0.023	0.354	0.000	−0.016, 0.016	0.971	0.007	−0.004, 0.017	0.209	−0.006	−0.018, 0.007	0.380
PM × WP	0.011	−0.012, 0.033	0.347	−0.010	−0.031, 0.012	0.384	0.010	−0.007, 0.027	0.238	−0.011	−0.029, 0.007	0.226
Negative support												
PM	−0.055	−0.126, 0.016	0.129	−0.050	−0.115, 0.015	0.130	−0.138	−0.201, −0.076	<0.001	−0.108	−0.185, −0.032	0.005
PM × time slope	−0.005	−0.018, 0.007	0.395	0.002	−0.010, 0.013	0.775	0.005	−0.007, 0.017	0.399	−0.013	−0.027, 0.000	0.059
WP	−0.031	−0.131, 0.069	0.541	0.021	−0.066, 0.108	0.641	−0.007	−0.081, 0.066	0.844	−0.038	−0.120, 0.044	0.362
WP × time slope	−0.002	−0.021, 0.017	0.816	−0.002	−0.020, 0.015	0.805	−0.002	−0.017, 0.012	0.752	0.003	−0.014, 0.019	0.743
PM × WP	−0.006	−0.043, 0.032	0.771	−0.010	−0.042, 0.023	0.561	0.034	0.008, 0.059	0.011	0.001	−0.037, 0.040	0.947
						Women						
Positive support												
PM	−0.063	−0.094, −0.031	<0.001	−0.006	−0.040, 0.027	0.716	−0.018	−0.054, 0.019	0.349	0.119	0.073, 0.164	<0.001
PM × time slope	0.009	0.004, 0.015	0.001	0.005	−0.001, 0.010	0.115	0.007	0.000, 0.013	0.037	0.006	−0.002, 0.014	0.137
WP	0.017	−0.045, 0.079	0.592	0.062	−0.009, 0.133	0.087	−0.012	−0.055, 0.031	0.591	0.020	−0.033, 0.073	0.462
WP × time slope	0.011	−0.001, 0.024	0.077	0.001	−0.014, 0.017	0.846	0.002	−0.007, 0.011	0.684	0.004	−0.008, 0.016	0.478
PM × WP	0.025	0.007, 0.043	0.007	−0.003	−0.025, 0.020	0.828	0.009	−0.005, 0.024	0.203	0.015	−0.003, 0.033	0.095
Negative support												
PM	−0.047	−0.108, 0.015	0.136	−0.093	−0.156, −0.030	0.004	−0.035	−0.096, 0.025	0.254	0.016	−0.061, 0.093	0.684
PM × time slope	−0.002	−0.012, 0.009	0.776	−0.002	−0.013, 0.009	0.718	0.001	−0.009, 0.012	0.797	−0.002	−0.016, 0.013	0.820
WP	0.073	−0.013, 0.160	0.094	0.060	−0.020, 0.140	0.139	0.051	−0.014, 0.116	0.122	0.044	−0.029, 0.117	0.236
WP × time slope	−0.004	−0.021, 0.012	0.598	−0.011	−0.026, 0.005	0.176	−0.005	−0.018, 0.007	0.401	−0.003	−0.018, 0.013	0.736
PM × WP	−0.014	−0.045, 0.017	0.367	0.011	−0.020, 0.041	0.495	0.006	−0.018, 0.029	0.639	−0.015	−0.055, 0.025	0.456

Abbreviations: CI, confidence interval; PM, person-mean; WP, within-person.

[a] Per 1-unit increase. Adjustments for time, time-squared, age, age-squared, sex, highest educational attainment, total wealth quintile, number of depressive symptoms, and number of mobility limitations (plus interactions with time in study).

95% CI: −0.094, −0.031), but this association diminished over time (β = 0.009, 95% CI: 0.004, 0.015) (Web Figure 2F) and was weaker for participants with higher PM positive social support (β = 0.025, 95% CI: 0.007, 0.043). Higher memory scores were also associated with lower PM negative social support from children (β = −0.093, 95% CI: −0.156, −0.030) (Web Figure 3H) and with higher PM positive social support from friends (β = 0.119, 95% CI: 0.073, 0.164) (Web Figure 5F).

Similar associations between social support and age-related cognitive decline were found for analyses limited to the subsample of participants with complete data in all 5 waves and analyses, adjusted for retest effects (Web Tables 3–6).

DISCUSSION

Using 5 waves of data spanning an 8-year period, we examined the longitudinal associations between social support and cognitive function by sex and relationship type. We found that participants reporting higher positive social support and lower negative social support than others had higher cognitive scores and slower decline in memory, as did participants reporting higher-than-usual level of positive social support. Higher-than-usual negative social support was associated with higher executive function, but this association was weaker for participants with higher-than-average levels of negative social support. In addition, our findings indicated sex-specificity in the associations between social support and age-related cognitive decline, often contingent upon relationship type. By and large, for men, higher-than-average positive social support from a spouse/partner and lower negative social support from all types of relationships were associated with higher cognitive function and slower cognitive decline. Among women, positive social support from children and from friends—but not from a spouse/partner or from extended family members—was positively associated with cognitive function.

Longitudinal associations between social support and cognitive function

Our first objective examined whether between-persons differences and within-person changes in levels of social support were associated with age-related changes in cognitive function. In agreement with previous studies (24), we found that higher-than-average positive social support (i.e., between-persons difference) was associated with better cognitive function and slower decline in memory. Higher-than-usual positive social support (i.e., within-person change) was associated with slower decline in memory, independent of individuals' stable levels. Our findings demonstrated that both between-persons differences and within-person changes in positive social support are independently related to cognitive decline. Potential explanations include the stress-buffering characteristic of positive social support that facilitates the maintenance of homeostasis, benefitting cognitive function and health (25, 26). Reverse causation is also possible. Higher cognitive function promotes effective management of interpersonal relationships, leading to positive perceptions of one's social exchanges (27).We also found that higher-than-average negative social support across all relationship types was consistently associated with accelerated cognitive decline for men. This finding is in agreement with other studies of cognitive function in middle-aged and older adults (2, 28). On the other hand, the positive association between higher-than-usual negative social support and cognitive function obtained from the present study may be due to reverse causation. Higher-than-usual levels of executive function on a certain occasion may enable persons to engage in more complex social interactions, increasing the frequency of negative social exchanges (24, 29).

Social support and cognitive function by sex and relationship type

Our second objective examined whether the social-support and cognitive-function associations were modified by sex and by relationship type. Sex differences in associations between social support and cognitive function have been reported in some (10–12) but not all (13, 14) studies. In the present study, for men, higher-than-average positive social support and lower-than-average negative social support from their spouses/partners were associated with better cognitive function and slower cognitive decline. For women, higher-than-average positive social support from their spouses/partners was negatively associated with cognitive function, but the association with memory weakened over the follow-up period. Previous research has shown that the degree of health benefits from marriage/partnership differ according to sex (30). Relying on their spouse/partner as the main resource for social support, the quality and stability of intimate social ties are more instrumental for cognitive maintenance (31) and health (32, 33) for men than for women. Women are more sensitive to appraisals of partnership quality (34, 35), and they exchange social support with a wider range of social partners than men (8, 9). In the present study, higher-than-average positive social support from children and from friends was associated with better cognitive function for women. This is consistent with other studies (10–12) in which friendships were protective against cognitive decline for women but not for men. Our finding may indicate that positive exchanges from social ties beyond the spouse and immediate family may be particularly cognitively stimulating for women (12). It is also possible that women with high cognitive skills are more capable of managing friendships, thereby requiring less social support from more intimate social relationships.

Strengths and limitations

Strengths of our study include its sample size and the multiple and detailed assessments of cognitive function and social support from a range of social relationships, enabling exploration of sex-specific and relationship type–specific associations between social support and cognitive function over 5 waves of a longitudinal cohort representative of English older adults.

The present study has a number of limitations. Our measures of social support were self-reported, so the information may have been influenced by participants' personality traits. However, self-reporting may be the best method to capture participants' subjective interpretation of the social support they perceived. Loss to follow-up is another limitation. As the

length of follow-up increases, participants remaining in longitudinal studies of older populations are inevitably progressively healthier, are more socially connected, and have higher levels of cognitive function than those who left the study (36). The consistency between our main analysis findings and the supplementary analyses based on participants who took part at all 5 waves suggested that nonresponse bias has not materially influenced our results. Examination of retest effects indicated that the estimated rates of cognitive decline shown in our main analyses were reduced due to repeated cognitive assessments. Nevertheless, additional adjustments for retest effects did not alter the main associations of interest. Thus our findings are likely to be generalizable to healthy older adults, and our estimates might reflect conservative estimates of the range of cognitive decline over the 8-year period, with a reduced statistical power to detect strong associations between social support and cognitive decline.

The multiple associations tested in the present study would have inflated our chance of making type I errors. But we reported only the findings consistent to both domains of cognitive function in relation to each relationship type. Because assessments of social support and cognitive function were conducted in the same time period, the findings obtained here may involve reverse causation. Our study thus mainly indicated how social support and cognitive function coevolve over time, and did not definitively show the direction of these associations. Finally, although we adjusted our estimates for a range of covariates, there remains the problem of residual confounding that is common to all observational studies.

In conclusion, both between-persons differences and within-person changes in levels of positive support and negative support were independently associated with age-related changes in cognitive function. The associations between social support and cognitive decline were not derived equally from different relationship types for men and women. In line with the findings of previous studies (2, 11, 13, 28), the current study found that the associations between social support and cognitive function were moderate in magnitude. However, as an important component of healthy aging, social support should still be considered in any comprehensive intervention to slow cognitive decline in old age (37). The longitudinal evidence of the complex social-support and cognitive-function associations provided by this study might guide both future research efforts and intervention strategies designed to maximize the benefits of social support for successful cognitive aging.

ACKNOWLEDGMENTS

Author affiliations: Epidemiology and Biostatistics, School of Public Health, Sun Yat-sen University, Guangzhou, China (Jing Liao); Sun Yat-sen Global Health Institute, Sun Yat-sen University, Guangzhou, China (Jing Liao); and Research Department of Epidemiology and Public Health, Faculty of Population Health Sciences, University College London, London, United Kingdom (Shaun Scholes).

The English Longitudinal Study of Ageing was developed by a team of researchers based at University College London, the Institute for Fiscal Studies, and NatCen Social Research. Funding was provided by the National Institute on Aging (grants 2RO1AG7644-01A1 and 2RO1AG017644) and a consortium of United Kingdom government departments.

We thank Margaret Blake at NatCen Social Research for help accessing the English Longitudinal Study of Ageing data.

Conflict of interest: none declared.

REFERENCES

1. Fratiglioni L, Wang HX, Ericsson K, et al. Influence of social network on occurrence of dementia: a community-based longitudinal study. *Lancet*. 2000;355(9212):1315–1319.
2. Liao J, Head J, Kumari M, et al. Negative aspects of close relationships as risk factors for cognitive aging. *Am J Epidemiol*. 2014;180(11):1118–1125.
3. Coventry WL, Gillespie NA, Heath AC, et al. Perceived social support in a large community sample—age and sex differences. *Soc Psychiatry Psychiatr Epidemiol*. 2004;39(8):625–636.
4. Fuhrer R, Stansfeld SA. How gender affects patterns of social relations and their impact on health: a comparison of one or multiple sources of support from "close persons". *Soc Sci Med*. 2002;54(5):811–825.
5. van Tilburg T, Broese van Groenou M. Network and health changes among older Dutch adults. *J Soc Issues*. 2002;58(4):697–713.
6. Gurung RA, Taylor SE, Seeman TE. Accounting for changes in social support among married older adults: insights from the MacArthur Studies of Successful Aging. *Psychol Aging*. 2003;18(3):487–496.
7. Aartsen MJ, van Tilburg T, Smits CHM, et al. A longitudinal study of the impact of physical and cognitive decline on the personal network in old age. *J Soc Pers Relat*. 2004;21(2):249–266.
8. Stafford M, McMunn A, Zaninotto P, et al. Positive and negative exchanges in social relationships as predictors of depression: evidence from the English Longitudinal Study of Aging. *J Aging Health*. 2011;23(4):607–628.
9. Rook KS, Luong G, Sorkin DH, et al. Ambivalent versus problematic social ties: implications for psychological health, functional health, and interpersonal coping. *Psychol Aging*. 2012;27(4):912–923.
10. Thomas PA. Gender, social engagement, and limitations in late life. *Soc Sci Med*. 2011;73(9):1428–1435.
11. Béland F, Zunzunegui MV, Alvarado B, et al. Trajectories of cognitive decline and social relations. *J Gerontol B Psychol Sci Soc Sci*. 2005;60(6):P320–P330.
12. Zunzunegui MV, Alvarado BE, Del Ser T, et al. Social networks, social integration, and social engagement determine cognitive decline in community-dwelling Spanish older adults. *J Gerontol B Psychol Sci Soc Sci*. 2003;58(2):S93–S100.
13. Barnes LL, de Leon CFM, Wilson RS, et al. Social resources and cognitive decline in a population of older African Americans and whites. *Neurology*. 2004;63(12):2322–2326.
14. Ertel KA, Glymour MM, Berkman LF. Effects of social integration on preserving memory function in a nationally representative US elderly population. *Am J Public Health*. 2008;98(7):1215–1220.
15. Birditt KS, Jackey LM, Antonucci TC. Longitudinal patterns of negative relationship quality across adulthood. *J Gerontol B Psychol Sci Soc Sci*. 2009;64(1):55–64.
16. Shaw BA, Krause N, Liang J, et al. Tracking changes in social relations throughout late life. *J Gerontol B Psychol Sci Soc Sci*. 2007;62(2):S90–S99.

17. Hoffman L, Stawski RS. Persons as contexts: evaluating between-person and within-person effects in longitudinal analysis. *Res Hum Dev*. 2009;6(2–3):97–120.
18. Steptoe A, Breeze E, Banks J, et al. Cohort profile: the English Longitudinal Study of Ageing. *Int J Epidemiol*. 2013;42(6): 1640–1648.
19. Taylor R, Conway L, Calderwood L, et al. *Health, Wealth and Lifestyles of the Older Population in England: The 2002 English Longitudinal Study of Ageing: Technical Report.* London, UK: Institute of Fiscal Studies; 2007.
20. Huppert FA, Gardener E, McWilliams B. Cognitive function. In: Banks J, Breeze E, Lessof C, et al., eds. *Retirement, Health and Relationships of the Older Population in England: the 2004 English Longitudinal Study of Ageing (Wave 2)*. London, UK: Institute of Fiscal Studies; 2006.
21. Steel N, Huppert FA, McWilliams B, et al. Physical and cognitive function. In: Marmot M, Banks J, Blundell R, et al., eds. *Health, Wealth and Lifestyles of the Older Population in England: ELSA 2002*. London, UK: Institute of Fiscal Studies; 2002.
22. Katz S, Ford AB, Moskowitz RW, et al. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. *JAMA*. 1963;185(12):914–919.
23. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas*. 1977; 1(3):385–401.
24. Seeman TE, Lusignolo TM, Albert M, et al. Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur Studies of Successful Aging. *Health Psychol*. 2001;20(4):243–255.
25. Berkman LF, Glass T, Brissette I, et al. From social integration to health: Durkheim in the new millennium. *Soc Sci Med*. 2000;51(6):843–857.
26. Uchino BN, Carlisle M, Birmingham W, et al. Social support and the reactivity hypothesis: conceptual issues in examining the efficacy of received support during acute psychological stress. *Biol Psychol*. 2011;86(2):137–142.
27. Krueger KR, Wilson RS, Kamenetsky JM, et al. Social engagement and cognitive function in old age. *Exp Aging Res*. 2009;35(1):45–60.
28. Seeman TE, Miller-Martinez DM, Stein Merkin S, et al. Histories of social engagement and adult cognition: midlife in the US study. *J Gerontol B Psychol Sci Soc Sci*. 2011;66(suppl 1):i141–i152.
29. Hughes TF, Andel R, Small BJ, et al. The association between social resources and cognitive change in older adults: evidence from the Charlotte County Healthy Aging Study. *J Gerontol B Psychol Sci Soc Sci*. 2008;63(4):P241–P244.
30. Umberson D. Gender, marital status and the social control of health behavior. *Soc Sci Med*. 1992;34(8):907–917.
31. Håkansson K, Rovio S, Helkala EL, et al. Association between mid-life marital status and cognitive function in later life: population based cohort study. *BMJ*. 2009;339:b2462.
32. Chipperfield JG, Havens B. Gender differences in the relationship between marital status transitions and life satisfaction in later life. *J Gerontol B Psychol Sci Soc Sci*. 2001;56(3):P176–P186.
33. Curran SR, McLanahan S, Knab J. Does remarriage expand perceptions of kinship support among the elderly? *Soc Sci Res*. 2003;32(2):171–190.
34. Boerner K, Jopp DS, Carr D, et al. "His" and "her" marriage? The role of positive and negative marital characteristics in global marital satisfaction among older adults. *J Gerontol B Psychol Sci Soc Sci*. 2014;69(4):579–589.
35. Carstensen LL, Gottman JM, Levenson RW. Emotional behavior in long-term marriage. *Psychol Aging*. 1995;10(1): 140–149.
36. Kobayashi LC, Wardle J, Wolf MS, et al. Cognitive function and health literacy decline in a cohort of aging English adults. *J Gen Intern Med*. 2015;30(7):958–964.
37. Agrigoroaei S, Lachman ME. Cognitive functioning in midlife and old age: combined effects of psychosocial and behavioral factors. *J Gerontol B Psychol Sci Soc Sci*. 2011;66(suppl 1): i130–i140.