Social support and cognition in a community-based cohort: the Atherosclerosis Risk in Communities (ARIC) study

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Abstract

Objective: social support has demonstrated cross-sectional associations with greater cognitive function and a protective effect against cognitive decline in older adults, but exploration of its temporal role in cognitive ageing from mid-life to older adulthood has been limited. We aimed to quantify the associations of social support, assessed at mid-life, with cognitive function in mid-life and with cognitive decline into late life among African Americans and Caucasians.

Methods: data from the community-based, prospective Atherosclerosis Risk in Communities (ARIC) cohort of 15,792 biracial participants were examined for baseline and longitudinal associations of mid-life social support with global cognition at mid-life and with 20-year change in global cognition, respectively, stratified by race. Interactions with sociodemographic and cardiometabolic covariates were additionally explored within each race group. Social support was ascertained using two metrics: interpersonal support and social network.

Results: interpersonal support was directly associated with greater global cognition at baseline in both race groups. Social network was directly associated with greater global cognition at baseline among Caucasians and African American females, but it was not significantly associated with global cognition in African American males. Neither mid-life social support measure was associated with 20-year change in global cognition.

Conclusions: higher levels of social support were moderately associated with greater multi-dimensional cognitive function at mid-life, but mid-life social support was not associated with temporal change in global cognitive function over 20 years into late life. Prospective studies with time-dependent measures of social support and cognition are needed to better understand the role of social engagement in ageing-related cognitive functioning.

Keywords: *older people, cognition, social, support, cognitive, psychosocial, social support*

Objective

Cognitive outcomes among adults approaching older age are influenced by vascular exposures [1–4], sociodemographic variables [5–7] and psychosocial factors [8–13]. Social support is a

particular psychosocial construct that may decelerate the cognitive ageing process, stemming from both its positive, cross-sectional associations with greater cognitive function [9–13] and protective associations against steeper cognitive decline reported among older adults [11, 14–16].

Models explaining the link between social support and cognition indirectly through social mechanisms have been proposed [17, 18]. In addition, a direct neurological correlation between social support and increased grey matter volume has been observed, albeit in younger adults [19]. The temporal relationship between social support and cognition from mid-life to late life, however, is not well understood primarily because of the paucity of prospective data with cognitive and social support information collected prior to the seventh decade of life (i.e. 60–69 years of age).

We assessed whether social support is associated with cognitive function at mid-life, and whether mid-life social support is protective against faster cognitive decline into older adulthood, in efforts to clarify the temporal relationship between social support and ageing-related cognition. To achieve this, we estimated the associations of two metrics of social support ascertained at mid-life—interpersonal support and social network—with global cognitive function in mid-life and with 20-year change in global cognitive function among African American and Caucasian men and women aged 48–67 from the large, population-based Atherosclerosis Risk in Communities (ARIC) Study.

Methods

Study population

The prospective ARIC Study [20] enrolled 15,792 participants aged 45–64 during 1987–89 (Visit 1). Participants were recruited using a probability sample from four US communities: Forsyth County, NC; Jackson, MS; suburbs of Minneapolis, MN and Washington County, MD. ARIC participants were then followed up at clinical exams in 1990–92 (Visit 2), 1993–95 (Visit 3), 1996–98 (Visit 4) and 2011–13 (Visit 5). The study was approved by the Institutional Review Boards at each study centre.

Cognitive assessments

The Digit Symbol Substitution Test (DSST) [21], Delayed Word Recall Test (DWRT) [22] and Word Fluency Test (WFT) [23] of cognition were administered at ARIC Visits 2, 4 and 5. The DSST is a test of executive function and processing speed, the DWRT measures verbal learning and immediate memory and the WFT assesses executive function and expressive language. All tests are validated, standardised instruments commonly used in epidemiologic studies of dementia and cognitive function. Together, the tests include most of the measures recommended in the Uniform Data Set executed in 2005 across all National Institute on Aging-sponsored Alzheimer's Disease Centers [24].

A z -score was calculated for each test to standardise participants' cognitive scores to their baseline scores at Visit 2 (also baseline for the purposes of our study). This was done by first calculating the mean and standard deviation of scores on the DSST, DWRT and WFT for the entire study population at baseline. Then for each test, the baseline population

mean was subtracted from each participant's raw score at subsequent visits, and this difference was divided by the baseline population standard deviation. A global z -score was created at Visits 2, 4 and 5 by averaging individual z -scores across the three tests among participants with three non-missing scores at each visit. This global z -score serves as a standardised, multi-domain measure of cognitive performance used to represent global cognitive function.

Social support measures

Participants' social support was also assessed at baseline (Visit 2) using the short form of the Interpersonal Support Evaluation List [ISEL-SF; 25] as well as the Lubben Social Network Scale [LSNS; 26]. Both questionnaires are psychometrically valid and routinely applied instruments to measure perceived social support [27, 28]. The 16-item ISEL-SF is used to measure an individual's perception of his or her appraisal support, tangible assets, belonging support and self-esteem support. Each question of the ISEL-SF is scored on a 4-point rating scale (definitely true, probably true, probably false and definitely false; scored 0–3). The total (summed) score is an aggregate index of social support, with higher scores indicating greater levels of perceived interpersonal support [28]. Established cut-offs for ISEL-SF scores do not exist, so we categorized total scores into quartiles based on the distribution of the subgroup of interest (e.g. Caucasian participants).

The LSNS is a self-assessed measure of the size and availability of one's active social network of family, friends and peers, consisting of 10 questions on a 0–5 rating scale. Total scores range from 0 to 50 and are classified based on established levels of risk for social isolation [29]: socially 'isolated' (≤ 20), 'high risk' for isolation (21–25), 'moderate risk' for isolation (26–30) and 'low risk' for isolation (≥ 31). We collapsed the first two of these categories together to form a category designated as 'isolated/high risk', as $<5\%$ of participants scored within the 'isolated' range.

Analytic samples

Participants were excluded from analyses if they were not of African American or Caucasian race ($n = 42$), were African American in Minneapolis ($n = 20$) or Washington County ($n = 30$), had missing global z -scores at baseline ($n = 83$), had missing education level ($n = 20$) or had any missing responses on the ISEL-SF ($n = 237$) or LSNS ($n = 900$). This resulted in analytic samples for cross-sectional analyses of social support measures with global z -score at baseline to be composed of 13,782 participants for ISEL-SF and 13,119 participants for LSNS. The study populations for longitudinal analyses included those participants from cross-sectional analyses who repeated multi-domain cognitive testing at Visits 4 and 5 ($N = 5,411$ for ISEL-SF and $N = 5,195$ for LSNS).

Statistical models and covariates

All analyses were stratified by race, given the reported racial differences in rates of cognitive decline [30]. Within each race group, we also tested for modification of cross-sectional and longitudinal associations between social support measures and cognitive outcomes by each baseline covariate (indicated by $P < 0.10$ for the interaction term).

Generalised linear models (GLMs) were used to estimate cross-sectional mean differences in global α -score across categories of each social support measure, with the least level of the social support measure (i.e. first quartile for ISEL-SF and 'isolated/high risk' group for LSNS) as the referent category. Fully adjusted GLMs controlled for the following potential confounders at baseline: age (continuous), sex, study centre, highest education level (<high school, high school, >high school), cigarette smoking (current, former, never), alcohol consumption (current, former, never), prevalent hypertension (mean resting blood pressure $>140/90$ mmHg or self-reported use of antihypertensive medication) and prevalent diabetes (fasting glucose of 126 mg/dl, non-fasting glucose of 200 mg/dl, a self-reported history of diabetes or treatment for diabetes at Visit 2).

Subsequently, generalised estimating equation (GEE) models were used to estimate longitudinal mean differences in 20-year change in global α -score by categories of each social support measure, with the lowest category of each social support measure as the reference group. Fully adjusted GEE models controlled for the aforementioned baseline covariates, time on study and interactions between these

covariates and time on study. GEE models were chosen due to their ability to account for intraindividual correlation of cognitive test scores through repeat visits. Statistical analyses were performed in SAS, version 9.3 (SAS Institute Inc., Cary, NC, USA).

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Results

Characteristics of participants ($N = 13,119$) involved in the examination of the cross-sectional association between social network (as measured by LSNS) and global α -score at baseline are summarised in Table 1. Baseline distributions of covariates across categories of ISEL-SF were similar as those across LSNS, so we only present characteristics by LSNS. Furthermore, while the highest proportion of participants scored in the middle categories on the ISEL-SF or LSNS, for brevity, we report estimates of mean difference in cognitive outcomes only between those categories representing the highest versus lowest categories of social support. Of note,

Table 1. Baseline characteristics^a by race group and Lubben Social Network Scale (LSNS) category ($N = 13,119$)

	African Americans			Caucasians		
	Low risk ($n = 916$)	Moderate risk ($n = 1,265$)	Isolated/high risk ($n = 909$)	Low risk ($n = 2,902$)	Moderate risk ($n = 4,570$)	Isolated/high risk ($n = 2,557$)
Age, years, mean (SD)	56.6 (5.8)	56.1 (5.8)	55.9 (5.7)	57.6 (5.7)	57.2 (5.7)	57.0 (5.7)
Female, n (%)	576 (62.9)	853 (67.4)	560 (61.6)	1,563 (53.9)	2,587 (56.6)	1,237 (48.4)
Study centre, n (%)						
Forsyth County, NC	98 (10.7)	139 (11.0)	119 (13.1)	897 (30.9)	1,423 (31.1)	840 (32.9)
Jackson, MS	818 (89.3)	1,126 (89.0)	790 (86.9)	—	—	—
Minneapolis, MN	—	—	—	1,063 (36.6)	1,650 (36.1)	870 (34.0)
Washington County, MD	—	—	—	942 (32.5)	1,497 (32.8)	847 (33.1)
Education level, n (%)						
<High school	365 (39.8)	466 (36.8)	314 (34.5)	500 (17.2)	651 (14.3)	418 (16.3)
High school	281 (30.7)	358 (28.3)	248 (27.3)	1,271 (43.8)	2,213 (48.4)	1,109 (43.4)
>High school	270 (29.5)	441 (34.9)	347 (38.2)	1,131 (39.0)	1,706 (37.3)	1,030 (40.3)
Cigarette smoking, n (%)						
Current	224 (24.5)	324 (25.6)	225 (24.8)	505 (17.4)	979 (21.4)	622 (24.3)
Former	255 (27.9)	381 (30.2)	271 (29.8)	1,153 (39.7)	1,857 (40.7)	1,075 (42.1)
Never	436 (47.6)	558 (44.2)	412 (45.4)	1,244 (42.9)	1,731 (37.9)	860 (33.6)
Alcohol consumption, n (%)						
Current	295 (32.2)	441 (34.9)	311 (34.3)	1,769 (61.0)	2,933 (64.2)	1,714 (67.0)
Former	253 (27.7)	386 (30.5)	321 (35.4)	489 (16.8)	816 (17.9)	443 (17.3)
Never	367 (40.1)	437 (34.6)	275 (30.3)	644 (22.2)	817 (17.9)	400 (15.7)
Hypertension, n (%)	432 (47.5)	591 (47.1)	432 (47.8)	688 (23.8)	1,052 (23.1)	611 (24.0)
Diabetes, n (%)	239 (26.3)	298 (23.9)	224 (24.9)	377 (13.0)	493 (10.8)	280 (11.0)
Global α -score, mean (SD)	-0.73 (1.03)	-0.68 (1.05)	-0.69 (1.01)	0.27 (0.86)	0.28 (0.85)	0.15 (0.88)

^aCharacteristics appearing in this table are for analytic sample using LSNS as the exposure.

Table 2. Race-stratified estimates, with 95% confidence intervals (CIs) and *P* values, of mean differences in global α -score of multi-domain cognitive function (global α -score) at baseline and in 20-year change in global α -score by social support metric

	African Americans				Caucasians			
	N	Estimate	95% CI	<i>P</i> value	N	Estimate	95% CI	<i>P</i> value
Interpersonal support (highest versus lowest quartile)								
Cross-sectional (Baseline)								
Model 1	3,285	0.60	(0.51, 0.69)	<0.001	10,497	0.30	(0.26, 0.34)	<0.001
Model 2	3,285	0.34	(0.27, 0.42)	<0.001	10,497	0.20	(0.16, 0.24)	<0.001
Fully adjusted	3,220	0.33	(0.25, 0.41)	<0.001	10,450	0.19	(0.15, 0.23)	<0.001
Longitudinal (20-year change)								
Fully adjusted	1,012	−0.01	(−0.14, 0.12)	0.84	4,373	0.01	(−0.05, 0.05)	0.95
Social network ('low risk' versus 'isolated/high risk')								
Cross-sectional (Baseline)								
Model 1	3,090	0.01	(−0.08, 0.09)	0.93	10,029	0.11	(0.07, 0.15)	<0.001
Model 2	3,090	0.07	(0.00, 0.15)	0.05	10,029	0.12	(0.08, 0.16)	<0.001
Fully adjusted	3,029	0.08	(0.01, 0.15)	0.03	9,981	0.12	(0.08, 0.16)	<0.001
Longitudinal (20-year change)								
Fully adjusted	976	0.01	(−0.11, 0.13)	0.87	4,194	−0.03	(−0.09, 0.03)	0.29

Model 1: adjusted for age, sex and study centre;

Model 2: adjusted for age, sex, study centre and education level;

Fully adjusted: adjusted for age, study centre, sex, education level, cigarette smoking, alcohol consumption, hypertension and diabetes.

associations between the middle relative to lowest level of the social support measures and cognitive outcomes were generally similar or slightly depreciated in magnitude.

Social support and cognition in mid-life

In baseline models adjusted for sociodemographic and additionally for cardiometabolic covariates, higher levels of interpersonal support and social network were each significantly associated ($P < 0.05$) with greater multi-dimensional cognitive function in both race groups (Table 2). Estimates of cross-sectional associations between interpersonal support and global α -score, controlled for age, sex, and study centre, were attenuated by 43 and 33% upon adjustment for education level in African Americans and Caucasians, respectively. Estimates from fully adjusted models indicate a difference of 32 and 22% of one standard deviation in the baseline global α -score of our analytic samples of African Americans (1.03) and Caucasians (0.86), respectively, between the highest and lowest quartiles of interpersonal support.

In fully adjusted models, the level of active social network was modestly (~10% of one standard deviation in baseline global α -score between the highest and lowest categories) associated with global α -score at baseline in each race group. The estimate of this association became statistically significant among African Americans in fully adjusted models. Conversely, subsequent control for covariates only inappreciably affected the estimate of the cross-sectional association between social network and global α -score among Caucasians.

Social network ('low risk' versus 'isolated/high risk') was significantly associated with greater global α -score at baseline in African American females (mean difference = 0.17, 95% CI: 0.08, 0.26) but not in African American males (mean difference = −0.07, 95% CI: −0.19, 0.05). There was no other evidence of interaction detected.

Mid-life social support and 20-year cognitive change

In fully adjusted models, the mean 20-year decline in global α -score was −0.85 (−0.98, −0.73) with SD = 0.06 among African American participants and −0.99 (95% CI: −1.06, −0.93) with SD = 0.03 among Caucasian participants. Longitudinal associations between social support metrics and 20-year change in global α -score were not observed in African Americans or Caucasians (Table 2). Lastly, no evidence of effect modification by any covariates was detected in longitudinal analyses.

Conclusions

Using prospective data from the population-based ARIC cohort, this study examined associations of mid-life interpersonal support and social network with global cognition at mid-life and with change in global cognition into late life. Higher level of social support was moderately associated with greater global cognitive functioning at mid-life but did not predict change in global cognitive function into older adulthood.

The associations between social support and global cognition observed at mid-life in this study, and reported at late life in other studies [10–16], may point to an influence of social engagement on cognition in different life epochs, although such a hypothesis is not supported by the literature. Conversely, these cross-sectional associations may represent reverse or bi-directional causality.

The absence of longitudinal associations in this study suggests the lack of a relationship between mid-life social support and cognitive decline into late life. Yet reliance on a single measurement of this psychosocial exposure, assessed only at baseline, may have failed to ascertain time-varying

associations. For instance, changes in social support systems that occur between mid-life and older age may have the strongest effect on cognitive trajectories thereafter.

Bias attributable to selective cohort attrition over the course of the long cohort follow-up may also contribute to explain the lack of longitudinal associations. Participants with less social support in mid-life did in fact have a higher incidence of co-morbidities, disability and other factors associated with death or dropout over the extended follow-up period in these data. Their underrepresentation in analytic samples may have diminished the ability of this study to detect significant protective effects for mid-life social support against steeper cognitive decline, depending on whether this group's cognitive decline was sufficiently accelerated in comparison to that of those participants who were included in analytic samples. To counterbalance for this predicted underrepresentation, we applied inverse-probability-of-attrition weights to longitudinal models. These weights, however, did not lead to any marked change in longitudinal estimates.

While social support in mid-life would not appear to be protective against cognitive decline into late life, higher level of social support was moderately associated with greater cognitive function at mid-life. Further clarification of the roles of social support in cognitive ageing will require consideration of changes in the strength, duration and timing of social networks across the life course. Prospective cohorts initiated at mid-life or earlier, characterized with both time-varying social support and cognitive measures, would assist in further elucidating the temporal relationship between social engagement and cognitive ageing.

Key points

- We investigated the temporal role of social engagement in cognitive ageing using population-based data.
- Social support was modestly associated with greater cognitive function at mid-life.
- Mid-life social support did not predict cognitive decline into older adulthood.
- Disentanglement of the temporal relationship between social engagement and cognitive ageing necessitates prospective studies with time-repeating measures of social support and cognition.

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Conflicts of interest

None declared.

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Social resources and cognitive ageing across 30 years: the Glostrup 1914 Cohort

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Abstract

Background: to examine associations between social resources and cognitive ageing over 30 years.

Methods: participants in the Glostrup 1914 Cohort, a year of birth sample, completed a standardised battery of cognitive ability tests every 10 years from age 50 to 80, summarised as general cognitive ability. Participants also provided information concerning a range of social resources, including marital status and living arrangements from age 50, and from age 70, details regarding social support, social contact and loneliness.

Results: across the follow-up, participants were less likely to be married, falling from 85.0 to 40.4% between ages 50 and 80, while the proportion of those living alone increased from 13.1 to 54.2%. In separate growth curve models, being married, living with others and not feeling lonely were all associated with higher cognitive ability level, while more telephone contact had a negative association. Marital status (at ages 50 and 60) and loneliness at age 70 were the only social resources associated with cognitive change; married individuals and those not feeling lonely experienced less cognitive decline. When the social resources showing significant associations were considered together (and accounting for sex, education and social class), loneliness was associated with lower cognitive ability level and greater cognitive decline, while married individuals experienced less decline.