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Association of social integration with cognitive status in a multi-ethnic cohort: results from the KHANDLE study

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Abstract

We evaluated overall and race-specific relationships between social integration and cognition in older adults. Kaiser Healthy Aging and Diverse Life Experiences (KHANDLE) cohort participants included 1343 Asian, Black, Latino, or non-Latino White Kaiser Permanente Northern California members. We estimated the effect of social integration on verbal episodic memory, semantic memory, and executive function derived from the Spanish and English Neuropsychological Assessment (SENAS) Scales. Social integration scores included marital status; volunteer activity; and contact with children, relatives, friends, and confidants. We estimated covariate-adjusted linear mixed-effects models for baseline and 17-month follow-up cognition. Social integration was associated with higher baseline cognitive scores (average β=0.066 (95% Confidence Interval: 0.040,0.092)) overall and in each racial/ethnic group. The association did not vary by race/ethnicity. Social integration was not associated with estimated rate of cognitive change. In this cohort, more social integration was similarly associated with better late-life cognition across racial/ethnic groups.

Keywords

Social Integration; Cognition; Racial/Ethnic Disparities

Introduction

Since Berkman and Syme's pioneering work linking increased social ties and relationships to lower mortality [1], numerous studies have confirmed that individuals with rich social

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ties have better physical and mental health [2]. Social networks characteristics, such as a social engagement and social networks size, predict multiple domains of morbidity and mortality [2–4], including cognitive aging [5–11]. Within this growing literature, however, there has been surprisingly little work assessing heterogeneity across racial/ethnic groups, likely due to the fact that few cohorts include enough non-White older adults to evaluate the link between social integration and cognition by race/ethnicity, and even fewer studies include multiple racial/ethnic groups to support evaluation of effect modification. One study conducted in the Health and Retirement Study found higher social integration slowed cognitive decline in White participants but not in Black participants [7] (though the sample size was small for Black participants). Research in the Chicago Health and Aging Project found that increased participation in social activities may be more beneficial for cognition in White participants than in Black participants[12]. Understanding racial/ethnic heterogeneity is important to evaluate whether racial/ethnic differences in social integration might contribute to racial/ethnic disparities in dementia risk in older adults, and evaluating such differences may allow for deeper understanding of the likely mechanisms linking social networks with cognition.

Figure 1 shows potential ways in which social network composition may influence cognition. For example, confidants provide love and affection, access to resources (i.e. may facilitate finding a job), emotional support, and may constrain/enable health behaviors (social influence). These resources may in turn have direct physiologic consequences (e.g., attenuation of stress response, reduced exposure to toxins); prevent or improve management of chronic diseases such as diabetes and hypertension; and offer cognitive stimulation to benefit cognition. For several reasons (e.g., access to material resources or emotional support), race/ethnicity may modify how social networks affect cognitive outcomes [9,13,14]. Previous work has documented racial/ethnic differences in the characteristics of social networks. For example, Black individuals have smaller networks but more contact with network members and more family members in their networks, and Black and Hispanic older adults are less likely to experience social isolation compared to White adults [15,16]. The resources provided by social networks likely differ by race/ethnicity due to differences in network members' financial support, time constraints, geographic proximity, or behavioral norms and expectations [17,18]. Further, other racially-patterned factors not directly related to social networks, such as religion, socioeconomic status and cultural norms, may influence the mechanisms by which social ties influence cognition, effectively altering the impact of networks. Despite these theoretical arguments for potential differences in the impact of social networks on cognition across race/ethnicity, there is very limited empirical evidence.

This paper used data from a multi-ethnic cohort of older US adults who identify as Asian, Black, Latino, or White, the four major racial/ethnic groups in the United States. The goals of this paper were to 1) describe the distribution of a social integration index across race/ethnicity; 2) evaluate the relationship between social integration and cognitive function; and 3) assess whether social integration-cognition associations differ by race/ethnicity. Because of special relevance of confidants to both emotional and instrumental support for older adults [19,20], we also evaluated the associations with daily contact with a confidant. This threshold was chosen a-priori, but in post-hoc analyses we also evaluated each threshold

separately (presence of a confidant, daily contact, weekly contact, monthly contact and several times a year contact, see appendix 4).

Methods

Study participants and data collection

We used data from wave 1 (baseline) and wave 2 of the Kaiser Healthy Aging and Diverse Life Experiences (KHANDLE) cohort, which comprises community-dwelling older adults residing in the San Francisco Bay and Sacramento areas of California. KHANDLE aims to evaluate how race/ethnicity and life course health and sociocultural factors influence late-life brain health and cognitive decline. Individuals eligible for KHANDLE were long-term members of Kaiser Permanente Northern California, an integrated healthcare delivery system; were age 65 years or older on January 1, 2017; spoke English or Spanish; and had previously participated in Kaiser Permanente multiphasic health checkup exams between 1964-1985. Stratified random sampling by race/ethnicity and educational attainment was used with the goal of recruiting approximately equal proportions of Asian, Black, Latino, and White participants and achieving diversity in educational attainment. Exclusion criteria included: electronic medical record diagnosis of dementia or other neurodegenerative disease (frontotemporal dementia, Lewy body disease, Pick's disease, Parkinson's disease with dementia, Huntington's disease); and presence of health conditions that would impede participation in study interviews, defined by hospice activity in the past 12 months, history of severe chronic obstructive pulmonary disease in the past 6 months, congestive heart failure hospitalizations in the past 6 months, and history of end stage renal disease or dialysis in the past 12 months. At baseline, 1,712 individuals were enrolled. Follow-ups were conducted on average 17.4 months after baseline assessment. At wave 2, there was greater missingness in the executive function scores (n=310), verbal episodic memory scores (n=314) and semantic memory scores (n=376) compared to the baseline assessment. The cohort was approved by the Kaiser Permanente Northern California and UC Davis Institutional Review Boards (IRB Number: CN-16-2786) and all enrolled participants provided informed consent.

Measures

Social integration—To assess social integration, we adhered as closely as possible to the Berkman-Syme Social Network Index [1] which has been used in numerous prior studies [7,21,22]. We created a social integration score, ranging from 0 to 6, by assigning one point for each of the following that a participant reported: being married or living with a partner as if married; spending any time volunteering in the past 12 months; having monthly contact with one or more relatives; having monthly contact with one or more children; having monthly contact with one or more friends; and having daily interaction with a confidant. Participants who reported having no children, no relatives, or no friends also received a score of 0 for the respective measure. Given prior evidence that having a confidant might be of special relevance for both emotional and instrumental support [19,20], as well as for other health outcomes such as mortality due to coronary artery disease and dementia [23,24], we also evaluated this indicator as a primary exposure. Having a confidant was coded as a

binary variable (1 if participant reported having a confidant that he or she sees daily and 0 otherwise).

We conceptualize race/ethnicity (Asian, Black, Latino and White) as a social construct and potential modifier of the association between social integration and cognitive outcomes. Racial/ethnic differences in health are contingent on the specific interpretation of racial identity in contemporary society, where on-going and historical structural racism have shaped racial/ethnic identities and continue to create differences in health outcomes across racial/ethnic groups.

Cognitive outcomes—Outcomes included three cognitive domains: verbal episodic memory, semantic memory and executive functioning. They were derived from the Spanish and English Neuropsychological Assessment Scales (SENAS), which was given to all participants at baseline in their preferred language (English or Spanish). The SENAS battery of cognitive tests has previously undergone extensive development for valid comparisons of cognitive change across racial/ethnic and linguistically diverse groups. Verbal episodic memory composite scores were derived from a multi-trial word-list-learning test. Semantic memory composite scores were derived from verbal (object-naming) and non-verbal (picture association) tests. Executive function composite scores were obtained using component tasks of category fluency, phonemic (letter) fluency, and working memory (digit-span backward, visual-span backward, list sorting). Details of the administration procedures, development, and psychometric characteristics have been extensively described in previous publications [25]. Each domain was z-standardized using the full baseline sample mean and standard deviation.

Covariates—Unless stratified by race/ethnicity, all models adjusted for race/ethnicity. In addition, model 1 adjusted for variables that could potentially confound the association between social integration and cognitive status. We included linear and quadratic age (centered at 65), gender and years of education. Years of education ranged from 0 to 20 years. For participants with greater than a high school education, years of education was derived from a categorical variable coded so that some college, but no degree=13 years; Associate's degree=14 years; Bachelor's degree=16 years; Master's degree=18 years; Doctoral or equivalent degree=20 years. For participants with less than an Associate's degree, vocational degrees and certificates (entailing 6+ months of formal training) were counted as an additional year of education [26]. For participants with less than a high school education, years of education ranged from 0 to 12. For analyses, years of education was centered at 12.

Model 2 additionally adjusted for variables reported at baseline that could either be determinants or consequences of social integration: weekly alcohol use, average combined activities of daily living and instrumental activities of daily living (ADL and IADL) score, income (z-scored) and retirement status. Weekly alcohol use was calculated as the product of the self-reported number of drinks on days in which participant drank and the frequency with which they drank (turned into a continuous measure as follows: 0.5, 3 and 7 days a week if participants reported drinking none or less than once a week, between 1 and 6 days a week and every day, respectively). For participants missing both volume and frequency

measures, we used the answer to the question “Do you ever drink alcoholic beverages such as beer, wine or liquor?”: if participants responded no, we assigned the lowest possible values to both the volume and frequency measures (i.e. 0 drinks for volume and none or less than once a week for frequency); if participants responded yes, but did not respond to the frequency and volume questions, weekly alcohol use was set to missing. Household income was recoded as a continuous variable using the upper bound for each of the income categories and z-standardized (alternative analyses using log-transformed income delivered almost identical coefficients and are not shown). Average combined ADL and IADL score was calculated as the average combined score for participants missing no ADL and IADL responses, and set to missing otherwise. Lastly participants who reported being retired and not working full or part-time were classified as retired, and were classified as not retired otherwise. Because the temporal order of our exposures and these additional covariates is ambiguous, we consider these in a secondary analysis.

In primary analyses, we excluded participants who were missing any of the SENAS measures at baseline (n=26); participants who did not answer whether they were married, had relatives, children, friends, or a confidant and participants who did not answer how many relatives, children, or friends they saw at least once a month and how often they saw their confidant (n=68); participants who identified as Native American (n=1) and participants who had missing data in any of the covariates (n=274), leaving 1343 KHANDLE participants with complete information for our analysis. In addition to these complete case analyses, we report sensitivity analyses using multiple imputation to retain the full sample (n=1617) in the Appendix.

Statistical analysis

We first described the distribution of social integration scores overall and by racial/ethnic group.

Cross-sectional analysis—To simplify interpretation and increase power, we assessed whether it was appropriate to estimate a single effect of each exposure (social integration and daily interaction with a confidant) on all three cognitive domains by testing whether the race-specific association of each exposure with cognition differed depending on the cognitive domain assessed, following Gold et al[27]. To do this, we fit a linear mixed-effects model predicting $Y_{ij,}$ where *i* indexes the individual and *j* indexes the cognitive domain. This approach treats each of the three cognitive domain assessments as repeatedly measured outcomes for each individual, adjusting for an indicator of which domain was being measured (executive function was the reference group). We included interactions between race and indicators of cognitive domain and evaluated interactions between integration score and each race/domain combination. These interactions allowed for the possibility that the effect of social integration on cognition differed across the three cognitive domains and across each race/domain combination; and we included them in our model to test whether we could appropriately estimate a single effect of social integration that was constrained to be the same for each of the cognitive domains. The social integration by race/domain interactions were mostly non-significant and close to null. We concluded that we could estimate a single effect for all three cognitive domains, with the exception of the verbal

episodic memory domain among Asian respondents for social integration and the verbal episodic memory domain among both Asian and Latino respondents for daily interaction with a confidant (see details in Appendix 1). To remove the influence of these interactions from our main effect estimates, we included an interaction term between integration score and an indicator for the Asian/verbal episodic memory domain (as well as an indicator for the Latino/verbal episodic memory domain for the daily interaction with confidant exposure) in all models. Because these specific coefficients were unstable due to interactions between race/ethnicity, cognitive domain and gender, we only report the main coefficients which were stable even when including this interaction.

We assessed whether the relationship between social integration and cognitive score was approximately linear by including integration score as a categorical variable (with 0 as reference); we found no evidence of statistically significant deviations from linearity (see Appendix 2). Therefore, we modeled integration score as a linear term for subsequent models.

We estimated linear mixed-effects models with random individual-level intercepts and continuous integration score as the exposure for both model 1 and model 2 using wave 1 outcome data only. These models estimated the shared effect of the integration score on the three cognitive domains as outcomes (see equation 1 in Appendix 1). Lastly, we estimated a similar linear mixed-effects model using daily interaction with a confidant as the primary exposure.

To evaluate whether these associations differed across race/ethnicity, we first included an interaction term between each exposure and race and conducted an F-test to test for statistically significant differences. Because in a moderate sample, substantively important differences may not reach statistical significance, we also repeated the above analyses in models stratified by race/ethnicity to show race-specific effect estimates regardless of statistical significance of the interaction terms.

Longitudinal analysis—Due to the missingness in the wave 2 outcomes, we conducted the longitudinal analysis on the unbalanced data, including both assessments for participants who had them and only the wave 1 assessment for participants who were missing the wave 2 assessment (n=259).

For primary analyses of the association between social integration and cognitive change, we estimated the above mixed models on data from both wave 1 and wave 2 assessments, including an interaction between age of assessment and the social integration score. This model is used to assess whether social integration modifies the effect of age on cognition. For simplicity of interpretation and to increase power, though we included both linear and quadratic terms for age in our model, we only tested the interaction of integration score with the linear age term. Because there were only two waves of data, it was not possible to estimate random slopes models or estimate separately practice effects and cognitive aging. The coefficients for the age by social integration score thus represent a combination of between-person and within-person effects. We followed the same procedure for models using confidant as the primary exposure.

In sensitivity analyses, we used multiple imputation by chained equations (MICE) on all the models described above, which is valid under a missing at random assumption. We used 20 imputations to impute missing values for income, weekly alcohol use, ADL/IADL score, retirement status and years of education. The pooled p-values from the F-tests for the interaction between each exposure and race/ethnicity were calculated using the *micombine* function from the *miceadds* package in R.

Results

The sample characteristics for the 1343 KHANDLE participants included in our analysis are shown in Table 1. The average age for participants at wave 1 was 75.4 (SD = 6.4) and 40% of participants were male. Participants with higher integration scores were slightly younger, more likely to be male, and more educated. The distribution of integration score varied by race/ethnicity: the average integration score was 3.6 (SD = 1.2) for Asian, 3.4 (SD = 1.3) for Black, 3.3 (SD = 1.2) for Latino and 3.5 (SD = 1.3) for White participants, with a higher score indicating more social contact.

Figure 2 shows the distribution of the measures of social integration by race. Nearly all (93%) participants scored a 2 or higher in our social integration index. The most common type of social connection across all racial/ethnic groups was at least monthly contact with friends and children, and the least common was daily interaction with a confidant. Compared to other groups, Asian respondents were more likely to report being married or living with a partner as if married, having at least monthly contact with relatives and daily interaction with a confidant, while Black participants were less likely to report these measures. Latino participants were more likely to report seeing a child at least once a month and less likely to report volunteering in the past 12 months compared to participants in the other three racial/ethnic groups. Lastly, a greater proportion of White respondents reported at least monthly contact with friends, but a lower proportion reported at least monthly contact with relatives.

Cross-sectional analysis results

In cross-sectional analyses, higher social integration scores were associated with better cognitive scores in model 1 (β = 0.066 (95% CI: 0.040,0.092)); indicating that cognitive scores in all three domains were 0.066 SD higher for each additional increment of 1.0 in the integration score. This association attenuated slightly in model 2 (β = 0.047 (0.021,0.073)) (Table 2). The F-test for the integration score by race interaction was not significant (P = 0.85 for both model 1 and model 2), indicating no statistically significant difference in the estimated effects of social integration across racial/ethnic groups. In minimally adjusted race-stratified models (model 1), the point estimates indicated higher social integration scores were associated with better cognitive scores among Asian (β = 0.082 (0.019,0.145)), Black (β = 0.076 (0.03,0.122)), Latino (β = 0.064 (0.009,0.120)), and White (β = 0.050 (0.004,0.097)) participants (Table 2). With additional covariate adjustment (model 2), the confidence intervals were wider, and the association remained statistically significant only for Black participants (Black: β = 0.061 (0.014,0.109)).

Respondents who reported having daily interaction with a confidant averaged higher cognitive scores (β = 0.137 (0.064,0.211)). The F-test for the interaction between this exposure and race was not significant (P = 0.57 for model 1, P = 0.52 for model 2). In minimally adjusted race-stratified models (model 1), confidence intervals were wider, but associations remained positive for Asian (β = 0.226 (0.065,0.388)), Black (β = 0.119 (−0.021,0.258)), Latino (β = 0.111 (−0.051,0.272)), and White (β = 0.087 (−0.046,0.220)) respondents. With additional covariate adjustment (model 2), the results were attenuated (Table 2).

Longitudinal analysis results

In longitudinal analyses, social integration was associated with better cognition at age 65 in model 1 (β = 0.067 (95% CI: (0.018,0.116)) (Table 3). The overall age-coefficient (β = −0.261 (−0.510, −0.012)) suggested a 1-unit lower social integration score was associated with a difference in cognition similar in magnitude to being about 2.5 years older $\left(\frac{\beta_{(\text{integrationscore})}}{(\beta_{age})/10} \sim 2.5\right)$. Social integration did not modify the slope of cognition associated with older age overall in model 1 (β =−0.001 (−0.041,0.039)) or in any race/ethnicity specific model. When using daily interaction with confidante as the primary exposure, we again found that this exposure was associated with better cognition at age 65 and did not modify the slope of cognition associated with older age. (Table 4).

For the models described above, the results we obtained from the multiple imputation were qualitatively similar, though the confidence intervals changed slightly (see Appendix 3).

Discussion

In this sample representing older adults from four major racial/ethnic groups, higher social integration assessed by our 6-item index was associated with better cognitive scores at baseline. The positive association was consistent across all four racial/ethnic groups with little evidence of effect modification by race. When examined separately, daily interaction with a confidant was also associated with higher cognitive scores for the full sample. Although the estimate for the interaction between each exposure and race/ethnicity did not meet the criterion for statistical significance, the coefficients for Asian participants were two to three times as large as the coefficients for White participants. Our analysis including both wave 1 and wave 2 cognitive assessments found that neither social integration nor having a confidant was associated with the age slope in cognition overall or within any racial/ethnic group, though these results should be interpreted cautiously given the short follow-up time.

Our finding that higher social integration is associated with higher cognition at baseline is consistent with prior research [6,8–10,12,28]. Although no prior work has focused on evaluating the association of having a confidant with cognitive outcomes, confidants are an especially important source of support for older adults and may thus be particularly relevant for cognition. Prior work has shown that social support is associated with both better cognitive function at baseline and at follow-up and that having a confidant is the primary source of both emotional and instrumental support [19,20].

Our paper is also the first to directly compare associations across four racial/ethnic groups. Our findings of no racial/ethnic variations but of significant race-specific effects are in accordance with some studies, but not all. For example, Barnes et al [12] found a differential effect of social engagement, defined in their study as participation in social activities, on cognition between Black and White respondents to the Chicago Health and Aging Project study. However, they did not find a differential effect of social networks, defined as the average number of children, relatives and friends seen at least once a month on cognition. Ertel et al [7] and Pugh et al [29] did not find an association between social integration or social networks size with cognition in African American respondents to the Health and Retirement Study (Ertel) or in the Minority Aging Research Study cohort (Pugh). Another study found that in a cohort of older Chinese American adults, social network size and volume of contact were associated with better cognition [30].

Our findings of generally consistent, positive associations between social integration and cognition are especially convincing because participants were all from the same study, and were subject to similar recruitment processes and identical measurement protocols. This consistency suggests that integration is similarly important for cognition, regardless of race/ethnicity, and that mechanisms accounting for the connection between social networks and cognition likely rely on features of networks that are common across racial/ethnic groups. Since we included income as a covariate in our regressions to account for differences in the financial resources and composition of social networks across racial/ethnic groups, this may implicate emotional or other non-financial mechanisms.

Evidence on the association between social integration and cognitive change is less consistent. While some studies find a longitudinal association using a mixed-effects model approach [7,12], other studies estimated models using a baseline-adjustment approach which may be vulnerable to bias towards cross-sectional associations [6,8,10 31,32]. The lack of association between social integration and cognitive decline in our findings suggests the influence of social connections on cognition – if causal – does not provide large benefit in slowing longitudinal deterioration over the short term. However, our longitudinal analyses should be interpreted very cautiously because we only had two waves of data, separated by approximately 18 months. Very little cognitive change may have occurred during this time period.

This study has several limitations. Our composite measure of social integration partially reflects multiple, conceptually distinct, domains of social networks, social engagement and social integration, which could each affect cognition in different ways. Different study designs will be better positioned to evaluate the causal relevance of specific types of social connections for cognitive aging. Though we made an effort to minimize type I error by using an index for our exposure and by using a mixed-effects model approach, we recognize the potential of chance findings. In longitudinal analyses, our model specification used both between- and within-person differences to estimate whether social integration was associated with faster age-related cognitive decline. Although the potential biases from this model are more likely to create spuriously positive associations rather than spuriously null associations, the longitudinal results should be regarded as preliminary. We also did not evaluate change in social integration, which might co-occur with changes in cognition;

assessing how changes in social integration affect cognition is an important future direction which would ideally be pursued in a study with a longer follow-up period to allow for substantial fluctuations in integration.

A key strength of our study was the diversity of the KHANDLE cohort, with four major racial/ethnic groups represented in approximately balanced sample sizes. KHANDLE was intentionally designed to facilitate comparisons across racial/ethnic groups. Even so, for some comparisons – specifically the association of confidants with cognition in Asian participants – the differences in effect estimates are meaningful and would be considered substantively significant even if not statistically significant [33]. We used rigorous mixed models to improve the statistical power to detect associations or differences between racial/ethnic groups. The psychometrically valid SENAS battery was designed to measure subtle changes in cognition without limitation due to floor or ceiling effects.

We find that for Asian, Black, Latino, and White older adults, average cognition across multiple domains is better among individuals who are more socially integrated. These results are encouraging about the relevance of prior research on social connections and cognition for individuals of all racial/ethnic groups. Further research should focus on understanding the mechanisms linking social integration to cognitive outcomes, and if they operate similarly for racial/ethnic groups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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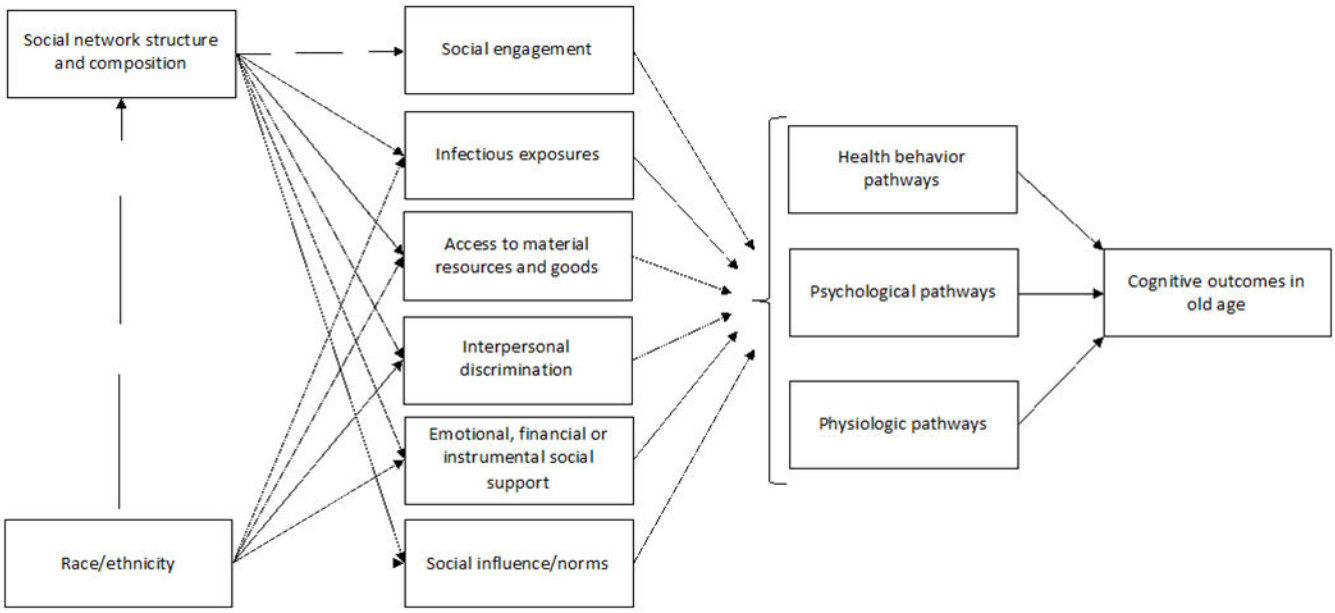

Figure 1 –.

Conceptual model representing possible reasons the effects of social ties on cognitive outcomes in old age may differ by race/ethnicity. The structure and composition of social networks may differ by race/ethnicity and in the contemporary social context characterized by racial/ethnic segregation, historical and on-going structural racism, racial/ethnic social identities may directly influence the mechanisms that mediate the effect of social networks. Modified from Berkman et al.

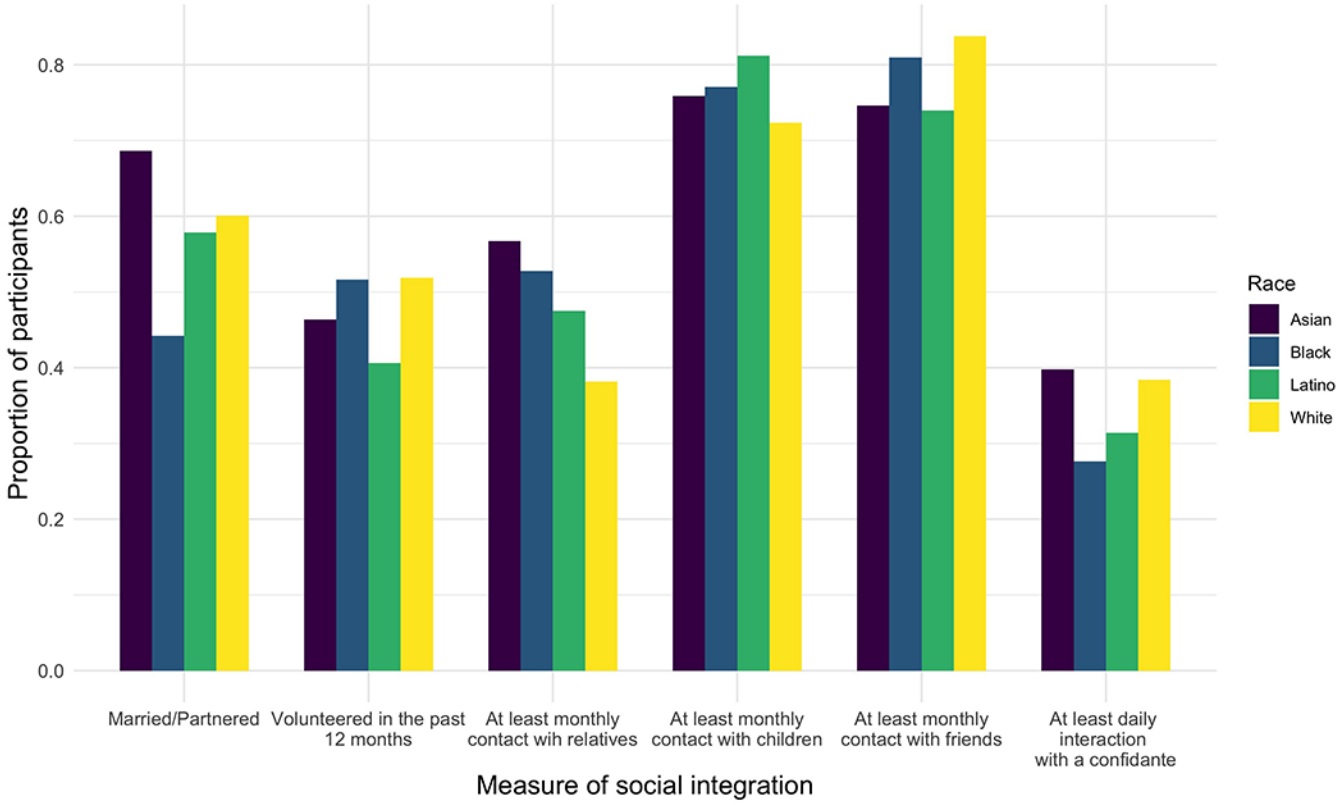

Figure 2 –.

Proportion of participants who reported being married or living with a partner as if married, volunteering any time in the past 12 months, having at least one relative, child, and friend they see at least once a month, and a confidant they see daily.

Table 1 –

Sample characteristics by integration score for the 1343 KHANDLE participants included in the complete case analysis.

	Social Integration Score						
	Overall	**0 or 1**	**2**	**3**	**4**	**5**	**6**
n	1343	96	217	384	361	208	77
Mean age (SD)	75.4 (6.4)	76.5 (6.7)	77.2 (7.0)	76.0 (6.6)	74.8 (6.2)	73.8 (5.3)	73.1 (4.9)
Gender = Male (%)	540 (40.2)	37 (38.5)	67 (30.9)	139 (36.2)	154 (42.7)	101 (48.6)	42 (54.5)
Race (%)							
Asian	319 (23.8)	18 (18.8)	38 (17.5)	84 (21.9)	104 (28.8)	55 (26.4)	20 (26.0)
Black	362 (27.0)	30 (31.2)	65 (30.0)	111 (28.9)	85 (23.5)	46 (22.1)	25 (32.5)
Latino	261 (19.4)	18 (18.8)	42 (19.4)	84 (21.9)	76 (21.1)	34 (16.3)	7 (9.1)
White	401 (29.9)	30 (31.2)	72 (33.2)	105 (27.3)	96 (26.6)	73 (35.1)	25 (32.5)
Mean years of education (SD)	14.9 (2.9)	14.30 (2.5)	14.42 (3.3)	14.82 (3.0)	14.96 (2.7)	15.3 (3.0)	15.7 (2.5)
Mean annual household income in thousands of dollars (SD)	89.8 (46.6)	61.9 (37.1)	73.6 (43.6)	85.9 (46.8)	95.1 (44.2)	107.2 (44.8)	117.7 (43.8)
Mean number of drinks per week (SD)	2.8 (4.6)	3.1 (5.5)	2.4 (3.7)	3.0 (5.1)	2.7 (4.3)	2.9 (4.5)	3.1 (4.1)
Mean ADL/IADL score (SD)	1.3 (0.4)	1.4 (0.5)	1.3 (0.4)	1.3 (0.3)	1.2 (0.3)	1.2 (0.3)	1.2 (0.3)
Retired (%)	1057 (78.7)	79 (82.3)	177 (81.6)	308 (80.2)	271 (75.1)	169 (81.2)	53 (68.8)

Note: participants with integration score of 0 and 1 are combined in the table due to small cell sizes but kept separate in the analysis. Higher ADL/IADL score corresponds to more difficulty.

Table 2 –

Estimated associations of social integration score (top panel) and daily contact with confidant (bottom panel) with baseline cognition, from mixed-effects linear regression models using Kaiser Healthy Aging and Diverse Life Experiences Cohort baseline data.

	Model 1 N=1,343	**Model 2 N=1,343**
	β (95% CI)	**β (95% CI)**
Estimated effect of social integration in model for:		
Overall	0.066 (0.040, 0.092)	0.047 (0.021, 0.073)
Asian	0.082 (0.019, 0.145)	0.062 (0.000, 0.124)
Black	0.076 (0.030, 0.122)	0.061 (0.014, 0.109)
Latino	0.064 (0.009, 0.120)	0.052 (−0.006, 0.111)
White	0.050 (0.004, 0.097)	0.028 (−0.020, 0.075)
p-value for test of race*social integration	0.852	0.851
Estimated effect of daily contact with confidant in model for:		
Overall	0.137 (0.064, 0.211)	0.113 (0.041, 0.186)
Asian	0.226 (0.065, 0.388)	0.207 (0.049, 0.364)
Black	0.119 (−0.021, 0.258)	0.089 (−0.050, 0.228)
Latino	0.111 (−0.051, 0.272)	0.099 (−0.062, 0.261)
White	0.087 (−0.046, 0.22)	0.073 (−0.057, 0.202)
p-value for test of race*confidant	0.570	0.520

CI=Confidence Interval. Coefficients are interpreted as the effect of social integration score on the executive function, verbal episodic memory, or semantic memory cognitive domains with the exception of episodic memory among Asian respondents for social integration and among Asian and Latino respondents for daily interaction with confidant. Model 1 adjusted for age, gender, race, and years of education, model 2 adjusted for age, gender, race, years of education, weekly alcohol use, average score for combined activities of daily living (ADL) and instrumental ADL, income and retirement status. Social integration score ranges from 0 to 6.

Table 3 –

Estimated associations of social integration score with average cognition and age-slope in cognition, from mixed-effects linear regression models using Kaiser Healthy Aging and Diverse Life Experiences Cohort baseline and first follow-up data.

	Model 1 N=1,343 β **(95% CI)**	**Model 2 N=1,343** β **(95% CI)**
Overall		
Integration score	0.067 (0.018,0.116)	0.048 (−0.001,0.097)
Age (in decades)	−0.261 (−0.510, −0.012)	−0.253 (−0.499, −0.007)
Age^2	−0.080 (−0.152, −0.009)	−0.007 (−0.139,0.002)
Integration score x age	−0.001 (−0.041,0.039)	−0.001 (−0.041,0.038)
Asian		
Integration score	0.09 (−0.024,0.204)	0.07 (−0.042,0.182)
Age	−0.363 (−0.930,0.204)	−0.273 (−0.828,0.282)
Age^2	0 (−0.168, 0.168)	−0.002 (−0.233,0.026)
Integration score x age	−0.003 (−0.093,0.086)	−0.003 (−0.09,0.084)
Black		
Integration score	0.100 (0.012,0.187)	0.087 (0,0.175)
Age	−0.150 (−0.607,0.308)	−0.150 (−0.606,0.306)
Age^2	−0.112 (−0.255, 0.021)	−0.106 (−0.244,0.032)
Integration score x age	−0.026 (−0.102,0.051)	−0.028 (−0.105,0.048)
Latino		
Integration score	0.106 (0,0.212)	0.095 (−0.013,0.203)
Age	−0.249 (−0.770,0.273)	−0.213 (−0.736,0.313)
Age^2	−0.002 (−0.170, 0.123)	−0.028 (−0.013,0.203)
Integration score x age	−0.031 (−0.122,0.06)	−0.029 (−0.12,0.062)
White		
Integration score	0.022 (−0.068,0.112)	−0.008 (−0.096,0.08)
Age	−0.336 (−0.805,0.134)	−0.391 (−0.848,0.067)
Age^2	−0.104 (−0.233, 0.026)	−0.073 (−0.199,0.054)
Integration score x age	0.020 (−0.051,0.090)	0.025 (−0.043,0.093)

CI=Confidence Interval. Model 1 adjusted for age, gender, race, and years of education, model 2 adjusted for age, gender, race, years of education, weekly alcohol use, average score for combined activities of daily living (ADL) and instrumental ADL, income and retirement status. Social integration score ranges from 0 to 6.

Table 4 –

Estimated associations of daily interaction with confidant with average cognition and age-slope in cognition, from mixed-effects linear regression models, Kaiser Healthy Aging and Diverse Life Experiences Cohort baseline and first follow-up data.

	Model 1 N=1,343 β (95% CI)	Model 2 N=1,343 β (95% CI)
Overall		
Confidant	0.156 (0.024,0.287)	0.103 (−0.027,0.233)
Age (in decades)	−0.241 (−0.431,−0.051)	−0.246 (−0.434,−0.058)
Age^2	−0.090 (−0.160,−0.020)	−0.073 (−0.143,−0.004)
Confidant x age	−0.039 (−0.145,0.066)	−0.013 (−0.116,0.090)
Asian		
Confidant	0.339 (0.054,0.624)	0.317 (0.039,0.595)
Age	−0.319 (−0.752,0.114)	−0.231 (−0.655,0.194)
Age^2	−0.011 (−0.177,0.155)	−0.026 (−0.188,0.136)
Confidant x age	−0.100 (−0.324,0.124)	−0.096 (−0.315,0.122)
Black		
Confidant	0.149 (−0.104,0.403)	0.110 (−0.141,0.362)
Age	−0.185 (−0.535,0.165)	−0.207 (−0.556,0.142)
Age^2	−0.136 (−0.272, 0.000)	−0.117 (−0.253,0.019)
Confidant x age	−0.075 (−0.315,0.164)	−0.066 (−0.303,0.170)
Latino		
Confidant	0.241 (−0.047,0.529)	0.230 (−0.060,0.519)
Age	−0.370 (−0.765,0.029)	−0.312 (−0.714,0.092)
Age^2	−0.011 (−0.158,0.135)	−0.017 (−0.166,0.131)
Confidant x age	−0.097 (−0.313,0.119)	−0.095 (−0.312,0.122)
White		
Confidant	0.023 (−0.223,0.271)	−0.088 (−0.327,0.152)
Age	−0.245 (−0.608,0.118)	−0.331 (−0.685,0.024)
Age^2	−0.120 (−0.246,0.006)	−0.077 (−0.201,0.046)
Confidant x age	0.001 (−0.189,0.189)	0.085 (−0.100,0.268)

CI=Confidence Interval. Model 1 adjusted for age, gender, race, and years of education, model 2 adjusted for age, gender, race, years of education, weekly alcohol use, average score for combined activities of daily living (ADL) and instrumental ADL, income and retirement status. Social integration score ranges from 0 to 6