Title: Social engagement and cognitive health in a population-based study of older men and women in rural South Africa

Authors: Guy Harling, Lindsay Kobayashi, Meagan T. Farrell, Ryan G. Wagner, Lisa Berkman

Abstract: We investigated how patterns of social engagement and cognitive health in a population-based study of over 5000 individuals aged ≥ 40 years in rural South Africa fit with three existing theories of how social engagement and cognitive function are interconnected in older age. We found that respondents with lower cognitive function had smaller, denser social networks that were more local and more kin-based than their peers. Lower cognitive function was associated with receipt of less social support in general, but this difference was stronger for emotional and informational than for financial and physical support. These patterns suggest that cognitively impaired older adults in this setting rely on their core social networks for support, and that theories developed in higher-income and higher-education settings may also apply elsewhere in the world.

Introduction

By 2050, 70% of dementia cases worldwide are projected to occur in low-and-middle income countries (LMICs), such as those in sub-Saharan Africa (Prince et al., 2013). However, the social drivers of cognitive health in older LMIC populations are not well understood (Lekoubou et al., 2014; Olayinka & Mbuyi, 2014). Education is perhaps the strongest known protective factor against aging-related cognitive decline and dementia (Clouston et al., 2015; Nguyen et al., 2016; Vemuri et al., 2014). However, in many LMICs, school access and quality are limited, especially for those who are now middle-aged or older (Kenn, 2016; UNESCO, 2018). In the South African context, non-White citizens were systematically excluded from educational opportunities during the Apartheid era of 1948-1994 (Christie & Collins, 1982). Alternative means of developing, maintaining, and promoting cognitive health may therefore be particularly important for the current generation of older non-White South Africans.

Social connectedness is hypothesized to be a key protective mechanism against cognitive decline. Social networks have been theorized to impact health in myriad ways, at macro-social, community and interpersonal levels (Berkman et al., 2000). One strong hypothesized effect is that greater social stimulation protects against cognitive decline, i.e. the “use it or lose it” hypothesis (Hultsch et al., 1999). There is substantial longitudinal observational evidence that loneliness and social isolation are associated with incident cognitive decline and dementia (Bassuk et al., 1999; Kuiper et al., 2015; Shankar et al., 2011). There is also related evidence that higher levels of social engagement are associated with less cognitive decline (Barnes et al., 2004; Ertel et al., 2008; Teresa E Seeman et al., 2001). There is some evidence that these associations are stronger in mid-life compared to older ages (Teresa E. Seeman et al., 2011). Furthermore, a small number of randomized trials have shown the ability of increased social engagement to improve cognitive performance (Hikichi et al., 2017; Mortimer et al., 2012; Pitkala et al., 2011). In this literature, a range of aspects of social engagement have been examined, such as social contact count, frequency of contact with friends or family, levels of emotional support and attendance at religious or community events.

While the substantial literature discussed above links social dis-engagement to subsequent cognitive decline, it is also to be expected that cognitive impairment or dementia following a period of cognitive decline will lead to social dis-engagement. This latter situation may arise due to the impaired individual being less able to engage with others, and others being less able or less motivated to engage with them. Evaluations of this 'reverse' causal process, whereby impaired cognitive function leads to social disengagement, are relatively rare (Aartsen et al., 2002; Hosking et al., 2017; Small et al., 2012). In practice, the association is likely to be a virtuous circle, whereby better cognitive health promotes ability to engage in stimulating social relationships and activities which further promote cognitive health in older age, or a vicious one in which low social engagement and poor cognitive function negatively impact one-another (Bosma et al., 2002; Hultsch, et al., 1999). This divergence is likely to be exacerbated by perceived loss of cognitive capacity, e.g. through reduced word recall, which can lead to greater disengagement independent of measured cognitive ability (Farrell et al., 2014).

At the same time, a third social process might be expected, whereby older adults experiencing cognitive decline begin to receive more care-related support. This support is likely to be primarily instrumental, including physical and financial assistance, but may also include emotional support as and if those with cognitive decline become disorientated or afraid. Social contacts may also decide to shift from providing emotional support to providing instrumental or financial support, as they notice cognitive decline.

Importantly, this shedding of social connections and accretion of care receipt is likely to be non-random. Following the Convoy Model (Antonucci & Akiyama, 1995), the closest social connections are most likely to maintained as cognitive capacity declines, while peripheral ties are shed (Clay et al., 2008). Caregiving is likely to be performed most often by those who are geographically close, and by those for whom there is an expected intertemporal reciprocity, i.e. offspring and other kin (Schulz & Martire, 2004). These close social ties are likely to be strongly interconnected. A recent cross-sectional comparison of US individuals with normal cognitive function, mild cognitive impairment, and mild Alzheimer's disease showed a progressive shift towards smaller, denser and more kin-focused social networks with greater symptomology (Perry et al., 2017).

Existing research on all of these causal processes has largely been conducted in higher-income countries and among relatively highly educated populations. The role of social engagement in later-life cognitive health in low-income settings is less well examined, and it is not clear how context-specific any buffering effects of social engagement might be. Observation of older Spanish adults educated prior to World War II showed that both having few social contacts and non-participation in social activities were associated with subsequent cognitive decline (Zunzunegui et al., 2003). Within Africa, two studies in Nigeria showed a cross-sectional positive association of social engagement and cognitive function (Ejechi, 2015), and a longitudinal association between social non-engagement and incident dementia (Gureje et al., 2011). We are not aware of any previous work exploring whether cognitive decline leads to loss of social connections or increases in care receipt in LMICs.

Analytic hypotheses

We therefore conducted an analysis of the first round of data collected for a South African rural cohort of middle-aged and older adults, to determine whether the patterns of social engagement seen in this population were consistent with the three causal processes described above. Specifically, we hypothesized that individuals with cognitive impairment will have:

1. Fewer social contacts, due either to cognitive decline having led to reduced contacts, or limited contacts having led to cognitive decline;
2. More kin-focused, geographically proximate and densely connected social contact groups, as peripheral ties are shed and support is drawn from individual's closest contacts;
3. Lower levels of social support of all kinds, due to having shed social contacts, offset in the case of physical and financial support by an increased need for instrumental assistance.

Our cross-sectional data source does not allow us to disentangle these effects, particularly those running from social engagement to cognitive function, and those from cognitive function to social engagement. However, we are able to provide an initial picture of how social factors and cognitive capacity are patterned in this setting, and generate hypotheses to test with future longitudinal data.

Methods

Setting and sample

Our sample comprises the baseline responses in the Health and Aging in Africa: a Longitudinal Study of an INDEPTH community in South Africa (HAALSI) cohort (Gómez-Olivé et al., 2018). HAALSI is a population-based cohort of middle-aged and older males and females aged 40 and above, and is a Health and Retirement Study (HRS) sister study. The baseline sample consists of a random sample of adults aged ≥40 in the MRC/Wits Rural Public Health and Health Transitions Research Unit site in Mpumalanga Province, South Africa (hereafter, "Agincourt") (Kahn et al., 2012). The Agincourt area is rural and, while improvements have occurred since the end of Apartheid, it continues to have limited access to basic services including healthcare. HAALSI interviews were conducted in-home by trained interviewers in the local Shangaan language between November 2014 and November 2015.

Measurement of key variables

Cognitive functioning was assessed in two ways based on a battery of cognitive measures adapted from validated measures in the U.S. HRS and adapted for local cultural relevance and language in Agincourt. The battery consisted of questions assessing: orientation in time (ability to state the correct date, month, year, and South African President; 4 items total); immediate and delayed recall of 10 words read out loud (20 items total); and ability to count forward from 1 to 20 (1 item) and complete a number pattern (2, 4, 6, ?; 1 item). First, we generated a latent cognitive Z-score with a mean of 0 and standard deviation of 1, based on confirmatory factor analysis from all measures in the battery (Kobayashi et al., 2017). Second, we generated a binary variable identifying those with cognitive impairment: those who scored ≤1.5 standard deviations below the mean on the sum of values for time orientation and immediate and delayed word recall, which are believed to reflect most closely aging-related cognitive impairment, or who required a proxy respondent and were reported to have "fair" or "poor" memory.

We used a range of measures of social engagement based on a social network name generator: "Please tell me the names of [up to] 6 adults with whom you have been in communication either in person or by phone or by internet in the past six months, starting with the person who is most important to you for any reason." If the respondent was married and living with their spouse, the spouse's name was added to the list of contacts ("alters") if not otherwise named. For each named alter, sociodemographic information (age, sex, kinship and residential location) was elicited, alongside frequency of communication and how frequently the alter provided emotional, informational, physical and financial support (Harling, Morris, et al., 2018). Finally, respondents were asked how frequently they believed each named alter communicated with each other alter.

We measured level of social contact as the number of contact names provided and the estimated number of days per month in which an alter had had contact with a respondent, summed across all named alters (i.e., a maximum of 30 * 7 = 210 contact-days). We measured social support as the number of support-days received per month in same manner, but specific to each support type. To evaluate our hypotheses regarding kinship and physical proximity, we categorized alters as either kin or non-kin, and as living in the same household, same village, within the Agincourt site or elsewhere in South Africa. Finally, we measured the effective size of each respondent egocentric network as a respondent's alter count, minus the average number of ties that each alter has to other alters (Burt, 1992). Effective size reflects the breadth of independent sources of input respondents have available to them.

Statistical analysis

After describing exposures and outcomes, we conducted multivariable regression for each exposure and outcome. We used linear models for cognitive function Z-scores and logistic models or cognitive impairment (yes vs. no). All models were hierarchical, nesting respondents in interviewers, and adjusted for month of interview, since interviewer identity and interview month have previously been shown to systematically affect HAALSI social network responses (Harling, Perkins, et al., 2018). We also adjusted all models for factors believed to predict both cognitive function and social engagement, namely: age; gender; country of origin; educational attainment; self-rated childhood health; father's occupation; literacy; marital status; household size; employment status and household wealth. As an additional step to test for our association reflecting physical health differences, we re-ran the multivariable models adding binary indicators for good/very good self-reported health now and any report an a limitation in the basic activities of daily living (ADLs).

Results

A total of 5059 eligible respondents completed HAALSI baseline questionnaires (85.9% response rate), of whom 5019 had a valid response for the cognitive impairment variable and 4927 had a valid cognitive Z-score. For cognitive impairment, 416 (8.3%) of respondents scored more than 1.5 standard deviations below the mean or required a proxy interview with ‘fair’ or ‘poor’ proxy-reported memory. Mean cognitive Z-scores declined with age and the likelihood of cognitive impairment rose with age; women had worse cognitive function than men, especially over age 70 (Figure 1).

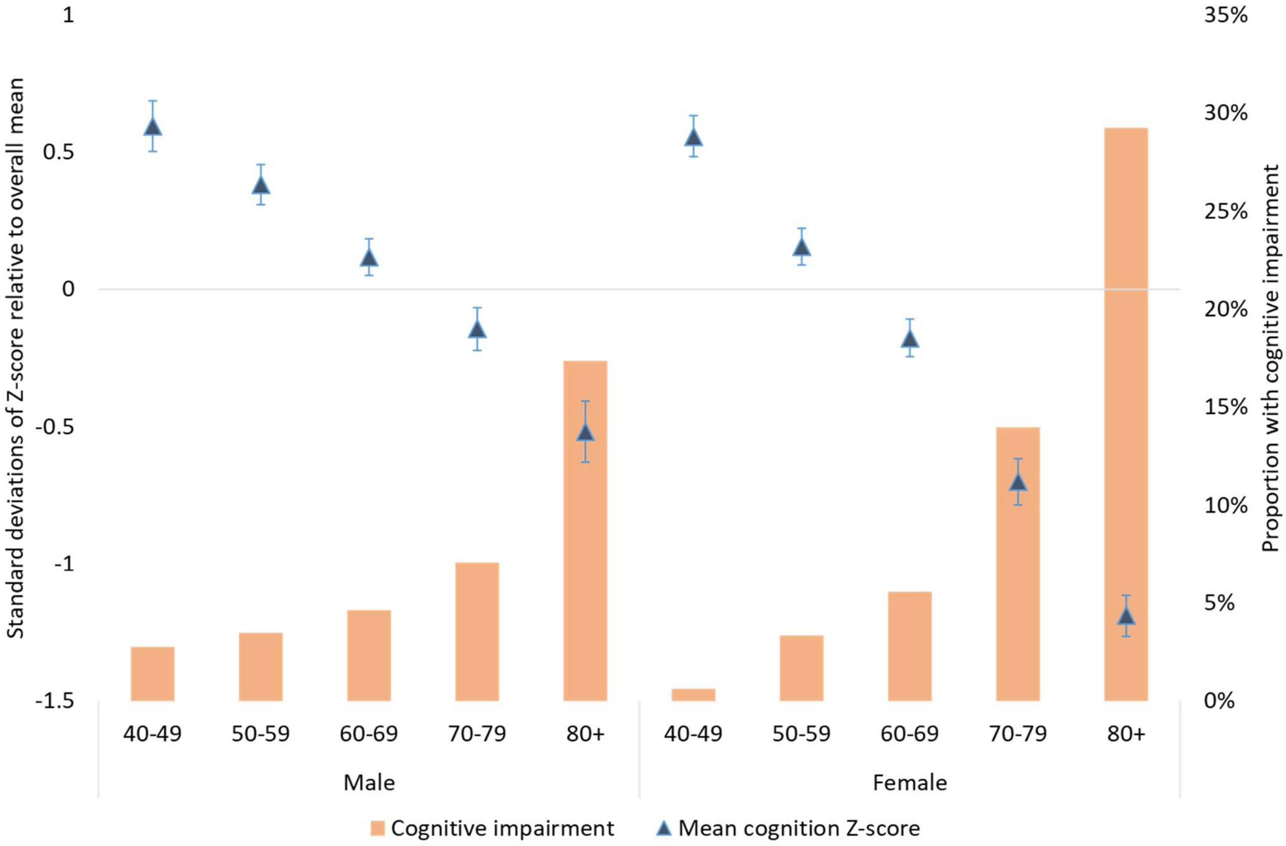

Figure 1. Cognition outcomes in HAALSI baseline by age and gender

In multivariable models, almost all the social engagement variables were positively associated with higher cognitive Z-score values and negatively with cognitive impairment (Table 1). Broad social contact was substantially lower among those with cognitive impairment or a low cognitive Z-score. For example, individuals reporting 22 total communication events per month (one standard deviation below the mean) had an adjusted probability of 14.8% of cognitive impairment, compared to 7.9% for those reporting 99 events (one standard deviation above the mean).

Individuals with lower cognitive status named fewer kin and non-kin contacts; however, this was asymmetric, with a greater difference in non-kin than in kin contacts across cognition levels. As a result, the proportion of all contacts that were kin was substantially lower for those with cognitive impairment. Similarly, respondents with cognitive impairment had fewer contacts living at all distances, but the differences were greatest for those contacts living outside the same household. Finally, the effective size of the immediate social networks of those with lower cognitive scores was non-significantly smaller than that of their peers, indicating a more closely connected set of contacts. Individuals with poorer cognitive status also reported that their social contacts provided all kinds of social support less frequently than did their cognitively stronger peers. However, the differences were greater for informational and emotional support than for financial and physical support. Rerunning our analyses adjusting for current physical health had almost no impact on the associations reported in Table 1. We also provide the full regression models for the outcome of number of named contacts, as an exemplar to show the associations of all covariates with our outcomes.

Table 1. Descriptive statistics and adjusted regression models for social engagement variables & cognitive status

Variable (unit of change for regressions)	Mean (SD) or percent	[IQR]	Cognitive impairment		Standardized cognition score (SD)	
			Logistic		GLM	
Named contacts (count)	3.1	[2, 4]	0.66	[0.59, 0.73]	0.03	[0.01, 0.04]
Communication events per month (SD)	60.6 (38.3)	[30, 90]	0.63	[0.54, 0.74]	0.05	[0.02, 0.07]
Contact kinship						
Named kin (count)	2.4	[1, 3]	0.78	[0.71, 0.86]	0.01	[0.00, 0.02]
Any named non-kin (binary)	35.5%		0.46	[0.34, 0.63]	0.07	[0.03, 0.11]
Percent named contacts who are kin (10 %age points) †	79.1	[67, 100]	1.08	[1.02, 1.13]	-0.01	[-0.02, 0.00]
Contact distance ‡						
Same household (count)	0.8	[0, 1]	0.78	[0.65, 0.93]	-0.02	[-0.05, 0.01]
Same village (count)	1.3	[0, 2]	0.61	[0.53, 0.69]	0.03	[0.01, 0.05]
Agincourt area (count)	0.4	[0, 0]	0.67	[0.54, 0.83]	0.06	[0.03, 0.09]
Elsewhere South Africa (count)	0.5	[0, 1]	0.65	[0.55, 0.78]	0.03	[0.01, 0.05]
Egonet effective size						
Effective size (range 1-5.7) †	1.1	[1, 1]	0.84	[0.54, 1.33]	0.04	[0.00, 0.09]
Support types						
Informational, per month (SD)	29.3 (33.1)	[4, 40]	0.66	[0.55, 0.80]	0.05	[0.02, 0.07]
Emotional, per month (SD)	26.5 (32.8)	[4, 35]	0.65	[0.53, 0.79]	0.07	[0.05, 0.10]
Financial, per month (SD)	15.0 (22.2)	[1, 30]	0.83	[0.71, 0.98]	0.02	[0.00, 0.05]
Physical, per month (SD)	24.5 (26.1)	[4, 34]	0.72	[0.61, 0.86]	0.03	[0.00, 0.05]

Each set of regression coefficients represents results from a different model, with the exception of 'contact distance' models (‡), where all four variables were included in a single regression. All models are hierarchical (individuals nested in interviewers) and are adjusted for age, gender, employment status, household size, household wealth, educational attainment, literacy, marital status, father's occupation, childhood health status and interview month. † Models for percent of contacts who are kin and egonet effective size are also adjusted for the number of contacts named. N for 'cognitive impairment' models is 4974; N for 'cognition score' models is 4888. IQR: Interquartile range; SD: Standard deviations.

Table 2. Complete adjusted regression model for named contact counts

	Cognitive impairment		Standardized cognition score (SD)	
Named contacts (count)	0.67	[0.61, 0.75]	0.03	[0.01, 0.04]
Age and gender (ref: male 40-49)				
Male 50-59	1.24	[0.59, 2.62]	- 0.07	[-0.16, 0.01]
60-69	1.21	[0.57, 2.58]	- 0.11	[-0.20, -0.02]
70-79	2.08	[0.98, 4.41]	- 0.23	[-0.33, -0.13]
80+	3.27	[1.48, 7.20]	- 0.40	[-0.52, -0.28]
Female 40-49	0.27	[0.08, 0.88]	0.06	[-0.03, 0.14]
50-59	0.83	[0.39, 1.78]	- 0.05	[-0.14, 0.03]
60-69	1.01	[0.48, 2.14]	- 0.19	[-0.28, -0.10]
70-79	1.92	[0.91, 4.06]	- 0.52	[-0.63, -0.42]
80+	3.80	[1.79, 8.09]	- 0.80	[-0.92, -0.69]
Employment status (ref: not working)				
Employed (part or full time)	0.62	[0.33, 1.17]	0.03	[-0.03, 0.09]
Homemaker	0.92	[0.51, 1.66]	- 0.14	[-0.23, -0.06]
Household size (ref: living alone)				
Living with one other person	1.27	[0.80, 2.01]	- 0.03	[-0.11, 0.06]
Living with 2-5 others	1.00	[0.68, 1.47]	- 0.01	[-0.07, 0.06]
Living with 6+ others	0.85	[0.55, 1.31]	- 0.01	[-0.08, 0.07]
Household asset level (ref: lowest quintile)				
Second lowest quintile	0.98	[0.70, 1.37]	0.10	[0.05, 0.16]
Middle quintile	0.84	[0.58, 1.22]	0.16	[0.10, 0.22]
Second highest quintile	0.96	[0.65, 1.41]	0.15	[0.09, 0.21]
Highest quintile	0.78	[0.48, 1.26]	0.19	[0.13, 0.26]
Educational attainment (ref: no formal education)				
Some primary (1-7 years)	0.76	[0.51, 1.14]	0.29	[0.23, 0.34]
Some secondary (8-11 years)	0.61	[0.23, 1.63]	0.43	[0.36, 0.51]
Secondary or more (12+ years)	1.21	[0.42, 3.46]	0.67	[0.58, 0.76]
Country of origin:				
Mozambique/other vs South Africa	1.34	[1.01, 1.77]	- 0.12	[-0.16, -0.07]
Marital status (ref: currently married)				
Never married	2.62	[1.48, 4.63]	- 0.06	[-0.15, 0.03]
Separated/divorced	1.32	[0.84, 2.07]	- 0.06	[-0.12, 0.01]
Widowed	1.33	[0.93, 1.90]	- 0.07	[-0.12, -0.02]
Can vs. cannot read or write	0.15	[0.10, 0.23]	0.55	[0.49, 0.60]
Father's occupation (ref: skilled)				
Unskilled	1.33	[0.99, 1.80]	- 0.05	[-0.10, -0.01]
Other	1.34	[0.88, 2.06]	- 0.06	[-0.12, 0.01]
Don't know	1.89	[1.33, 2.70]	- 0.09	[-0.15, -0.02]
Childhood self-rated health:				
Good/very good vs. moderate/bad/very bad	0.74	[0.50, 1.09]	0.13	[0.06, 0.20]
Any report of ADL limitation	0.38	[0.28, 0.53]	0.15	[0.08, 0.22]
Current self-rated health:				
Good/very good vs. moderate/bad/very bad	0.76	[0.58, 1.00]	0.05	[0.01, 0.10]
Intraclass correlation coefficient	0.12		0.16	
Observations	4,973		4,887	

Both models are hierarchical (individuals nested in interviewers) and contain fixed effects for month of interview.

Discussion

We find striking associations between two measures of cognitive impairment and a range of measures of social engagement, which together provide support for all three of the analytic hypotheses with which we began. First, and most broadly, we found that individuals with impaired cognition reported smaller core social networks of important others, and reported less communication with these contacts. This association is agnostic as to causal mechanism. Fewer ties may reflect contacts lowering engagement due to the increased difficulty of interaction, or respondents with impairment finding ties increasingly difficult to maintain, or those with more ties being better able to maintain their cognitive capacity.

Second, we saw a smaller number of both kin and non-kin ties among respondents with worse cognition, but the latter was substantially lower than the former – leading to the social networks of those with worse cognition having a larger proportion of kin vs non-kin. Linked to this kin finding, HAALSI participants with cognitive impairment had fewer ties with people in all geographic locations, but the difference was less for contacts living in the same household than for others. These two findings highlights that ties with individuals not bound by reciprocal familial obligations were more infrequent for those with cognitive impairment. Third, we found a non-significant negative association between the level of connectedness between contacts and cognitive scores. This suggests that the ties not present for those respondents with cognitive impairment were more peripheral to their lives. All of this paints a picture of a core support network being retained by those with cognitive impairment.

Third, when we separate out the support being provided to respondents, we found lower levels of all support types for those with lower cognitive scores. However, once again the difference was not the same for all types. Specifically, those with lower cognitive scores had the greatest difference in support for informational and emotional support, a moderate difference for physical support and the least difference for financial support. This pattern of findings amounts to a general decline in social connectivity – as described above – offset to some extent for financial and physical support, which we might expect to rise as care needs rise for those with cognitive impairment.

While we cannot prove causality at this time, our findings suggest that further exploration of these patterns in longitudinal data are warranted, including the use of methods that can separate out the two possible causal directions and multiple potential mechanisms responsible for the associations shown. Our findings add to existing evidence of a positive association of social engagement and cognition in populations with limited educational attainment (Ejechi, 2015; Gureje, et al., 2011; Zunzunegui, et al., 2003). This growing literature suggests that there may be a benefit to social engagement for older adults in terms of protecting cognition, and possibly an impact of declining cognition on social engagement.

Limitations

The most significant limitation of this work is the cross-sectional nature of the data analysed. Given the high likelihood of bi-directional causality between the key groups of variables, we are not able to prove that impairment causes reduced social engagement, or vice versa, at this time. However, we have provided evidence of a very particular pattern of associations between different measures of social engagement, social support and cognitive impairment. This pattern appears consistent with both impairment leading to changes in social connectivity, and changes in social connectivity leading to impairment.

Another important issue to consider is generalizability. This study was conducted in a rural part of South Africa that was substantially impoverished under the Apartheid regime, limiting educational opportunities, affecting social relationships and family bonds and potentially affecting cognitive capacity through workplace and home-based environmental exposures. Our findings should be applicable to other rural South African settings, and potentially to urban populations within the country too. It is less clear how they might apply in other African and LMIC nations, and it will be important to evaluate this in other datasets in the future.

Third, much of the data we are considering is self-reported, and thus potentially open to social desirability and recall bias. While the cognitive measures are less susceptible due to their indirect approach to measuring cognition (i.e. the respondents were not directly asked if they felt they had cognitive impairment), social support and engagement measures did rely on self-report. Insofar as these self-reports may have been differentially biased by cognitive level, this may introduce bias into our associational measures. While the increased effort required by those with cognitive impairment may temper our interpretation of the overall lower level of social engagement in this group, it is harder to see how this could have led to the differential associations seen by kin, geography and support type.

Conclusions

In our cross-sectional analysis of over 5000 middle-aged and older adults in rural South Africa, we found respondents with lower cognitive function had smaller, denser social networks that were more home- and kin-based than their peers. These cognitively impaired individuals received less social support in general, but less so for instrumental support. These patterns suggest that cognitively impaired older adults in this setting rely on their core social networks for support, and that theories developed in higher-income and higher-education settings may also apply here.

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