Cognitive Function and Impairment in Older, Rural South African Adults: Evidence from "Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in Rural South Africa"

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Abstract

Background/Aims: We aimed to estimate the prevalence of cognitive impairment, and the sociodemographic and comorbid predictors of cognitive function among older, rural South African adults.

Methods: Data were from a population-based study of 5,059 adults aged ≥ 40 years in rural South Africa in 2015. Cognitive impairment was defined as scoring ≥ 1.5 SDs below the mean composite time orientation and memory score, or requiring a proxy interview with "fair" or "poor" proxy-reported memory. Multiple linear regression estimated the sociodemographic and comorbid predictors of cognitive score, with multiplicative statistical interactions between each of age and sex with education.

Results: Cognitive impairment increased with age, from 2% of those aged 40–44 (11/516) to 24% of those aged ≥ 75 years (214/899). The independent predictors of lower cognitive score were being older, female, unmarried, not working, having low education, low household wealth, and a history of cardiovascular conditions. Education modified the negative associations between female sex, older age, and cognitive function score.

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Conclusions: The prevalence of cognitive impairment increased with age and is comparable to rates of dementia reported in other sub-Saharan African countries. Age and sex differences in cognitive function scores were minimized as education increased, potentially reflecting the power of even poor-quality education to improve cognitive reserve.

Keywords

Africa; Age factors; Education; Cross-sectional studies; Epidemiology; Prevalence; Sex; Sociodemographic characteristics; Cognitive function; Cognitive impairment

Introduction

The populations of most sub-Saharan African countries are rapidly aging. By 2050, 72 million people across sub-Saharan Africa are projected to experience Alzheimer's disease and related dementias (according to DSM-IV or ICD-10 criteria or similar clinical criteria, collectively referred to from hereon as "dementia"), an increase of 257% since 2015 [1]. Currently, there are very few population-based studies on the prevalence of dementia, cognitive impairment, or cognitive functioning in sub-Saharan African countries [1–16], a gap requiring urgent attention given the rapidly increasing life expectancies and projected rise of dementia in this global region. Population-based data on dementia, cognitive impairment, and cognitive functioning are needed to generate prevalence estimates, identify risk factors, and assist health systems, communities, and aid organizations in prioritizing resources to prevent and provide care for people with dementia in sub-Saharan Africa.

Here, we focus on South Africa, a country that is undergoing simultaneous demographic and epidemiologic transitions: the share of South Africa's population aged over 65 years is now larger than that aged under 5 years, and increasing incidence rates of chronic aging-related conditions are coinciding with a high prevalence of chronic human immunodeficiency virus (HIV) infection [17–19]. South Africa experienced a period of apartheid from 1948 to 1994, which, by legislation, limited the geographic movement, educational opportunities, and employment opportunities for South Africans who were deemed to be non-white [20]. Apartheid and its earlier precursors have shaped the health of South Africa's older population in many ways, which are not yet completely understood [20–23]. In particular, cognitive function and impairment have been understudied in older, black South Africans who lived through apartheid, particularly those residing in rural regions [2].

In 2015, we launched "Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa" (HAALSI), a population-based study in the rural northeast of South Africa [24]. Here, using a screening tool adapted from the US Health and Retirement Study (HRS), we aimed to estimate the prevalence of cognitive impairment and the sociodemographic and key co-morbid predictors of cognitive function in older, rural South African adults.

Materials and Methods

Study Design

"Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa" (HAALSI) is a population-based cohort of 5,059 adults aged 40 years with an 86% response rate [24]. Here, we report on baseline cross-sectional findings collected in 2015. HAALSI is harmonized with the US HRS and is representative of the Agincourt Health and Socio-demographic Surveillance System Census of approximately 116,000 individuals living in Mpumalanga province, northeast South Africa [24, 25]. In-person interviews were conducted by trained, local fieldworkers using computer-assisted personal interviews and blood was drawn for HIV status and biomarker ascertainment. All interview materials were translated to the local Shaangan language and back-translated, and pilot tested for accuracy, appropriateness, and comprehensibility in a sample of older local residents who did not become part of the HAALSI study population. Ethical approval was granted by the University of Witwatersrand Human Research Ethics Committee and the Harvard T.H. Chan Harvard School of Public Health Institutional Research Ethics Board. Each respondent or proxy respondent provided informed consent prior to being interviewed.

Study Measures

Cognitive Measures—A cognitive battery was administered, using measures adapted from the US HRS brief screening instrument for dementia [26, 27]. The cognitive battery assessed time orientation (ability to state the correct date, month, year, and South African President; 4 points total) and immediate and delayed recall of 10 words read out loud (1 point for each word; 20 points total). The cognitive function outcome was the total score out of 24 on the combined time orientation and immediate and delayed recall items. The cognitive battery also included 2 numeracy measures, which were not included in the present analysis as they are thought to reflect schooling more strongly than aging-related cognitive impairment.

Definition of Cognitive Impairment—We followed the method of Wu et al. [28] to categorize cognitive impairment, using a combination of cognitive battery scores and proxy memory assessments, which Wu et al. [28] developed and validated against DSM-diagnosed dementia in the Aging, Demographics, and Memory Study sub-study of the US HRS. We used the same cognitive battery and proxy memory assessments as those validated by Wu et al. [28] in the US HRS. Scores of 1.5 SDs below the overall cognitive battery mean were considered to indicate cognitive impairment [29]. While we recognize that many respondents assigned to this category will, in fact, present with dementia, the lack of a clinical dementia rating or DSM diagnosis to validate our categorization means that we may lack specificity to identify dementia, and thus conservatively define our outcome as "cognitive impairment". A total of 116 participants had proxy interviews completed on their behalf by a friend or family member, due to their being cognitively or verbally unable to complete the study interview. Proxy respondents were asked to rate the incapacitated participant's memory on a 5-point Likert scale. In total, 32 rated the participant's memory as "poor" (28%), 47 as "fair" (41%), 28 as "good" (24%), 8 as "very good" (7%), and 1 did not know. The 79 participants whose memory was rated as "fair" or "poor" were included in the

cognitive impairment group to reduce bias in study estimates that may be introduced by their exclusion [28].

Sociodemographic and Comorbidity Covariates—The following variables were selected in order to investigate sociodemographic patterning of cognitive function and its associated comorbidities: age (40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75), sex (male; female), highest level of education (no formal education [0 years], some primary school [1–7 years], some secondary school or higher [8+ years]), marital status (married or cohabiting; single/divorced/widowed), employment status (working part-time or full-time; not working; homemaker), household wealth quintile; HIV infection status (negative; positive), hypertension (yes; no), and self-reported physician diagnosis of each of stroke, angina, or myocardial infarction (ever; never), and drinking alcohol 5 days per week (yes; no). All variables were self-reported, except for HIV and hypertension. HIV status was determined through HIV enzyme-linked immunosorbent assays on dried blood spots as negative, positive, or missing, which included participant refusals and indeterminate tests. Hypertension was defined as a mean systolic blood pressure >140 mm Hg or mean diastolic blood pressure >90 mm Hg, or controlled blood pressure with self-reported use of hypertensive medication.

Statistical Analyses

The prevalence of cognitive impairment and the cognitive score means and standard deviations were calculated overall and according to covariates. We used multiple linear regression to estimate relationships between all covariates and total cognitive score. In 2 separate, fully-adjusted models, we fitted multiplicative statistical interactions between each of sex and education, and age and education. We then estimated the marginal effects of age and sex on mean fully adjusted predicted cognitive battery score over categories of educational attainment. Finally, we fitted a model with a 3-way multiplicative interaction between age, sex, and education, and from this model plotted the predicted values of cognitive battery score. The interaction analyses were conducted because the cognitive effects of education were hypothesized to differ according to sex and age in this study: accessibility and quality of education has improved over time for subsequent birth cohorts among black South Africans, although girls have been continually disadvantaged compared to boys with respect to educational access and quality [21, 30–32]. Statistical analyses were conducted using SAS 9.4 (Cary, NC, USA) and StataSE 15.0 (College Station, TX, USA).

Missing Data

All proxy (116/5,059) and non-proxy participants (4,943/5,059) were included in the cognitive impairment estimate, except for 40 out of 4,943 non-proxy participants (3%) who declined the cognitive battery, for a total of 5,019 out of 5,059 (99%). Of the remaining 4,903 out of 4,943 non-proxy participants who completed the cognitive battery, 125 (3%) were missing data on at least one covariate. Therefore, a total of 4,778 out of 4,943 non-proxy participants (97%) were included in the analytical sample for regression modeling. The non-proxy participants who were not included in regression modeling were similar on all characteristics, but were slightly more likely to be male than female (4% of males vs. 3% of females missing data).

Results

The mean cognitive score was 11.40 (SD 4.45; range 0–24; Table 1). In total, 416 out of 5,059 participants (8%) were categorized as having cognitive impairment, 337 were on the basis of scoring 1.5 SD below the mean cognitive score, and 79 were proxy respondents with "fair" or "poor" memory. The prevalence of cognitive impairment increased with age, from 2% of those aged 40–44 to 24% of those aged 75 years. Of the non-proxy participants with cognitive impairment, 87% (294/337) scored either 0 or 1 on the time orientation items (knowledge of the correct date, month, year, and President) and 44% (148/337) rated their memory as "fair" or "poor." The cognitive scores were normally distributed, similar to those observed in the HRS, although the HAALSI distribution was shifted to the left of the HRS distribution (online supplementary Appendix; see www.karger.com/doi/10.1159/000493483).

The independent predictors of cognitive score (out of 24 points) are shown in Table 2. Older age was negatively associated with cognitive score (–0.45 points per 5 years of age; 95% CI –0.51 to –0.39), and females had lower average scores than males (–0.18 points; 95% CI –0.42 to 0.06). Cognitive scores increased with educational attainment; adults with some secondary education or higher scored, on average, 3.05 points (95% CI 2.69–3.30) higher than those with no formal education (Table 2). Being HIV positive or hypertensive were associated with higher cognitive scores, while having a history of physician-diagnosed stroke, angina, or heart attack was associated with lower cognitive score (Table 2).

The negative association between age and cognitive score decreased in magnitude with increasing levels of education, from –0.54 (95% CI –0.62 to –0.46) per 5 years of age in adults with no formal education to –0.40 (95% CI –0.53 to –0.26) in those with secondary education or higher (Table 3). Similarly, being female was negatively associated with cognitive score for adults with no formal education (–0.72; 95% CI –1.06 to –0.37), but there were no sex differences in cognitive scores for adults who had any level of education (Table 3). When a 3-way multiplicative interaction between age, sex, and education was fitted, the negative slope of cognitive change with increasing age was steeper at each level of educational attainment for females than for males (Fig. 1).

Discussion

In this population-based study of rural South African adults aged 40 years and over, approximately 8% of the sample were estimated to have cognitive impairment. Cognitive impairment increased with age, from 2% of those aged 40–44 years to 24% of those aged 75years. The key predictors of poor cognitive function were sociodemographic in nature. The associations with HIV status and hypertension were of weaker magnitudes and in the unexpected positive directions, which may be due to selective HIV infection and survival prior to the study entry, differential access to care, or other pathways that require further investigation. Further longitudinal findings may shed more light on these associations. The lower cognitive scores observed among females compared to males with no formal education was completely negated among older adults who had at least some education. These findings suggest that even the poor-quality education that was available to this study

population under apartheid may have positively affected later-life cognitive function, and that sex disparities in later-life cognitive functioning are restricted to older adults who had no formal education. These findings are a valuable baseline "snapshot" of cognitive function and impairment in the older population of rural, northeast South Africa. Future follow-ups that are underway in this cohort will build upon these baseline results, with clinical dementia ratings based on neuroimaging, expert review, and exclusion of competing diagnoses.

Comparison to Other Research

Very little research has investigated the prevalence of cognitive impairment or dementia in sub-Saharan Africa. Lekoubou et al. [4] 2014 systematic review of dementia prevalence studies in sub-Saharan Africa retrieved 49 studies, many of which utilized hospital-based samples and only one of which was conducted in South Africa, in an urban community of 139 "coloured" adults in 1983, with 9% dementia prevalence according to MMSE/ICD-8 codes [33]. A total of 10 prevalence studies with a DSM-III/-IV outcome of dementia were identified for sub-Saharan Africa in a 2017 Alzheimer's Disease International report, with a pooled prevalence of 5.50% of adults aged 60; the pooled prevalence for women was approximately double that for men for all age groups [1, 2]. We found a slightly higher prevalence of cognitive impairment in our study of 8.22% of adults aged 40; this could be due to an overestimate of the people or possibility due to differences in sample composition. We identified one other population-based study of dementia prevalence in rural South Africa among 1,394 Xhosa-speaking adults 60 in the Eastern Cape, which found a prevalence of 12% according to the Community Screening Instrument for Dementia but did not observe gender-based or educational differences in dementia prevalence [8].

In Lekoubou et al. [4] systematic review, the most consistent risk factors for dementia incidence in older sub-Saharan African adults were older age, female sex or gender, having less than 6 years of education, rural residence, and family history of dementia. Most studies included in this review were conducted in Nigeria, and rural South Africa was not represented. In South Africa, the nationally representative Study of Global Ageing and Adult Health of 3,840 adults 50 in 2008 found that better memory and executive functioning scores were associated with being younger, male, of a white or Indian/Asian/colored ethnicity, married, having higher education, and having greater wealth [7]. These findings are consistent with those presented here for a rural cohort of older black South Africans. Overall, it appears that being older, being female, and having low education are consistently and strongly associated with poor cognitive function and dementia in older sub-Saharan African populations. This is consistent with a large body of evidence from high-income Western countries, although the associations between sex or gender and cognitive function are somewhat inconsistent [27, 28, 33–37].

Strengths and Limitations

Strengths of this study include its population-based design with a high response rate and low rate of missing data. Our study population is broadly representative of older, black populations in low-income rural regions of South Africa [38]. Given that life expectancy at birth in South Africa is currently only 60.6 years for men and 64.3 years for women [39], the HAALSI cohort represents some of the "oldest-old" black, rural South Africans, a

population that is understudied with respect to health outcomes. Our cognitive measures included were adapted from validated measures, and translated and back-translated to ensure cultural appropriateness and reliability in the local Shangaan language. The relatively high number of older adults with no formal education in this study allowed us to examine age- and sex- based-differences in cognitive function by educational category, giving evidence from a setting where many people could not access schooling. Overall, the HAALSI cohort is a unique and valuable data resource that allows for the investigation of health outcomes in the understudied older population of rural South Africa in the midst of an epidemiological and demographic transition.

There are also several limitations of our study. Age, period, and cohort effects could not be separated, as it was a cross-sectional analysis of baseline data. The age differences in cognitive function and impairment that we observed may, at least in part, reflect improved educational quality over time across the 20th century for black South Africans rather than cognitive aging processes. We did not have a physician-diagnosed outcome of dementia, and therefore our prevalence estimate must be thought of as "cognitive impairment." This outcome will certainly include people with dementia, as well as those who are cognitively impaired for reasons other than a dementia or other neurodegenerative disorder. For example, sensory impairments or psychiatric conditions could negatively affect performance on a cognitive battery, independently of dementia. There remains no consensus on the best method to test cognitive function and screen for dementia in sub-Saharan African populations. Most existing screening measures have been developed for relatively well-educated Western, high-income populations, and differences in language, literacy, education, and culture are difficult to overcome in adapting measures. Here, we used a validated and well-accepted brief screening tool for dementia adapted from the US HRS that lacked floor or ceiling effects. The study participants who were categorized as having cognitive impairment overwhelmingly failed or scored a single point on the time orientation measure and half had "fair" or "poor" self-rated memory.

Conclusions

There are currently very few population-based studies of cognitive impairment, dementia, or cognitive function in sub-Saharan African regions. HAALSI is one of the few studies to examine cognitive function among older adults in post-apartheid rural South Africa. Using a brief screening tool adapted from the US HRS, we found that the prevalence of cognitive impairment rises from 2% of adults aged 40–44 to 24% of those aged 75+ years in rural South Africa. Further, being older, female, and having a lack of education are key predictors of poor cognitive function in this population. Longitudinal follow-up of the HAALSI cohort begins in 2018, and future dementia prevalence estimates will use a clinical dementia rating based on neuroimaging, expert review, and exclusion of competing diagnoses, in addition to a novel tablet assessment of cognitive function that minimally involves literacy or language skills [40]. The findings presented here are a valuable baseline for future longitudinal research within HAALSI and other research on aging in rural, sub-Saharan African contexts.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements and Funding Source

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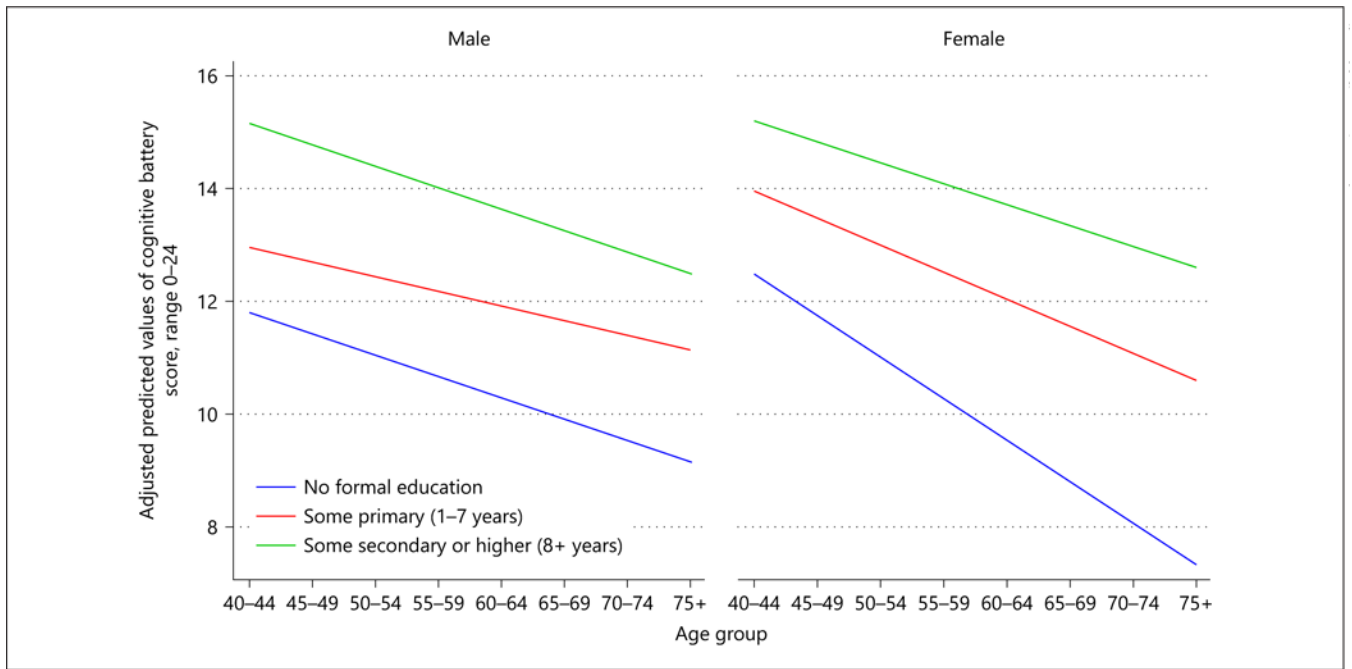
Fig. 1.
Fully adjusted predicted mean cognitive scores ($n = 4,778$).

Table 1.

Sample Characteristics, "Health and Aging in Africa: a longitudinal study of an INDEPTH community in South Africa"

Characteristic	Total[*], *n* (%) 5,059/5,059 (100%)	Mean cognitive score[†] 11.41 (4.45)	Cognitive impairment[‡], *n* (%) 416/5,019 (8%)
Age, years			
40–44	519 (10)	14.00 (4.13)	11 (2)
45–49	399 (8)	13.25 (3.79)	9 (2)
50–54	783 (15)	12.84 (4.30)	31 (4)
55–59	627 (12)	12.01 (4.04)	24 (4)
60–64	753 (15)	11.40 (3.82)	37 (5)
65–69	551 (11)	11.09 (4.12)	41 (8)
70–74	514 (10)	10.03 (3.88)	49 (10)
75+	913 (18)	8.27 (4.30)	214 (24)
Gender			
Male	2,345 (46)	11.73 (4.40)	163 (7)
Female	2,714 (54)	11.13 (4.48)	253 (9)
Educational attainment			
No education	2,307 (46)	9.46 (4.28)	350 (15)
Some primary (1–7 years)	1,715 (34)	12.16 (3.67)	52 (3)
Some secondary or higher (8+ years)	1,020 (20)	14.41 (3.93)	10 (1)
Employment status			
Employed (part- or full-time)	805 (16)	13.65 (4.24)	14 (2)
Not working	3,719 (74)	10.90 (4.41)	369 (10)
Homemaker	521 (10)	11.47 (3.94)	32 (6)
Marital status			
Married	2,575 (51)	12.19 (4.20)	105 (4)
Unmarried	2,480 (49)	10.57 (4.56)	311 (13)
Household wealth quintile			
5 (richest)	1,046 (21)	12.96 (4.24)	36 (4)
4	1,001 (20)	11.71 (4.47)	73 (7)
3	991 (20)	11.41 (4.22)	71 (7)

Characteristic	Total[*], *n* (%) 5,059/5,059 (100%)	Mean cognitive score[†] 11.41 (4.45)	Cognitive impairment[‡], *n* (%) 416/5,019 (8%)
2	1,007 (20)	10.78 (4.34)	103 (10)
1 (poorest)	1,046 (20)	10.19 (4.50)	133 (13)
HIV infection status			
Negative	3,512 (70)	11.13 (4.45)	311 (9)
Positive	1,048 (21)	12.21 (4.15)	44 (4)
Missing	499 (10)	11.72 (4.87)	61 (13)
Hypertension			
No	2,052 (42)	11.61 (4.49)	227 (8)
Yes	2,884 (58)	11.25 (4.39)	169 (8)
Ever stroke, angina, or heart attack			
No	4,786 (95)	11.47 (4.45)	377 (8)
Yes	269 (5)	10.22 (4.28)	37 (14)
Alcohol consumption 5 days/week			
No	4,751 (94)	11.46 (4.41)	377 (8)
Yes	304 (6)	10.61 (5.00)	38 (13)

[*] Numbers in rows may not sum to 5,059 due to missing data;

[†] proxy study participants are excluded from the mean cognitive battery scores;

[‡] defined as scoring 1.5 SD below the mean on the time orientation and word recall measures, or requiring a proxy interview with "fair" or "poor" memory as rated by the proxy respondent.

Table 2.

Linear regression model predicting total cognitive score, "Health and Aging in Africa: a longitudinal study of an INDEPTH Community in South Africa," South Africa, 2015 ($n = 4,778$)

Characteristic	Linear regression predicting total cognitive score		
	B	**95% CI**	**SE**
Age, years			
Per 5 years	−0.45	−0.51 to −0.39	0.03
Gender			
Male	Ref	–	–
Female	−0.18	−0.42 to 0.06	0.12
Educational attainment			
No education	Ref	–	–
Some primary (1–7 years)	1.94	1.69 to 2.20	0.13
Some secondary or higher (8+ years)	3.05	2.69 to 3.30	0.18
Employment status			
Employed (part- or full-time)	Ref	–	–
Not working	−0.64	−0.97 to −0.32	0.17
Homemaker	0.02	−0.43 to 0.47	0.23
Marital status			
Married or living as married	Ref	–	–
Single/divorced/widowed	−0.89	−1.13 to −0.65	0.12
Household wealth quintile			
5 (richest)	Ref	–	–
4	−0.56	−0.90 to −0.21	0.18
3	−0.60	−0.95 to −0.25	0.18
2	−0.87	−1.23 to −0.51	0.18
1 (poorest)	−1.12	−1.50 to −0.76	0.19
HIV infection status			
Negative	Ref	–	–
Positive	0.47	0.19 to 0.76	0.14
Missing	0.15	−0.26 to 0.56	0.21

Characteristic	Linear regression predicting total cognitive score		
	B	**95% CI**	**SE**
Hypertension			
No	Ref	–	–
Yes	0.36	0.13 to 0.58	0.12
Ever stroke, angina, or heart attack			
No	Ref	–	–
Yes	−0.68	−1.17 to −0.17	0.25
Alcohol consumption 5 days/week			
No	Ref	–	–
Yes	−0.31	−0.77 to 0.16	0.24

All variables in table mutually adjusted for.

Marginal effects of age and sex on cognitive score over education categories, "Health and Aging in Africa: a longitudinal study of an INDEPTH Community in South Africa," South Africa, 2015 ($n = 4,778$)

Characteristic	Linear regression predicting total cognitive score		
	β	95% CI	SE
Age (per 5 years) × education			
No education	−0.54	−0.62 to −0.46	0.04
Some primary (1–7 years)	−0.37	−0.46 to −0.28	0.05
Some secondary or higher (8+ years)	−0.40	−0.53 to −0.26	0.07
Gender (female vs. male) × education			
No education	−0.72	−1.06 to −0.37	0.18
Some primary (1–7 years)	0.28	−0.10 to 0.66	0.19
Some secondary or higher (8+ years)	0.15	−0.33 to 0.64	0.25

Adjusted for employment status, marital status, household wealth quintile, HIV infection status, hypertension, history of stroke/angina/heart attack, and alcohol consumption.