Cognitive functioning and associated factors in older adults in South Africa

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Objective. To investigate cognitive functioning and associated factors in a national probability sample of older South Africans who participated in the Study of Global AGEing and Adult Health (SAGE) in 2008.

Methods. In 2008 we conducted a national population-based cross-sectional study with a sample of 3 840 adults aged ≥50 years in South Africa. We administered a questionnaire surveying socio-demographic characteristics, health variables, and anthropometric and blood pressure measurements. Multivariate regression analyses were used to assess the association of socio-demographic factors and health variables with cognitive functioning.

Results. Mean variables in the sample were: 5.9 recalled words, a verbal fluency of 9.9 words in a specified category (animals), a forward and backward digit span of 5.2 and 3.2, respectively, and an overall mean cognition score of 48.5. Higher overall cognitive functioning (a combination of memory and executive functioning) was positively associated with: younger age; white, Indian/Asian or coloured ethnicity; being married; a higher level of education; greater wealth; a higher level of physical activity; a greater quality of life; and a better subjective health status.

Conclusions. Our findings can be used to refine future projections of cognitive function and healthcare needs in ageing middle-income societies such as those in South Africa.

Cognition can be divided into domains of ability including orientation, memory, executive function and language.[1] Cognitive function is influenced by many factors such as genes, home environment in childhood, education and occupation.[1] Cognitive decline is first detectable in the fifth decade of life, with age-related decline from this point onwards.[2]

There is little research on cognitive functioning and variability among older adults in South Africa. In various cross-sectional and longitudinal studies, better cognitive performance in older adults has been found to be associated with: (*i*) socioeconomic status (younger age, female or male gender, higher education, greater wealth, population group);[3-5] (*ii*) illness conditions and health status (fewer depressive symptoms, no hypertension, no cardiovascular disease, particularly heart failure, no type 2 diabetes, no insomnia, no malnourishment, better quality of life (QoL) and life satisfaction);[6-13] (*iii*) social coherence and contact (attendance at religious gatherings);[4,14] and (*iv*) healthy behaviour (physical activity, no smoking and moderate alcohol use).[15-20]

We aimed to investigate cognitive functioning and associated factors in a national probability sample of older South Africans who participated in the Study of Global AGEing and Adult Health (SAGE) in 2008.

Methods

In 2008 we conducted a national population-based cross-sectional study with a sample of 3 840 South African adults aged ≥50 years. The SAGE two-stage probability sample design yielded national and sub-national estimates to an acceptable precision at provincial level, by locality type (urban and rural) and population group (black, coloured, Indian/Asian and white). The individual response rate among adults aged ≥50 years was 77%.

We administered a questionnaire surveying socio-demographic characteristics and health variables, and conducted anthropometric and blood pressure measurements. The questionnaire was translated into the major languages of the participants (Afrikaans, Northern Sotho, Southern Sotho, Tsonga, Tswana, isiXhosa and isiZulu). Simultaneous translation was used for respondents who were interviewed in a language for which a formal translated version had not been produced, with emphasis on consistent translation of keywords and phrases. To ensure the quality of translation, a list of keywords and phrases provided by the World Health Organization (WHO) for translation and back-translation were translated from English into vernacular languages by the original translator, then back-translated into English by an independent translator who provided all possible interpretations. The back-translations were cross-checked with the original English version. If no match was found, both translator and back-translator were

consulted to reach a final agreement on the best solution and changes to the translated questionnaire were made where necessary. The interview commenced with filter questions about memory, to allow the interviewer to assess whether the respondent was cognitively and physically able to complete the interview. If unable to do so, the interviewer attempted to administer the proxy respondent questionnaire, and the respondent was excluded from the sample. The SAGE survey was carried out in partnership between the National Department of Health (DoH), the Human Sciences Research Council (HSRC) and the WHO. The study was approved by the HSRC Research Ethics Committee and the DoH.

Cognitive capacity

Cognitive tests were used to measure cognitive performance and to measure objective indicators of various aspects of cognition. The tests, which together measured concentration, attention and immediate memory, and were intended to measure the cognitive domains most affected by impairment and the early stages of dementia, included:

- *Verbal fluency (executive function).* Ability to retrieve information from semantic memory was measured by asking respondents to produce as many words as possible in a given category (animals) within a fixed amount of time (1 minute). Verbal fluency was defined as the number of correctly named animals.[21]
- *Immediate and delayed verbal recall.* Respondents were presented verbally with 10 words, repeated 3 times to saturate the learning curve. To test delayed recall and recognition, respondents were asked to recall as many of the 10 words as possible after 10 minutes. Verbal recall was defined as the average number of words recalled, thereby assessing learning capacity, memory storage and memory retrieval.[22]
- *Digit span (forward and backward).* Digit span served as an estimate of working memory. In the forward test, respondents were read a series of digits (e.g. '8, 3, 4') and were requested to recall them immediately. Following correct recall, they were given a longer series of digits, until failure. In the backward test, the respondents were requested to recall the numbers in reverse order. The digit span was defined as the length of the longest correctly recalled list.[23,24]

Overall cognition

The overall cognitive score was calculated by summation of the results of verbal fluency, verbal recall and digit span, converted to a scale of 0 (worst cognition) - 100 (best cognition).

Depression

Symptom-based depression in the 12 months preceding recruitment was assessed based on the World Mental Health Survey version of the Composite International Diagnostic Interview.[25] The diagnosis of depression was based on *The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research (DCR-10)* and was derived from an algorithm accounting for reported symptoms of depression during the preceding 12 months.[26] In addition, patients who responded affirmatively to the question, 'Have you ever been diagnosed with depression?' were added to the symptom-based depression.

Sleeping problems

The prevalence of sleeping problems was estimated with the question: 'Overall in the last 30 days, how much of a problem did you have with sleeping, such as falling asleep, waking up frequently during the night or waking up too early in the morning?'. Response options ranged from 1 (none) to 5 (extreme/cannot do). Sleeping problems were defined by responses of 'severe' or 'extreme/cannot do'.

Blood pressure

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured in triplicate on the right arm or wrist of the seated respondent using an automated device. The average of the last 2 readings was used. In accordance with the *Seventh Report of the Joint National Committee of Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*,[28] individuals with an SBP≥140 mmHg and/or a DBP ≥90 mmHg and/or who reported the current use of anti-hypertensive medication were considered to be suffering from high blood pressure.

Tobacco use

Lifetime tobacco use was assessed with the question: 'Have you ever smoked tobacco or used smokeless tobacco?'. Lifetime tobacco users were asked: 'Do you currently use (smoke, sniff or chew) any tobacco products such as cigarettes, cigars, pipes, chewing tobacco or snuff?'. The response options were: 'yes, daily'; 'yes, but not daily'; and 'no, not at all'. These questions were based on the WHO *Guidelines for Controlling and Monitoring the Tobacco Epidemic*.[29]

Alcohol use

Lifetime alcohol use was assessed with the question: 'Have you ever consumed a drink that contains alcohol (such as beer, wine, spirits, etc.)?'. Response options were: 'yes' or 'no, never'. Lifetime alcohol users were asked about current alcohol use in the preceding month, and current alcohol users were asked: 'During the past 7 days, how many drinks of any alcoholic beverage did you have each day?'. Risky alcohol use was defined ≥10 alcoholic drinks in the preceding week.

Height and weight

Body mass index (BMI) – weight (kg) divided by height (m) squared – was measured and used as an indicator of obesity (defined as a BMI ≥30 kg/m^2) and underweight (BMI<18.5 kg/m^2).

Physical activity

Physical activity was measured using the General Practice Physical Activity Questionnaire (GPAQ). The instrument gathers information on physical activity in three domains (activity at work, travel to and from places, and for recreation), as well as on time spent being inactive. The questionnaire also assesses vigorous and moderate activities performed at work and for recreation. The number of days in a week spent on different activities and time spent in a typical day for each activity were recorded.[30] In addition to the total minutes of activity, the activity volume was computed by weighing each activity type by energy requirement in metabolic equivalents (METs). One MET was defined as the energy cost of quiet inactivity or sitting quietly, equivalent to a calorie consumption of 1 kcal/kg/h. An MET minute showed the total activity volume on a weekly basis, calculated by multiplying the time spent on each activity during a week by the MET values of each level of activity. MET values for different activities were set: 4 METs for moderate intensity physical activity, transport-related

Table 1. Sample characteristics and prevalence of cognitive functioning among older South Africans

Variable	Total sample n (%)	Mean verbal recall*	Mean executive function†	Mean FDS	Mean BDS	Mean overall cognition score	Mean overall cognition z-score
Total (N)	3 840 (100)	5.9	5.9	5.1	3.2	48.5	
Age (years)							
50 - 59	1 695 (49.9)	6.2	10.3	5.4	3.4	50.1	0.19
60 - 69	1 233 (30.6)	5.9	9.8	5.0	3.1	47.7	-0.07
70 - 79	661 (14.0)	5.5	9.7	4.8	2.9	45.3	-0.26
≥80	251 (5.5)	5.1	7.9	4.2	2.3	40.2	-0.68
Gender							
Male	1 638 (44.1)	6.1	10.2	5.3	3.4	50.1	0.13
Female	2 202 (55.9)	5.8	9.8	5.0	3.0	47.3	-0.10
Population group							
Black	2 053 (74.0)	5.8	9.7	4.8	2.8	45.6	-0.19
White	269 (9.3)	6.8	12.1	6.1	4.8	59.9	0.82
Coloured	655 (12.8)	5.8	10.8	5.2	3.0	48.5	0.13
Indian/Asian	307 (3.8)	5.9	11.1	5.5	3.4	52.2	0.31
Marital status							
Single	512 (14.3)	5.9	9.6	4.9	3.0	46.7	-0.14
Married	2 007 (55.9)	6.1	10.4	5.4	3.4	50.7	0.18
Separated/Divorced	230 (5.9)	5.7	9.3	5.3	2.9	46.3	-0.18
Widow	1 020 (23.9)	5.6	9.3	4.8	2.7	45.1	-0.28
Educational level							
No schooling	854 (25.2)	5.5	9.3	4.3	2.2	41.7	-0.21
Less than primary	803 (24.0)	5.6	9.8	4.8	2.8	45.4	-0.25
Primary	779 (22.4)	5.8	9.6	5.1	2.8	47.9	-0.05
Secondary	923 (28.3)	6.5	10.9	6.0	3.2	55.6	0.58
Wealth							
Low	1 482 (40.6)	5.8	9.3	4.7	2.8	45.5	-0.24
Medium	731 (18.2)	5.7	9.8	5.0	2.9	46.5	-0.16
High	1 608 (41.2)	6.2	10.6	5.6	3.6	52.3	0.30
Geolocality							
Rural	1 276 (35.1)	5.9	9.9	4.7	2.6	45.4	-0.26
Urban	2 561 (64.9)	6.0	10.0	5.4	3.5	50.2	0.14
Subjective health status							
Very good - good	1 469 (37.9)	6.4	10.9	5.7	3.7	53.7	0.42
Moderate	1 681 (44.9)	5.8	9.5	5.0	2.9	46.2	-0.17
Bad - very bad	617 (17.5)	5.3	9.1	4.4	2.5	42.4	-0.50
Other conditions							
Hypertension	2 842 (77.3)	5.7	10.2	5.1	3.0	47.8	-0.03
Stroke	139 (4.0)	5.5	9.6	5.0	2.7	45.1	-0.27
Diabetes	219 (5.2)	5.9	10.0	5.2	3.1	48.3	-0.02
Depression	219 (5.8)	5.6	10.7	5.1	3.2	48.0	-0.19
Sleeping problem	353 (9.1)	5.3	9.8	4.9	3.0	46.1	-0.45
Underweight (BMI <18.5 kg/m²)	184 (4.3)	5.0	8.9	4.8	2.6	43.1	-0.44

Table 1 (continued). Sample characteristics and prevalence of cognitive functioning among older South Africans

Variable	Total sample n (%)	Mean verbal recall*	Mean executive function[†]	Mean FDS	Mean BDS	Mean overall cognition score	Mean overall cognition z-score
Alcohol use in preceding month	557 (13.7)	5.8	9.9	5.4	3.0	48.0	-0.04
Physical activity							
Low	2 455 (60.5)	5.7	9.8	4.9	2.9	46.7	-0.16
Medium	446 (10.9)	6.2	10.8	5.2	3.3	50.4	0.16
High	939 (28.6)	6.2	10.9	5.3	3.3	50.9	0.25
Religious involvement	1 956 (52.9)	6.1	10.4	5.2	3.2	49.6	0.09
Social cohesion index (range 9 - 72), mean (±SD)	22.1 (±6.5)						
QoL (range 0 - 100), mean (±SD)	47.1 (±12.5)						
Low	956 (28.5)	5.3	8.9	4.6	2.5	42.7	-0.46
Medium	1 384 (33.5)	5.9	10.1	4.9	2.9	47.1	-0.06
High	1 500 (38.1)	6.2	10.1	5.5	3.6	52.5	0.37

FDS = forward digit span; BDS = backward digit span; BMI = body mass index; QoL = quality of life.
*List of 10 words.
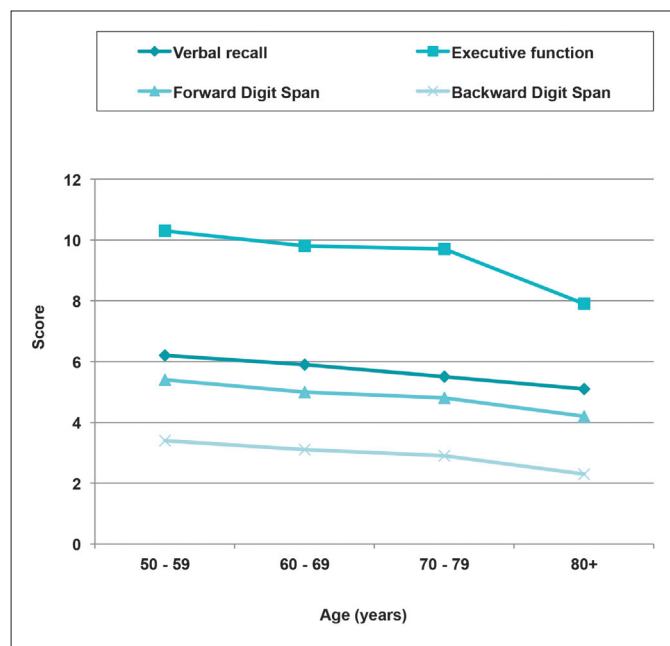[†]Average number of animals.

Fig. 1. Cognitive functioning among older South Africans per age group.

walking or cycling; and 8 METs for vigorous physical activity. Total physical activity was calculated as the sum of total moderate, vigorous and transport-related activities per week. The number of days and total physical activity MET minutes per week were used to categorise respondents according to low, moderate, and high levels of physical activity:

- *High* – vigorous-intensity activity on ≥3 days, achieving ≥1 500 MET (metabolic-equivalent) min/week; or ≥7 days of any combination of walking, moderate or vigorous intensity activities, achieving ≥3 000 MET min/week.
- *Moderate* – not meeting the criteria for 'high' activity, but meeting any of: ≥3 days of vigorous-intensity activity of ≥20 min/day; ≥5 days of moderate-intensity activity or walking of ≥30 min/day;

or ≥5 days of any combination of walking, moderate or vigorous intensity activities achieving ≥600 MET min/week.
- *Low* – not meeting criteria for high or moderate activity, including physical inactivity.

Moderate and high levels of physical activity were collapsed in further analysis.[30]

Social cohesion
Social cohesion was measured by asking respondents how often they had engaged in 9 activities in the preceding 12 months (e.g. attended any group, club, society, union or organisational meeting). Response options ranged from 1 (never) to 5 (daily). Cronbach's alpha for this social cohesion index in the sample was 0.73.

Religious activity
Frequency of attendance at religious services was recorded (on a 6-point scale, from more than once a week to never). Responses were categorised as: 1 (≥once a week) or 0 (once or twice a month, or never).

QoL
QoL was assessed with the WHOQOL-8 instrument containing 8 items empirically derived from the WHOQOL-Bref.[31] The summative model was used producing an index. Cronbach's alpha for the WHOQol-8 was 0.85 in this sample.

Economic status
To estimate economic or wealth status, a random-effects probit model was used to identify indicator-specific thresholds that represent the point on the wealth scale above which a household is more likely to own a particular asset than not. This enabled an estimation of an asset ladder. Combined with actual assets observed to be owned for any given household, this was used to produce an estimate of household-level wealth status, and wealth quintiles.[32]

Table 2. Multivariate logistic regression with cognitive functioning in older South Africans

	UOR (95% CI)	AOR (95% CI)
Gender		
Female	1.00	1.00
Male	1.52 (1.27 - 1.82)[‡]	1.28 (0.98 - 1.67)
Age (years)		
50 - 59	1.00	1.00
60 - 69	0.58 (0.42 - 0.80)[‡]	0.61 (0.41 - 0.90)*
70 - 79	0.43 (0.31 - 0.59)[‡]	0.47 (0.32 - 0.68)[‡]
≥80	0.19 (0.10 - 0.37)[‡]	0.25 (0.13 - 0.48)[‡]
Population group		
Black	1.00	1.00
White	5.04 (2.08 - 12.23)[‡]	2.74 (1.10 - 6.78)*
Coloured	1.92 (1.19 - 3.09)[†]	1.84 (1.08 - 3.15)*
Indian/Asian	2.28 (1.29 - 4.05)[†]	2.09 (1.08 - 4.04)*
Marital status		
Single	1.00	1.00
Married	1.78 (1.08 - 2.92)*	1.66 (1.05 - 2.63)*
Separated/Divorced	0.85 (0.48 - 1.50)	0.77 (0.43 - 1.37)
Widow	0.76 (0.47 - 1.22)	1.12 (0.71 - 1.76)
Educational level		
No schooling	1.00	1.00
Less than primary	1.00 (0.67 - 1.48)	1.08 (0.77 - 1.53)
Primary	1.32 (0.86 - 2.02)	1.51 (0.91 - 2.49)
Secondary or higher	4.05 (2.24 - 7.32)[‡]	3.40 (1.70 - 6.83)[‡]
Wealth		
Low	1.00	1.00
Medium	1.17 (0.68 - 2.03)	1.00 (0.61 - 1.63)
High	2.64 (1.43 - 4.85)[†]	1.67 (1.11 - 2.50)*
Geolocality		
Rural	1.00	1.00
Urban	2.25 (1.43 - 3.54)[‡]	1.26 (0.93 - 1.69)
Other conditions		
Hypertension	0.76 (0.55 - 1.05)	-
Stroke	0.48 (0.31 - 0.73)[‡]	0.70 (0.30 - 1.62)
Depression	0.65 (0.45 - 0.96)*	0.96 (0.65 - 1.42)
Sleeping problem	0.61 (0.38 - 0.98)*	0.75 (0.49 - 1.13)
Diabetes	0.87 (0.57 - 1.34)	-
BMI <18.5 kg/m^2	0.41 (0.21 - 0.79)[†]	0.59 (0.41 - 1.06)
Subjective health status		
Very good - good	1.00	1.00
Moderate	0.35 (0.22 - 0.57)[‡]	0.66 (0.45 - 0.96)*
Bad - very bad	0.14 (0.08 - 0.27)[‡]	0.41 (0.24 - 0.70)[‡]
Daily tobacco use	0.79 (0.53 - 1.16)	-
Past month alcohol use	0.87 (0.59 - 1.28)	-

Table 2 (continued). Multivariate logistic regression with cognitive functioning in older South Africans

	UOR (95% CI)	AOR (95% CI)
Physical activity		
Low	1.00	1.00
High	2.80 (1.82 - 4.31)[‡]	2.43 (1.45 - 4.08)[‡]
Social cohesion index	1.02 (0.99 - 1.04)	-
Religious involvement	1.20 (0.80 - 1.81)	-
QoL		
Low	1.00	1.00
Medium	2.46 (1.72 - 3.52)[‡]	1.79 (1.29 - 2.48)[†]
High	4.81 (2.19 - 10.57)[‡]	2.24 (1.18 - 4.23)*

QoL = quality of life.
*p<0.5
[†]p<0.01.
[‡]p<0.00.

Chronic conditions

Other chronic conditions such as stroke and diabetes were assessed by self-report.

Data analysis

The data, captured with CSPro and analysed with STATA software (version 10), were weighted using post-stratified individual probability weights based on the selection probability at each stage of selection. Individual weights were post-stratified by province, sex and age, according to the 2009 SSA medium mid-year population estimates (http://www.statssa.gov.za/publications/P0302/P03022009.pdf). Weights were not normalised. Descriptive statistics were used to describe the sample, and cognitive and functional scores. Z-scores of overall cognitive functioning were calculated with reference to the mean scores of demographic and health variables. Computed estimates and odds ratios (ORs) were reported with 95% confidence intervals (CIs). A double-sided p-value of 0.05 was used as the cut-off for statistical significance. Associations between key outcomes of overall cognition and socio-demographic, social and health variables were evaluated with ORs. Unconditional multivariate logistic regression was used for evaluation of the effect of explanatory variables on the key outcome of overall cognition (binary-dependent variable). By taking the median as a cut-off point (48), the overall cognition score was dichotomised as poor or good. All variables statistically significant at p<0.05 in bivariate analyses were included in the multivariate models. Weighted percentages are reported here. Sample sizes refer to the number of participants who were asked the target question. Double-sided 95% CIs and p-values were adjusted for the multi-stage stratified-cluster sample design.

Results

The sample of 3 840 South Africans aged ≥50 years comprised 44.1% men and 55.9% women. The most prevalent population group was black (74%), almost half of the participants (49.9%) were aged 50 - 59 years. The educational level of most participants (71.6%) was lower than secondary school education and almost two-thirds (64.9%) lived in an urban area.

A very large proportion of older adults had hypertension (77.3%), 20.4% were daily tobacco users, 5.8% had depression (combining self-reported diagnosed depression and symptom reporting), 9.2% had diabetes and 4.3% were underweight. In addition, 4.0% had a history of stroke and 9.1% a sleeping problem. More than half (60.5%) engaged in low physical activity, 20.4% were daily tobacco users, and a small proportion (13.7%) were current alcohol users. More than half (52.9%) engaged in a religious activity at least once a week and 38.1% rated their QoL as high. Mean variables in the sample were: 5.9 recalled words, a verbal fluency of 9.9 animals, and a forward and backward digit span of 5.2 and 3.2, respectively. The overall mean cognition score, consisting of the 4 cognitive measures together converted to a scale of 0 (worst cognition) - 100 (best cognitive functioning), was 48.5 (Table 1). Fig. 1 shows the decline of cognitive functioning with age.

Predictors of cognitive functioning

In univariate analysis, a higher overall cognitive functioning was positively associated with: male gender; younger age; white, Indian/Asian or coloured ethnicity; being married; secondary level education or higher; wealth; residing in an urban area; moderate or high physical activity; medium or high QoL; a good or very good subjective health status; no history of stroke, depression or a sleeping problem; and not being underweight. In multivariate analysis, a higher overall cognitive functioning was positively associated with: younger age; white, Indian/Asian or coloured ethnicity; being married; secondary level education or higher; wealth; moderate or high physical activit; medium or high QoL; and a good or very good subjective health status (Table 2).

Discussion

In a national sample of older adults aged ≥50 years, we found a mean number of recalled words of 5.9, a mean verbal fluency of 9.9 (animals), a mean forward digit span of 5.2, a mean backward digit span of 3.2, and an overall mean cognition score of 48.5. These rates seem to be lower than reported in other studies, e.g. in English elderly,[33] Chinese elderly,[34] American older adults[35] and Mexican older adults.[36]

Consistent with other studies,[3-5,12,13,17,18] we found that higher overall cognitive functioning was positively associated with: younger age; white, Indian/Asian and coloured ethnicity; being married; a higher level of education; having greater wealth; engaging in moderate or high physical activity; a greater QoL; and a better subjective health status. The black population group had a lower overall cognitive functioning than the other population groups, possibly attributed to measurement or structural differences, or heterogeneity in the effect of background variables. For example, lower education was more deleterious for blacks, and high income or wealth conferred an advantage for whites. These findings underscore the importance of efforts to generate culture-fair measurement devices. However, culture-fair assessments may attenuate, but not eliminate, group differences in assessed cognition due to the incommensurate action of background variables.[37] Studies have indicated that illiterates underperform in neuropsychological tasks that require working memory and immediate verbal attention, which are processes required by the digit span task.[36]

Unlike other studies,[3,6-10,15,16,20] our study did not reveal an association between cognitive functioning and gender, illness (depression,

hypertension, cardiovascular disease, heart failure, diabetes or insomnia), social coherence (including attendance of religious gatherings)[4,14] and healthy behaviour (not smoking and moderate alcohol use).

Study limitations

The self-reporting of health variables such as depression symptoms, tobacco or alcohol use should be interpreted with caution. Cognitive impairment is commonly assessed with the Mini-Mental State Examination (MMSE)[38,39] in older adults; this should be included in future studies. This study was based on data collected in a cross-sectional survey; therefore, we cannot ascribe causality to any of the associated factors in the study.

Conclusion

Our findings can be used to refine future projections of cognitive function and healthcare needs in ageing middle-income societies such as South Africa.

Conflict of interest. The authors declare no conflicts of interest.

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