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Determinants of semantic and episodic memory decline among older adults in Ghana: Evidence from the WHO study on global AGEing and adult health Ghana wave 2

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ABSTRACT

Objective: Determined factors associated with semantic (SM) and episodic memory (EM) among older adults aged 50 years and older in Ghana.
Methods: Data from WHO Study on Global AGEing and Adult Health (SAGE) Ghana Wave 2 was used for this study. Semantic memory (SM) and Episodic memory (EM) were the main study outcomes separately. The study employed Nested Ordinary Least Square regression analysis by sequentially adding 6 blocks of variables and comparison tests between the nested models.
Results: The study involved 3575 adult Ghanaians aged 50 years and older with a mean ± standard deviation of 62.6 ± 18.4 years. The overall mean ± SD of EM and SM were 5.86 ± 2.51 and 11.69 ± 8.59 respectively. Overall, analysis from block 6 showed a significant variation in SM by approximately 16.9%(ΔR^2 = 1.17%) where increasing age, never married (β = −1.55; 95% CI = −2.41–0.69), being resident in Greater Accra (regional disparity) (β = −3.45; 95% CI = −4.73–2.20), underweight (β = −0.81;95% CI = −1.34–0.27), and moderate self-rated health (SRH) (β = −0.98; 95% CI = −1.52–0.45) significantly decreased SM. Similarly, increasing age, separated/divorced (β = −0.22; 95% CI = −0.35–0.87), being resident in Greater Accra (β = −0.53; 95% CI = −0.80–0.26), and moderate SRH (β = −0.20; 95% CI = −0.36–−0.04) significantly decrease EM with an overall significant variation of approximately 22.9%(ΔR^2 = 2.7%).
Conclusions: Increasing age, sex, marital status, regional disparity, and poor SRH significantly decreased both Semantic memory and Episodic memory. Higher educational attainment and life satisfaction significantly influenced SM and EM. These provide pointers to important socio-demographic determinants of SM and EM with implications for the implementation of the Ghana national ageing policy 2010, 'ageing with security and dignity', and as a key consideration for healthy ageing towards 2030.

1. Introduction

Population ageing has become an issue of global concern and is anticipated to have a major impact on healthcare systems worldwide [1,2]. People globally are living longer and the world's population of people aged 60 years and above is expected to increase to two billion by 2050. It is projected by the World Health Organization (WHO) that 80% of that population would be living in low- and middle-income (LMICS) countries [2]. In Africa, approximately 10% of the population would be constituted by older adults aged 60 years and above [2]. In Sub-Saharan Africa (SSA), Ghana is reported to have one of the largest populations of persons aged 60 years and above by 2050; projecting an increment from 7.2% to 14.1% [3,4].

Ageing is an unavoidable natural process that has been associated with memory decline [5]. Age-related declines are exhibited in attention, language, visuospatial abilities, processing speed, and autobiographical memory [6,7]. Recent conceptualizations of memory, view the construct, not as a unitary system but rather divide it into hierarchical taxonomic modules based on the duration of retention and the type of information that is

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being retrieved [8]. According to Squire, memory is defined as the faculty of encoding, storing, and retrieving information [9] which can be classified into; sensory, short term, and long term [10]. Two types of long-term (semantic and episodic memory) memory have been implicated in our daily function and are highly associated with ageing [11,12].

Semantic memory is conscious long-term memory for meaning, understanding, and conceptual facts about the world. Semantic memory is one of the two main varieties of explicit, conscious, long-term memory, which is the memory that can be retrieved into conscious awareness after a long delay (from several seconds to years) [13]. SM gradually increases from middle age to the young elderly but declines in very old adults. Though the reasons for the decline in SM has not been clearly underscored, it has been hypothesized that the very elderly have fewer resources to draw on and that their performance may be affected in some tasks by slower reaction times, lower attentional levels, slower processing speeds, or potentially lesser ability to use strategies [12,14]. Episodic memory on the other hand refers to stored representations for personally experienced episodes from one's life within a particular spatiotemporal context (e.g., dining experience) [9]. EM performance is thought to decline from middle age onwards when compared with SM, short-term memory, and priming [15]. The deficits may be related to impairment in the ability to recall in normal ageing and less so for recognition.

Age-related disorders and memory decline, are becoming more prevalent in LMICs as the world's population ages, affecting more than half of the world's older population [2]. Ghana is also experiencing rapid growth in its ageing population and its expected health challenges including memory decline and dementia [16]. Though some studies have explored cognitive decline among older adults[16,17] they are yet to specifically access SM and EM decline in this population. Ghana is putting in efforts to set up a programme for Geriatric care in the Health Service. It is imperative to understand the factors associated with semantic and episodic memory decline, especially among older adults. The provision of such information will enable the country to put in measures to develop cognitive remediation programmes to help the aged deal with such memory decline. This paper, therefore, sets out to determine the factors associated with semantic and episodic memory decline among older adults.

2. Methods

This research involved the WHO Study on Global Ageing and Adult Health (SAGE) Wave 2 for Ghana, conducted between 2014/2015. WHO SAGE was implemented in six lower-to-middle income countries including China, Ghana, India, Mexico, Russian Federation, and South Africa. SAGE covers a wide range of health indicators including demographic characteristics, visual difficulties, subjective well-being, health state, and others.

2.1. Study design

SAGE wave 2 adopted a cross-sectional study design with a multi-stage cluster sampling technique. Details about the study design and procedures for data collection have been published elsewhere [18–20].

2.2. Sampling strategy

SAGE was a nationally representative survey and the primary sampling units (PSUs) were stratified by region and location (urban/rural). The selection of the PSUs was based on proportional allocation by size and a random systematic sampling method. Respondents were recruited from selected probability sampled Enumeration Areas (EA) using a multistage cluster sampling strategy. EA was selected independently within each stratum with the number of EAs per region based on the population size of the region [18].

2.3. SAGE wave 2 participants selection

SAGE wave 2 sampling strategy was designed to account for expected attrition [19]. All wave 1 households (HH) were visited for wave 2 data collection. Replacements for sample attrition were done using a systematic sampling approach. New households were randomly selected using EA aerial photographic maps on which dwellings are visible, starting at a random point on the periphery of the EA.

Mutually exclusive HH was then classified into; SAGE wave 1 follow-up households with one or more members aged 50 years or older targeted for selection, new households with one or more members aged 50 years or older, SAGE wave 1 follow-up households which include residents aged 18–49 targeted for selection, new households which include residents aged 18–49 [19]. A total sample size of 3575 (comprising of 348 new participants and 3227 follow-ups from wave 1) of adults aged 50 years and above was used for this analysis.

2.4. Variable definition

The study generated four independent variables to assess its relationship with the outcomes; these involved Waist-Hip-Ratio (WHR), function difficulties, depression, and life satisfaction. The WHR was generated using WHO standard definition [21]; low if WHR ≤ 0.90 for males and ≤ 0.85 for females, moderate if 0.91–0.99 for males and 0.86–0.89 for females and high if WHR is ≥ 1.00 for males and ≥ 0.90 for females.

Functional difficulties were assessed using a composite question including 15 standard sub-Likert scale questions relating to standing for a long period, household responsibilities, joining community activities, concentration on doing something, walking for a long distance, washing the whole body, getting dressed, day to day work, carrying things, eating, getting up from lying, getting to and using the toilet, getting where you want to go, going out of home and emotional effect by health condition. Participants were classified as having difficulty (Yes) if their response to *15 standardized Likert* questions on functionality i.e. *In the last 30 days, how much difficulty did you have in … (response None = 1, Mild = 2, Moderate = 3, Severe = 4, and Extreme = 5);* were either mild, moderate, severe, or extreme and "No difficulty" if all responses were none. This process has been adopted elsewhere [22]. Jann Stata module to compute Cronbach's alpha for weighted data was used to assess internal consistency and reliability due to the design of the SAGE study. The overall test of reliability for functional difficulty domains is very high and of good quality measure FD ($\alpha = 0.93$).

Depression was assessed using the world mental health survey version of the composite international diagnostic interview [23]. Respondents were initially as sked if during the last 12 months; *(1) had a period lasting several days when feeling sad, empty, or depressed; (2) had a period lasting several days when lost interest in most things usually enjoyed such as personal relationships, work or hobbies/recreation; (3) had a period lasting several days when feeling energy decreased or tired all the time.* If the response on any one of these questions is 'yes', 15 standard questions were further used to assess depression among participants. The diagnostic procedure for depressive disorder over the past 12 months was clearly defined using the WHO ICD-10 classification of mental and behavioural disorders for a major depressive episode (F32) [24]. Depression scores were generated by adopting the algorithm proposed by Arokiasamy and colleagues was adopted to define depression in our study [25]. For the Life satisfaction variable, SAGE asked participants how satisfied are you with the following*; health; themselves; their ability to perform their daily living activities; their relationships; the conditions of their living place; and overall, how they were satisfied with their life as a whole these days*. These Likert questions had responses such as 'very dissatisfied; dissatisfied; neither satisfied nor dissatisfied; satisfied and very satisfied and an overall score ranging from 0 to 24 was generated. Participants were classified as; Low, moderate, and high if life satisfaction scores fell below the 25th, 50th, and 75th percentile respectively.

2.5. Outcome variable

The main study outcomes were semantic and episodic memory using psychological assessment processes. Semantic memory (SM) was assessed using verbal fluency with the ability to name animals within one minute. Respondents were encouraged to continue naming animals if they stop before the minute is up. In addition, participants were prompted to continue or repeat the fundamental instructions if there is a 15-s period of silence.

Episodic memory was assessed using a composite verbal recall and delayed recall. For verbal recall, participants were asked to repeat a list of words involving; Arm, Bed, Plane, Dog, Clock, Bike, Ear, Hammer, Chair, and Cat. Three attempts were assessed among participants and the corresponding correct recalled words were recorded. To generate the composite recall score summation of the correct words was estimated using the three attempts. For delayed recall, participants were asked over the past 10 min to recall the aforementioned 10 words, and the corresponding correct words were recorded. Episodic memory was then assessed by adding composite verbal recall and delayed recall, divided by the total number of attempts (4). This method of assessment has been adopted elsewhere [26,27].

2.6. Independent variables

Independent variables that were analyzed in this study included; Sex (male or female), age group (50–59, 60–69, 70–79 and 80 +), educational level (none, primary, Senior High School, SHS/ Middle School, MSLC, and tertiary), marital status (never married, separated/divorced, widowed), religion (none, Christian, Islam and primal indigenous), place of residence (rural vs urban), currently working (no or yes), region (involving the then 10 administrative regions), self-rated health (SRH) (good, moderate and bad), a place where born (same locality or different locality), difficulty in work activity (none, mild, moderate, severe, extreme), Non Communicable Disease (NCD) status (none and 1 + NCD) and WHR (low, moderate and high) and Hypertension status (Normal, Elevated and Hypertensive).

2.7. Data analysis

Stata 16.1 was used for data analysis and authors adjusted for the primary sampling units, stratification, and sampling weights as estimated by SAGE Wave 2. Bivariate and multivariate data analyses were carried out separately. For bivariate analysis, means of SM and EM were assessed by using a complex survey analytical method by adjusting for the Wald test. The F-test statistic was used to assess the significant mean difference by categorical variables. For multivariate data analysis, the authors adopted the Nested Ordinary Least Square analysis. The assumption for the Nested Ordinary Least Square regression procedure as presented in Fig. 1 below was to nest models by sequentially adding blocks of variables and then report comparison tests between the nested models. Normality of the outcome variable was tested using the Shpiro-Wilk test of normality. The test showed no significance (p-value>0.05), meaning that the outcomes of interest were normally distributed.

For each block, the choice of independent variables was selected based on *priori* from other scholars who found a significant association with cognitive impairment. For block 1, evidence can be found from [28–33], for block 2 [34–36], block 3 [30,37,38], block 4 [39–41], block 5 [42,43] and block 6 [44,45]. The variables selected were based on *priori*.

2.8. Patients and public involvement statement

The questionnaire used for the SAGE Wave 2 was modified from that of SAGE Wave 1 due to patient experiences and priority lessons learned. The design of SAGE Wave 2 was informed by the involvement of patients in Wave 1, modifications made were based on patient priorities. Recruitment of patients and conduct of the study was by the WHO SAGE Ghana Team. The WHO SAGE Ghana Team organizes national stakeholders meeting to disseminate the findings of the national survey. A report of the national survey based on all data collected is provided to the general public and available on the WHO SAGE website.

2.9. Ethical requirements

SAGE wave 2 study was approved by World Health Organization's Ethical Review Board with reference number RPC149 and also, the Ethical and Protocol Review Committee, College of Health Sciences, University of Ghana, Accra, Ghana. Written informed consent was obtained from all study participants. Informed consent was obtained from all participants involved.

3. Results

The study involved 3575 adult Ghanaians aged 50 years and older with a mean ± standard deviation of 62.6 ± 18.4 years and a male: female distribution of 47%: 53%. The overall mean ± SD of episodic memory (EM) and Semantic memory (SM) were 5.86 ± 2.51 and 11.69 ± 8.59 respectively. Overall, the mean differences in both EM and SM were significantly associated with sex, age groups, educational level, marital status, occupational status, region of residence, BMI, WHR, SRH, Qol, and life satisfaction (p-value < 0.05) (Table 1).

Nested regression analysis showed that demographic characteristics significantly explained approximately 12.7% of the variation in SM scores by socio-demographic characteristics (block 1). Increasing age, female sex, being never married, and regional disparity significantly decreased SM. Intuitively, older adults with SHS and tertiary educational level had significantly increased SM approximately 1.2 and 2 times respectively compared with older adults with no formal education [aβ(95% CI) = 1.21(0.54, 1.88) and 2.02(0.96, 3.08) respectively].

After adjusting lifestyle characteristics with socio-demographic characteristics, 13.3% (ΔR^2 = 0.67%) of the variations in SM were significantly explained by lifestyle characteristics of the older adults (block 2). There was no significant association between SM and those who currently smoked or used alcohol. With respect to the anthropometric measurements of the older adults (block 3), the analysis showed that a significant 14.2% (ΔR^2 = 0.91%) variation in SM was explained after adjusting for health risk factors (BMI and WHR). Older adults who were underweight and those with moderate WHR had significantly decreased SM [aβ(95% CI) = −0.94(−1.49, −0.39) and −0.82(−1.42, −0.22) respectively]. Analysis showed that participants with moderate SRH (block 4) had significantly decreased SM scores, approximately 1.3 times compared with older adults with good SRH [aβ(95% CI) = −1.30(−1.79, −0.80)]. Older adults with functional difficulty (block 4) had increased SM compared with their counterparts who had no functional difficulty [aβ(95% CI) = 0.58(0.73, 1.08)]. In block 5, nesting depression in block 4 aided no significant change in the EM scores variation (ΔR^2 = 0.02%). It was observed that QoL (block 6) increased the overall variations in SM by approximately 16.9%(ΔR^2 = 1.17%). Analysis showed that moderate and good QoL increased the SM score by 15% (95% CI = −0.59, 0.89) and 1.2 times (95% CI = 0.41, 1.99) compared with bad QoL (Table 2).

The nested regression analysis showed that demographic characteristics significantly explained approximately 17.8% of the variation in EM scores. The increasing age of the participant, being separated and widowed, and regional disparity significantly decreased EM whiles increasing levels in education by older adults increased EM significantly. When socio-demographic and lifestyle characteristics of the older adults were nested, the analysis showed no significant variation in EM. In addition, no significant association exists between EM and participants who were currently smoking and alcohol consumption.

Analysis of the anthropometric measurements showed a significant 18.8%(ΔR^2 = 0.94%) variation in EM after nesting health risk factors (BMI and WHR) with socio-demographic and lifestyle characteristics. Older adults who were underweight had significantly decreased EM by approximately 21% compared with those with normal weight [aβ(95% CI) = −0.21(−0.38, −0.05)]. Older adults with moderate WHR [aβ(95% CI) =

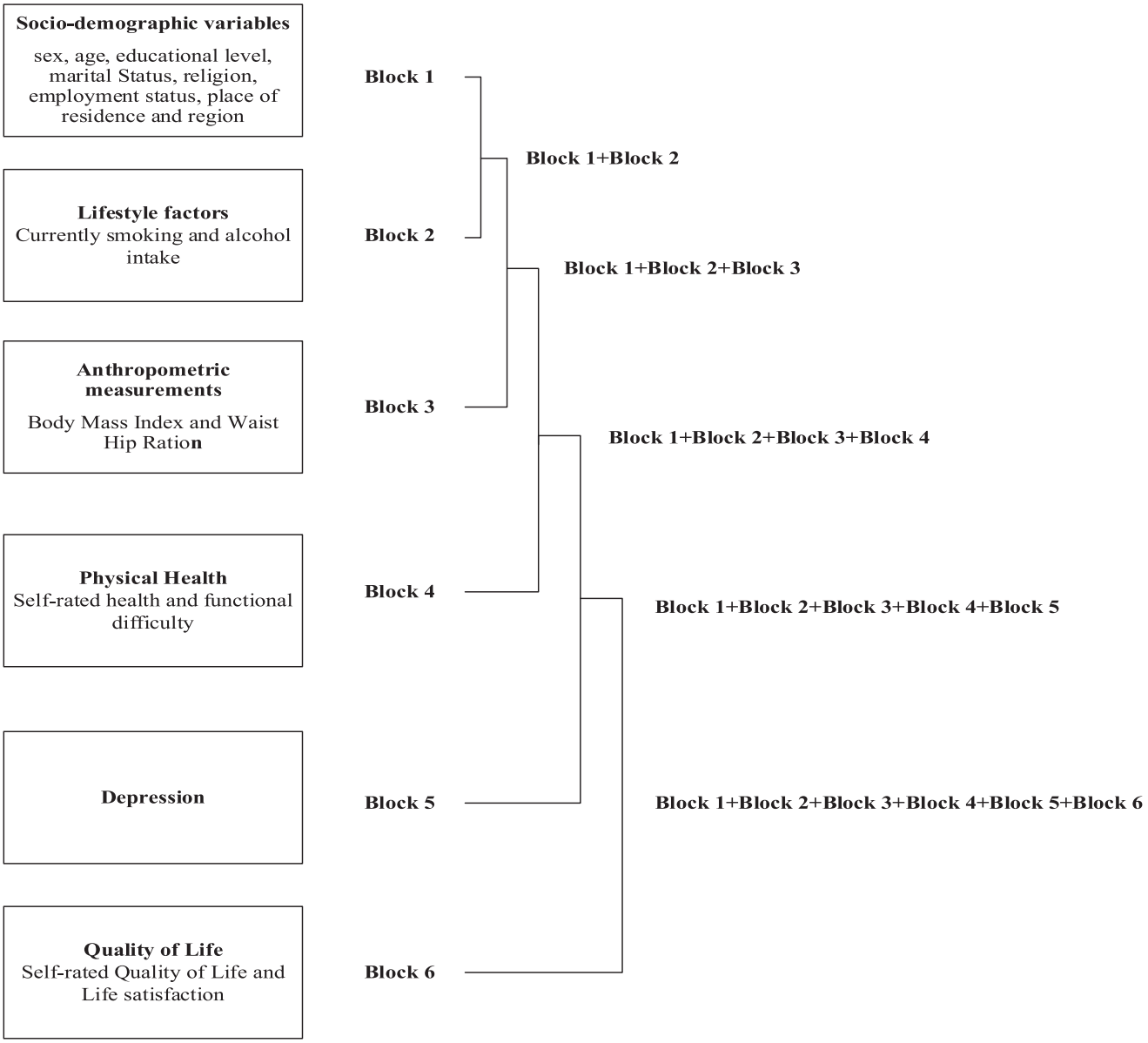

Fig. 1. Analytical process defining the sequential addition of blocks.

−0.29(−0.45, −0.12)] had significantly decreased EM compared with their counterparts with low WHR. In addition, older adults who rated their health as moderate and bad had significantly decreased SM scores by approximately 36% and 47% respectively compared with those who rated their health as good [aβ(95% CI) = −36(−0.52, −0.20) and −0.47(−0.68, −0.25) respectively]. Older adults with good QoL and high life satisfaction also had significantly increased EM score [aβ(95% CI) = 0.26(0.02, 0.49) and 0.61(0.40, 0.82) respectively] (Table 3).

4. Discussion

This study determined the factors associated with episodic memory (EM) and semantic memory (SM) using a nationally representative sample of 3575 Ghanaian adults aged 50 years and above. The general observation was that the mean differences in both EM and SM were significantly associated with the sex, age groups, educational level, marital status, occupational status, region of residence, BMI, WHR, SRH, QOL, and life satisfaction.

4.1. Factors associated with semantic and episodic memory

Increasing age was associated with a decline in both SM and EM scores. SM has been reported to remain unimpaired whether accessed implicitly using priming technique or explicitly through the direct test of general knowledge or vocabulary while episodic memory is known to decline significantly with age [12,46]. Though our study accessed SE using an explicit approach (verbal fluency) the finding is not consistent with what has been reported in earlier studies [46,47]. The findings on the other hand are in line with other studies which reported a similar decline in EM among older ages [8,48,49]. Such declines have been attributed to hippocampal volume, processing speed, and executive function which are seen as mediators between age relator episodic memory, particularly free recall, cued recall, and text memory [9,12].

Evidence from previous studies suggest that sex plays a critical role in memory function, and that sex influences memory type[50,51]. Our study found that female older adults had decreased SM but not EM. The dynamics under this evidence are intriguing in the essence that when women remember more details than men, it is unclear whether it is due to encoding or

Table 1
Descriptive characteristics and level of memory among older adults in Ghana, SAGE Wave 2, 2014–2015.

Response	Episodic Memory	Semantic Memory
	Mean ± SD	Mean ± SD
Overall	5.86 ± 2.51	11.69 ± 8.59
Sex		
Male	6.06 ± 2.41	12.36 ± 8.56
Female	5.68 ± 2.54	11.10 ± 8.36
P-value	<0.001	<0.001
Age		
50–59	6.17 ± 2.06	12.16 ± 7.38
60–69	5.91 ± 2.40	11.85 ± 9.17
70–79	5.36 ± 2.80	10.99 ± 9.70
80+	4.82 ± 3.21	9.73 ± 9.51
P-value	<0.001	<0.001
Education		
None	5.47 ± 2.71	10.87 ± 8.90
Primary	6.04 ± 2.16	11.85 ± 7.92
SHS	6.16 ± 2.26	12.68 ± 8.29
Tertiary	6.70 ± 2.28	13.28 ± 7.72
P-value	<0.001	<0.001
Marital Status		
Never married	6.23 ± 2.60	10.21 ± 5.83
Currently married	6.04 ± 2.39	12.03 ± 8.46
Separated/divorced	5.80 ± 2.34	12.42 ± 8.44
Widowed	5.35 ± 2.61	10.66 ± 8.77
P-value	<0.001	<0.001
Religion		
None	5.65 ± 2.69	10.45 ± 8.97
Christianity	5.94 ± 2.43	11.89 ± 8.52
Islam	5.82 ± 2.21	11.44 ± 8.29
Primal indigenous	4.99 ± 3.77	10.75 ± 9.93
P-value	<0.001	0.0529
Occupational status		
Not working	5.50 ± 2.70	11.28 ± 8.90
Working	6.03 ± 2.36	11.89 ± 8.42
P-value	<0.001	0.0257
Place of residence		
Urban	5.92 ± 2.16	11.55 ± 7.40
Rural	5.80 ± 2.82	11.82 ± 9.64
P-value	0.1882	0.4521
Region		
Ashanti	5.86 ± 2.27	13.28 ± 9.15
Brong Ahafo	5.92 ± 2.64	12.49 ± 7.77
Central	5.93 ± 2.51	11.66 ± 6.85
Eastern	6.31 ± 2.32	10.35 ± 7.79
Gt. Accra	5.69 ± 1.74	9.87 ± 6.33
Northern	5.78 ± 2.66	11.75 ± 9.18
Upper East	4.86 ± 3.57	9.97 ± 8.12
Upper West	5.95 ± 2.00	12.42 ± 10.76
Volta	5.72 ± 2.30	12.04 ± 7.27
Western	6.12 ± 2.56	12.49 ± 8.92
P-value	<0.001	<0.001
Currently smoking		
No	5.86 ± 2.52	11.61 ± 8.54
Yes	5.91 ± 2.27	13.28 ± 9.05
P-value	0.7957	0.0207
Current alcohol use		
No	5.83 ± 2.46	11.51 ± 8.64
Yes	5.97 ± 2.60	12.33 ± 8.31
P-value	0.1008	0.005
BMI		
Underweight	5.52 ± 2.85	10.73 ± 9.31
Normal weight	5.89 ± 2.55	11.77 ± 8.65
Overweight	5.99 ± 2.26	12.18 ± 8.27
Obesity	6.02 ± 2.31	11.49 ± 8.48
Missing		
P-value	<0.001	0.0025
Waist Hip Ratio		
Low	6.20 ± 2.47	12.60 ± 8.34
Moderate	5.83 ± 2.46	11.63 ± 8.99
High	5.69 ± 2.62	11.23 ± 8.75
Missing		
P-value	<0.001	<0.001
SRH		
Good	6.09 ± 2.30	12.21 ± 8.13
Moderate	5.53 ± 2.61	10.62 ± 8.85
Bad	5.23 ± 2.78	11.31 ± 10.01
Missing		
P-value	<0.001	<0.001
Functional difficulty		
No	11.81 ± 8.06	8.08 ± 5.02
Yes	11.64 ± 8.83	7.06 ± 5.58
P-value	0.58	<0.001
Depression		
No	11.67 ± 8.44	7.49 ± 5.39
Yes	12.12 ± 10.82	5.98 ± 5.93
P-value	0.381	<0.001
QoL		
Bad	10.63 ± 9.29	4.92 ± 6.37
Moderate	11.05 ± 8.04	7.11 ± 5.56
Good	12.47 ± 8.77	8.05 ± 4.77
Missing		
P-value	<0.001	<0.001
Life satisfaction		
Low	11.02 ± 8.67	6.26 ± 5.98
Moderate	11.87 ± 8.50	7.75 ± 5.32
High	12.24 ± 8.54	8.12 ± 4.30
Missing		
P-value	0.005	<0.001

Abbreviations: BMI = Body Mass Index, SRH = Self-rated Health, QoL = Quality of Life.

retrieval of details. The theoretical approaches to these gender differences point to an explanation based on coding as established by scholars [52,53]. This current finding contradicts some previous studies which indicate that both men and women had similar declines in memory [51,54]. However, it conforms to observations by Maitland and colleagues[55] who noted that female superiority in declarative memory declines with advancing age and that the female superiority in fluency drives differences in semantic memory. Picardi et al. [56] in their study reported that gender differences in memory are more related to the type of material (verbal vs. visuospatial) than to the type of processing (active vs. passive). This finding supports the idea that when age and educational level are well-matched among sexes, differences due to the stimuli processing disappear.

In addition, being separated and widowed was associated with a decline in both SM and EM. This is partially consistent with a previous study that observed significant changes in EM between married and single individuals but not in SM. In that study, the rate of decline in EM was significantly larger for single and widowed older adults [57]. In understanding the role of social relations and memory decline in ageing, Zahodne and colleagues[58] found that being married/partnered and reporting more frequent contact with friends were each independently associated with slower memory decline. Their longitudinal study helps to clarify which aspects of social relations are most likely to influence late-life episodic memory trajectories. Similarly, Zhang and colleagues also concluded that staying widowed for two years or more may be an independent risk factor for episodic memory decline after controlling for economic difficulties in Chinese older adults [59]. Thus potentially, the positive relationship and companionship in marriage may limit the decline in episodic memory in the older adult.

Table 2
Nested regression analysis showing factors associated semantic memory among older adults in Ghana, SAGE Wave 2, 2014–2015.

Variable	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]
Sex						
Male	Ref	Ref	Ref	Ref	ref	ref
Female	−0.83[−1.37, −0.29]**	−0.52[−1.05, 0.01]	−0.53[1.17, 0.11]	−0.49[−1.13, 0.14]	−0.52[−1.15, 0.11]	−0.50[−1.15, 0.15]
Age group						
50–59	Ref	Ref	Ref	Ref	Ref	Ref
60–69	−0.18[−0.72, 0.35]	−0.15[−0.67, 0.36]	−0.07[−0.59, 0.45]	−0.6[−0.58, 0.47]	−0.06[−0.58, 0.46]	−0.08[−0.61, 0.45]
70–79	−0.98[−1.60, −0.37]**	−0.95[−1.54, −0.36]*	−0.79[−1.39, −0.18]*	−0.67[−1.27, −0.62]*	−0.70[−1.31, −0.10]*	−0.72[−1.32, −0.12]*
80 +	−1.94[−2.76, −1.12]***	−1.87[−2.67, −1.07]***	−1.67[−2.49, −0.86]***	−1.60[−2.41, −0.79]***	−1.65[−2.45, −0.84]***	−1.67[−2.48, −0.86]***
Educational Level						
None	Ref	Ref	Ref	Ref	Ref	Ref
Primary	0.82[0.24, 1.41]	0.77[0.20, 1.33]	0.74[0.17, 1.31]*	0.67[0.10, 1.24]*	0.68[0.11, 1.25]*	0.68[0.10, 1.25]*
SHS	1.21[0.54, 1.88]***	1.23[0.59, 1.87]***	1.14[0.49, 1.78]**	1.10[0.45, 1.76]**	1.09[0.43, 1.74]***	0.99[0.34, 1.66]*
Tertiary	2.02[0.96, 3.08]***	2.12[1.10, 3.13]***	2.03[0.99, 3.07]***	2.04[0.99, 3.09]***	2.05[1.00, 3.10]***	1.79[0.73, 2.85]***
Marital Status						
Currently married	Ref	Ref	Ref	Ref	Ref	Ref
Never married	−1.51[−2.33, −0.68]***	−1.61[−2.44, −0.78]***	−1.53[−2.37, −0.69]***	−1.56[−2.40, −0.71]***	−1.55[−2.39, −71]***	−1.55[−2.41, −0.69]***
Separated/divorced	0.39[−0.26, 1.04]	0.25[−0.41, 0.90]	0.27[−0.37, 0.92]	0.36[−0.28, 1.01]	0.36[−0.28, 0.99]	0.41[−0.23, 1.05]
Widowed	−0.39[−0.86, 0.08]	−0.044[−0.90, 0.03]	−0.40[−0.87, 0.06	−0.32[−0.79, 0.14]	−0.33[−0.79, 0.14]	−0.30[−0.76, 0.17]
Religion						
Primal indigenous	Ref	Ref	Ref	Ref	Ref	Ref
None	−0.50[−2.02, 1.01]	−0.52[−2.04, 1.00]	−0.55[−2.11, 1.00]	−0.58[−2.14, 0.98]	−0.72[−2.27, 0.84]	−0.71[−2.25, 0.83]
Christianity	0.34[−0.65, 1.33]	0.51[−0.49, 1.51]	0.48[−0.51, 1.48]	0.36[−0.60, 1.32]	0.36[−0.60, 1.31]	0.30[−0.64, 1.25]
Islam	−0.14[−1.16, 0.87]	0.13[−0.89, 1.15]	0.09[−0.93, 1.10]	−0.01[0.99, 0.97]	−0.01[−0.98, 0.96]	−0.08[−1.03, 0.88]
Employment status						
Not working	Ref	Ref	Ref	Ref	Ref	Ref
Working	−0.29[−0.89, 0.31]	−0.27[−0.81, 0.27]	−0.30[−0.85, 0.25]	−0.36[−0.90, 0.18]	−0.33[−0.88, 0.21]	−0.41[−0.96, 0.13]
Place of residence						
Rural	Ref	Ref	Ref	Ref	Ref	Ref
Urban	−0.17[−0.66, 0.32]	−0.12[−0.61, 0.37]	−0.21[0.72, 0.29]	−0.23[−0.72, 0.27]	−0.23[−0.72, 0.27]	0.21[−0.71, 0.28]
Region						
Upper West	Ref	Ref	Ref	Ref	Ref	Ref
Ashanti	0.14[−0.87, 1.16]	0.15[−0.86, 1.17]	0.05[−0.97, 1.06]	0.49[−0.55, 1.52]	0.46[−0.57, 1.49]	0.17[−0.85, 1.21]
Brong Ahafo	−0.47[−1.41, 0.47]	−0.47[−1.40, 0.47]	−0.45[−1.40, 0.51]	−0.09[−1.05, 0.87]	−0.07[−1.02, 0.89]	−0.28[−1.23, 0.68]
Central	−1.27[−2.15, 0.39]*	−1.27[−2.16, −0.390]*	−1.34[−2.24, −0.44]*	−0.95[−1.86, −0.03]*	−0.94[−1.85, −0.03]*	−1.13[−2.05, −0.20]*
Eastern	−2.69[−3.83, −1.54]***	−2.74[−3.87, −1.60]***	−2.81[−3.97, −1.66]***	−2.31[−3.48, −1.15]***	−2.29[−3.45, −1.3]***	−2.54[−3.70, −1.37]***
Gt. Accra	−3.43[−4.71, −2.14]***	−3.52[−4.71, −2.34]***	−3.65[−4.85, −2.45]***	−3.24[−4.49, −1.99]***	−3.24[−4.48, −1.99]***	−3.45[−4.73, −2.20]***
Northern	−0.37[−1.37, 0.64]	−0.44[−1.44, 0.57]	−0.49[−1.50, 0.52]	0.09[−1.10, 0.92]	−0.06[−1.06, 0.94]	−0.21[−1.22, 0.81]
Upper East	−2.25[−3.43, −1.07]***	−2.27[−3.46, −1.08]***	−2.39[−3.58, −1.20]***	−2.26[−3.39, −1.12]***	−2.27[−3.40, −1.15]***	−2.45[−3.57, −1.33]***
Volta	−0.88[−1.94, 0.18]	−0.91[−1.98, 0.15]	−0.93[−1.99, 0.13]	−0.59[−1.65, 0.48]	−0.66[−1.71, 0.40]	−0.81[−-1.87, 0.24]
Western	−0.50[−1.42, 0.42]	−0.46[−1.39, 0.46]	−0.51[−1.45, 0.43]	−0.15[−1.09, 0.79]	−0.14[−1.08, 0.79]	−0.34[−1.28, 0.60]
Currently smoking						
No		Ref	Ref	Ref	Ref	Ref
Yes		1.52[−0.27, 3.31]	1.54[−0.27, 3.35]	1.48[−0.25, 3.20]	1.46[−0.26, 3.18]	1.63[−0.17, 3.42]
Current alcohol use						
No		Ref	Ref	Ref	Ref	Ref
Yes		0.46[−0.19, 1.10]	0.45[−0.19, 1.10]	0.45[−0.18, 1.08]	0.44[−0.19, 1.07]	0.37[−0.28, 1.01]

BMI						
Underweight			−0.94[−1.49, −0.39]**	−0.87[−1.41, −0.32]*	−0.87[−1.41, −0.32]*	−0.81[−1.34, −0.27]*
Normal weight			Ref	Ref	Ref	Ref
Overweight			0.37[−0.24, 0.98]	0.42[−0.18, 1.02]	0.42[−0.18, 1.01]	0.31[−0.29, 0.91]
Obesity			0.24[−0.58, 1.07]	0.25[−0.56, 1.06]	0.27[−0.55, 1.08]	0.05[−0.76, 0.86]
Waist Hip ratio						
Low			Ref	Ref	Ref	Ref
Moderate			−0.82[−1.42, −0.22]*	−0.70[−1.30, −0.11]*	−0.70[−1.29, −0.11]*	−0.70[−1.29, −0.10]*
High			−0.56[−1.29, 0.17]	−0.60[−1.31, 0.12]	−0.59[−1.30, 0.13]	−0.55[−1.28, 0.18]
SRH						
Good				Ref	Ref	Ref
Moderate				−1.30[−1.79, −0.80]***	−1.31[−1.81, −0.81]***	−0.98[−1.52, −0.45]***
Bad				−0.12[−0.99, 0.76]	−0.19[−1.07, 0.69]	0.32[−0.67, 1.33]
Functional difficulty						
No				Ref	Ref	Ref
Yes				0.58[0.73, 1.08]*	0.57[0.06, 1.07]*	0.54[0.02, 1.06]*
Depression						
No					Ref	Ref
Yes					0.90[−0.03, 1.82]	1.01[0.08, 1.94]*
QoL						
Bad						Ref
Moderate						0.15[−0.59, 0.89]
Good						1.20[0.41, 1.99]*
Life satisfaction						
Low						Ref
Moderate						0.18[−0.34, 0.70]*
High						0.16[−0.55, 0.87]
R^2	0.1266***	0.1333*	0.1424***	0.1559***	0.1577	0.1694***
ΔR^2	–	0.0067	0.0091	0.0136	0.0018	0.0117

Abbreviations: BMI = Body Mass Index, SRH = Self-rated Health, QoL = Quality of Life. R^2 denotes the coefficient of determination from the nested regression analysis and ΔR^2 denotes the change in the coefficient of determination from one block to another. Ref. represents the reference category used for inferences. P-value Notation: *p-value < 0.05, **p-value ≤ 0.01 and ***p-value ≤ 0.001.
Block 1 = Socio-demographic variables; Block 2 = Lifestyle factors; Block 3 = Anthropometric measurements; Block 4 = Physical health; Block 5 = Depression; Block 6 = Quality of life.

Table 3
Nested regression analysis showing factors associated episodic memory among older adults in Ghana, SAGE Wave 2, 2014–2015.

Episodic	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]	aβ[95%CI]
Sex						
Male	Ref	ref	Ref	Ref	ref	ref
Female	−0.13[−0.27, 0.01]	−0.14[−0.28, 0.00]	−0.15[−0.31, 0.01]	−0.13[−0.29, 0.03]	−0.13[−0.29, 0.03]	−0.11[−0.28, 0.49]
Age group						
50–59	Ref	Ref	Ref	Ref	Ref	Ref
60–69	−0.20[−0.34, −0.06]*	−0.20[−0.34, −0.06]**	−0.18[−0.31, −0.04]*	−0.16[−0.30, −0.02]	−0.16[−0.30, −0.02]*	−0.17[−0.31, −0.03]*
70–79	−0.56[−0.71, −0.40]***	−0.56[−0.71, −0.40]***	−0.51[−0.67, −0.35]***	−0.43[−0.60, −0.26]***	−0.43[−0.60, −0.26]***	−0.44[−0.61, 0.27]***
80+	−1.01[−1.25, −0.76]***	−1.01[−1.26, −0.76]***	−0.96[−1.20, −0.71]***	−0.87[−1.12, 0.62]***	−0.87[−1.12, −0.62]***	−0.88[−1.13, −0.63]***
Educational Level						
None	Ref	Ref	Ref	Ref	Ref	Ref
Primary	0.29[0.13, 0.45]***	0.29[0.14, 0.45]***	0.29[0.14, 0.44]***	0.27[0.12, 0.42]***	0.27[0.12, 0.42]***	0.27[0.13, 0.42]***
SHS	0.39[0.21, 0.58]***	0.39[0.21, 0.57]***	0.37[0.19, 0.54]***	0.36[0.18, 0.54]***	0.36[0.18, 0.54]***	0.32[0.15, 0.49]***
Tertiary	0.93[0.57, 1.29]***	0.94[0.58, 1.30]***	0.91[0.55, 1.27]***	0.88[0.53, 1.24]***	0.88[0.53, 1.24]***	0.79[0.45, 1.13]***
Marital Status						
Currently married	Ref	Ref	Ref	Ref	Ref	Ref
Never married	0.04[−0.33, 0.42]	0.05[−0.33, 0.42]	0.06[−0.32, 0.43]	0.03[−0.34, −0.39]	0.03[−0.34, 0.39]	−0.03[−0.38, 0.33]
Separated/divorced	−0.24[−0.42, −0.07]**	−0.24[−0.41, −0.07]**	−0.24[−0.41, −0.07]*	−0.19[−0.37, −0.02]*	−0.19[−0.37, −0.02]*	−0.15[−0.33, 0.02]
Widowed	−0.27[−0.40, −0.14]***	−0.27-0.40, −0.14]***	−0.27[−0.40, −0.14]***	−0.24[−0.37, −0.11]***	−0.24[−0.37, −0.11]***	−0.22[−0.35, −0.87]***
Religion						
Primal indigenous	Ref	Ref	Ref	Ref	Ref	Ref
None	0.24[−0.22, 0.70]	0.25[−0.21, 0.71]	0.24[−0.23, 0.71]	0.28[−0.18, 0.75]	0.28[−0.19, 0.75]	0.26[−0.19, 0.71]
Christianity	0.38[0.08, 0.67]*	0.38[0.08, 0.67]*	0.37[0.08, 0.66]*	0.34[0.05, 0.62]*	0.34[0.05, 0.62]*	0.29[0.00, 0.58]*
Islam	0.37[0.74, 0.67]*	0.36[0.06, 0.66]*	0.35[0.05, 0.65]*	0.32[0.03, 0.61]*	0.32[0.03, 0.61]*	0.27[−0.03, 0.57]
Employment status						
Not working	Ref	Ref	Ref	Ref	Ref	Ref
Working	0.02[−0.12, 0.16]	0.02[−0.12, 0.16]	0.02[−0.12, 0.15]	−0.05[−0.19, 0.09]	−0.05[0.19, 0.08]	−0.08[−0.22, 0.05]
Place of residence						
Rural	Ref	Ref	Ref	Ref	Ref	Ref
Urban	0.04[−0.10, 0.18]	0.04[−0.10, 0.18]	0.02[−0.13, 0.16]	−0.00[−0.15, 0.14]	−0.00[−0.15, 0.14]	−0.01[−0.15, 0.13]
Region						
Upper West	Ref	Ref	Ref	Ref	Ref	Ref
Ashanti	−0.41[−0.60, −0.22]***	−0.41[−0.60, −0.22]***	−0.43[−0.64, −0.23]***	−0.30[−0.50, −0.10]**	−0.30[−0.49, −0.10]**	−0.28[−0.49, −0.08]**
Brong Ahafo	−0.28[−0.48, −0.08]**	−0.28[0.48, −0.08]**	−0.27[−0.47, −0.07]**	−0.18[−0.38, 0.02]	−0.18[−0.38, 0.02]	−0.17[−0.37, 0.04]
Central	−0.24[−0.41, −0.06]**	−0.23[−0.41, −0.05]*	−0.24[−0.43, −0.06]**	−0.17[−0.36, 0.01]	−0.17[−0.36, 0.01]	−0.13[−0.37, 0.07]
Eastern	0.1.[−0.18, 0.39]	0.11[−0.18, 0.39]	0.09[−0.20, 0.38]	0.24[−0.06, 0.54]	0.24[−0.07, 0.54]	0.20[−0.10, 0.50]
Gt. Accra	−0.69[−0.95, −0.44]***	−0.69[−0.94, −0.43]***	−0.72[−0.99, −0.46]***	−0.61[−0.86, −0.35]***	−0.61[−0.87, −0.35]***	−0.53[−0.80, −0.26]***
Northern	−0.25[−0.45, −0.06]**	−0.25[−0.45, −0.06]*	−0.26[−0.46, −0.06]*	−0.15[−0.36, 0.05]	−0.16[−0.36, 0.05]	−0.11[−0.33, 0.10]
Upper East	−0.93[−1.24, −0.63]***	−0.93[−1.24, −0.63]***	−0.96[−1.27, −0.65]	−0.94[−1.24, −0.64]***	−0.93[−1.24, −0.64]***	0.92[−1.23, −0.61]***
Volta	−0.50[−0.74, −0.26]***	−0.49[−0.74, −0.25]***	−0.49[−0.73, −0.25]***	−0.41[−0.65, −0.18]***	−0.41[−0.64, −0.17]***	−0.38[−0.62, −0.14]**
Western	−0.13[−0.32, 0.05]	−0.13[−0.32, 0.05]	−0.13[−0.33, 0.06]	−0.05[−0.25, 0.14]	−0.05[−0.25, 0.14]	−0.04[−0.23, 0.16]
Currently smoking						
No		Ref	Ref	Ref	Ref	Ref
Yes		0.01[−0.35, 0.37]	0.00[−0.37, 0.38]	−0.03[−0.38, 0.32]	−0.03[−0.37, 0.32]	0.05[−0.33, 0.44]
Current alcohol use						
No		Ref	Ref	Ref	Ref	Ref
Yes		−0.05[−0.23, 0.13]	−0.05[−0.24, 0.13]	−0.04[−0.22, 0.14]	−0.04[−0.22, 0.14]	−0.06[−0.24, 0.12]

BMI						
Under weight			−0.21[−0.38, −0.05]*	−0.19[−0.36, −0.02]*	−0.19[−0.36, −0.02]*	−0.14[−0.30, 0.03]
Normal weight			Ref	Ref	Ref	Ref
Over weight			0.03[−0.13, 0.19]	0.04[−0.12, 0.19]	0.04[−0.12, 0.19]	0.01[−0.15, 0.16]
Obesity			0.122[−0.08, 0.32]	0.14[0.06, 0.34]	0.14[−0.06, 0.33]	0.06[−0.14, 0.26]
Waist Hip ratio						
Low			Ref	Ref	Ref	Ref
Moderate			−0.29[−0.45, −0.12]***	−0.25[−0.41, −0.08]**	−0.25[−0.41, −0.08]**	−0.22[−0.39, −0.06]**
High			−0.19[−0.37, −0.00]*	−0.17[−0.35, 0.00]	−0.18[−0.35, 0.00]	−0.14[−0.32, 0.05]
SRH						
Good				Ref	Ref	Ref
Moderate				−0.36[−0.52, −0.20]***	−0.36[−0.52, −0.20]***	−0.20[−0.36, −0.04]*
Bad				−0.47[−0.68, −0.25]***	−0.46[−0.68, −0.24]***	−0.12[−0.38, 0.13]
Functional difficulty						
No				Ref	Ref	Ref
Yes				0.08[−0.08, 0.23]	0.08[−0.07, 0.23]	0.08[−0.07, 0.23]
Depression						
No					Ref	Ref
Yes					−0.08[−0.32, 0.17]	0.01[−0.23, 0.26]
QoL						
Bad						Ref
Moderate						0.15[−0.07, 0.36]
Good						0.26[0.02, 0.49]*
Life satisfaction						
Low						Ref
Moderate						0.37[0.21, 0.52]***
High						0.61[0.40, 0.82]***
R^2	0.1784***	0.1786	0.1880**	0.2019***	0.2021	0.2293***
ΔR^2	–	0.0002	0.0094	0.0139	0.0002	0.0272

Abbreviations: BMI = Body Mass Index, SRH = Self-rated Health, QoL = Quality of Life. R^2 denotes the coefficient of determination from the nested regression analysis and ΔR^2 denotes the change in the coefficient of determination from one block to other. Ref. represents the reference category used for inferences. P-value Notation: *p-value < 0.05, **p-value ≤ 0.01 and ***p-value ≤ 0.001.
Block 1 = Socio-demographic variables; Block 2 = Lifestyle factors; Block 3 = Anthropometric measurements; Block 4 = Physical health; Block 5 = Depression; Block 6 = Quality of life.

Another key observation was that older adults with higher educational backgrounds, (secondary and tertiary education) had significantly decreased SM and EM decline compared with those with no formal education. This is consistent with existing literature which suggests that a higher level of education is associated with higher cognitive abilities including SM and EM [60,61]. It further affirms the assertion that higher educational status is a protective factor for episodic memory [62]. This observation could be attributed to an increased cognitive reserve which is linked to education, occupational attainment, and leisure activities [63].

There have been mixed reports concerning the effects of lifestyle characteristics such as smoking and alcohol consumption on the cognitive abilities of the aged [64–66]. The effects of smoking have been observed to be high among current smokers more than 75-year-old, as they perform poorly on cognitive tests and appear to decline in memory more rapidly than their peers who do not smoke [67]. Alcohol use in older adults has similar mixed reports, while evidence exists for memory decline in heavy drinkers, other observations indicate that light alcohol consumption could be a protective factor for memory in older adults [68]. Our observations are in contradistinction to these, we found no significant association between those who currently smoked and used alcohol and memory decline. Ours is, however, consistent with Topiwala and colleagues, who also reported no significant association in cross-sectional cognitive performance or longitudinal changes in semantic fluency or word recall [66].

Health risks (BMI and WHR) were significantly associated with a decline in SM and EM accounting for 14.2% and 21% of the variation in memory scores. Older adults who were underweight or with moderate WHR had significantly decreased SM and EM compared to those with normal weight and WHR respectively. This agrees with a study that explored overweight and cognition and found that SE and EM of participants with normal weight outperformed their counterparts after partially out diseases such as diabetes, stroke, and high blood pressure [69]. Contrary to this, Gardener and colleagues reported no associations for BMI and WHR and cognitive performance nor decline over time among older adults >65 years compared with worse global cognitive performance among those aged <65 years [70]. Similarly, higher WHR was associated with deficits in both executive functions and EM above and beyond the influence of demographic, comorbid health issues, health behaviours, personality traits, and self-perceived obesity. Higher BMI, however, was not associated with deficits in episodic memory [71].

Older adults with moderate and bad SRH had significantly decreased SM and EM scores. This is consistent with a recent study that observed that older adults with poor SRH showed a faster rate of memory decline compared with their counterparts with good patterns of SRH [72]. Small and colleagues also reported that only selected measures of episodic and semantic memory showed evidence of significant decline before age 75 beyond which all cognitive abilities showed evidence of statistically significant decline [73].

Counter-intuitively, older adults with functional difficulty had increased SM compared to those without functional difficulty. No relationship was, however, established between EM and functional difficulty (even though no functional difficulty increased the EM score by 8%). This is in agreement with other studies which report difficulties in functioning may be attributed to other physical health conditions rather than cognitive decline [74,75].

This analysis indicated that depression did not significantly influence SM and EM though it accounted for some variations in memory scores. Depressed mood tends to directly influence the processing speed and therefore generates difficulties in memory which may account for the variations seen in the memory scores [76]. This finding contradicts what Brunet and colleagues found, which suggested that semantic deficits in mild cognitive impairments were somewhat associated with the presence of concomitant depressive symptoms [77]. They noted that depression alone cannot account solely for the semantic deficits since those with late-life depression showed no semantic memory impairment. Similarly, other scholars averred that late-life major depression was associated with greater impairment in episodic memory compared with depression in young to middle adults [78,79].

Quality of life has been associated with improved cognitive abilities including memory outcomes. In our analysis, QoL accounted for approximately 16.9% and 29% of the variations in SM and EM respectively. Older adults with moderate and good QoL had increased SM and EM compared with those with bad- QoL. In addition, participants with moderate to high life satisfaction increased both SM and EM scores significantly. In essence, QoL and cognitive impairment have a bidirectional effect. Cognitive impairment significantly affects QoL [80] which conforms to the current finding. This corroborates evidence by other scholars showing that worse QoL is associated with worse cognitive performance and vice versa [81–83].

4.2. Limitations

Data used for this study is cross-sectional data from the WHO SAGE Wave 2 study in Ghana and does not allow for any cause-and-effect conclusions. Data was based mainly on self-report and might be susceptible to social desirability on the part of respondents. In addition, the measure for episodic memory and semantic memory is limited given that there are some aspects of these memory processes that were not assessed.

5. Conclusion

With Ghana's ageing population projected to increase in the coming years, the study established increasing age, educational level, marital Status, regional disparity, SRH, QoL, and life satisfaction as significant factors associated with both SM and EM in older adults aged 50 years and above. The increasing frailty associated with old age point to these important socio-demographic determinants of SM and EM. To promote well-being at all ages, in line with Sustainable Development Goals (SDGs) 3 by considering the factors associated with SM and EM in the years leading up to 2030. In addition, implementation of the Ghana National Ageing Policy 2010, 'ageing with security and dignity' should consider these factors to enhance the well-being of the older adult.

Authors contribution

George Ekem-Ferguson and John Tetteh developed the concept. John Tetteh analyzed the data. George Ekem-Ferguson, Keziah Malm, Anita Ohenewaa Yawson, Richard Biritwum, George Mensah, and Alfred Edwin Yawson wrote the first draft manuscript. All the authors reviewed the final version of the manuscript before submission.

Data availability

Data are available upon request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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