

# The Contributing Factors to Mild Cognitive Impairment (Difficulty in Remembering) in Ghana - A Logistic Regression Approach

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**Abstract** The study analyzed the contributing factors associated with Mild Cognitive Impairment (MCI) in Ghana using the WHO study on Global Ageing and Adult Health (SAGE) data from Ghana. The data consisted of 5011 participants. The respondents were asked to indicate their difficulty in concentrating or remembering things in the last 30 days. The study categorizes the response into two (None and Some difficulty) and analyzes using logistic regression. We found that a little above 40% of the people have MCI. The females were more vulnerable in experiencing MCI with odds exceeding those of males by more than 29%. MCI is more common among people experiencing severe or moderate vision problems. Also, it was discovered that those with higher degrees of education tend to have better memory than people with lower levels of education or no education. Again, MCI is susceptible among aged people who do not engage in physical activities like working or exercising as well as those that are depressed. The logistic regression model found age, sex, educational level, difficulties seeing, depression, SBP, HR, exercise, employment status, and tribe to be statistically significant in factors associated with MCI.

**Keywords** Cognitive, Difficulty, Impairment, Logistic, Memory

## 1. Introduction

The ageing population keeps rising in the world specifically in most developing countries. According to the World Health Organization (WHO), there are over 40 million aged estimated to have challenge in remembering, reasoning or difficulty in making decisions that pertains to their daily life around the world. Among this high numbers, approximately six out every ten of these people are in developing countries. The WHO anticipates these numbers to rising to over 70 million by 2030. In 2050, this figure is estimated to hit more than 130 million [1]. The population of Ghana is not different when it comes to ageing. The ageing population of Ghana (60 years and above) was 4.1% 1950, 4.5% in 1975, 5.2% in 2000. It is estimated that it will rise to 7.2% in 2025 and 11.9% in 2050 [2].

The occurrence of challenges associated with the health of the aged keeps increasing due to the increasing aged population. One of the commonest among these is the cognitive impairment or dementia [3]. The frequency of memory loss has substantially grown in recent years [4], and the scientific research community has shown a great deal of interest [5]. A deterioration in mental faculties, such as remembering, speech, and logical reasoning, which is sufficient to cause difficulties with everyday functioning is referred to as dementia. Elderly people are frequently concern about Alzheimer when these kinds of symptoms start to appear. Alzheimer disease is a neurodegenerative

dementia, that is it is irreversible and results in the loss of brain tissue. Another kind of dementia that results from inadequate blood supply to the brain is vascular dementia, which is equally irreversible. Loss of memory as a result of Alzheimer disease can occur together with vascular dementia [6].

It is very expensive to live with dementia. The expected yearly costs for cognitive impairment in the older population in China, for instance, are projected to reach US\$69 billion in 2020, which emphasized a negative impact on family and other caretakers [7]. In 2020, the projected cost of dementia worldwide was approximately 600 billion US dollars. Dementia can start as a mild cognitive impairment (MCI) (difficulty in remembering or memory loss). Dementia contributes to approximately 12% of the years been disable as a result of noncommunicable illnesses [8]. Due to the chronic and complex nature of cognitive impairment, medical intervention to alter its course has not been successful, and it has even been difficult to clearly slow the growth of impairment [9].

Better cognitive performance and resilience were linked to a healthy lifestyle, which included not smoking, consuming alcohol in moderation, engaging in more physical activity such as exercise and cardiovascular health, adhering to a Mediterranean diet, and engaging in more socioeconomic and intellectually challenging activities [10][11]. MCI may be associated with old age and socioeconomic disadvantages such as lack of education, poor employment success, and income level [12]. These research measurements, however, were inconsistent due to their cross-sectional design and incomplete epidemiological characteristics.

There is still the need for thorough factor assessment into MCI especially in developing countries such as Ghana. There are not many research that have systematically looked at the probabilities of exposure and non-exposure to the factors associated with memory loss and therefore, a thorough investigation of these elements is required.

## 2. Methods

### 2.1. Setting and Data

This study used the Wave 1 Ghana data from WHO Study on Global Ageing and Adult Health (SAGE). In all, 20 variables were extracted with 5011 data points. The variables are sex, age, marital status, education status, highest educational level, tribe, religion, working status (currently working or not), memory, depression status, difficulty seeing, SBP, DBP, pulse, weight, height, tobacco intake, alcohol intake, exercise and cataracts. The data was analyzed using the R statistical software.

### 2.2. Model Specification

We fitted a logistic regression model similar to the work of Ofori et al. [13] as shown in equation 1.

$$\omega = \log\left(\frac{\eta}{1-\eta}\right) = X\beta + \varepsilon \quad (1)$$

where  $\omega$  links the linear function to  $\log\left(\frac{\eta}{1-\eta}\right)$ .  $\eta$  is the probability of having dementia,  $X$  is the matrix of predictor variables,  $\beta$  is the vector of the regression parameters, and  $\varepsilon$  is the vector of residuals. Memory status (MCI) was categorized in to two; yes or no. This served as the binomial response variable. The matrix of predictor variables was made up of age, sex, highest educational level, tribe, working status (currently working or not), depression status, difficulty seeing, SBP, Pulse (heart rate) and exercise. The Likelihood Ratio Test of the hypothesis  $H_o : c(\beta) = 0$ , was used to assess the overall goodness of fit [14]. Here, we compared the likelihood that a respondent has MCI to the likelihood that they do not have MCI.

### 2.3. Goodness of Fit Test

The deviance and Hosmer-Lemeshow test were used to measure the fit of the model 1. The Hosmer-Lemeshow (HL) test tells whether the observed event rate match that of the expected event rate in a given subgroup [15]. It is given by

$$G_{HL}^2 = \sum_{i=1}^{10} \frac{(o_i - e_i)^2}{e_i(1 - e_i/n_i)} \sim \chi_8^2 \quad (2)$$

## 3. Results

According to Table 1, 43.3% of the 5011 participants had MCI. This means that 4 out of every 10 of the participants had some difficulty in remembering. Again, 55.3% of the aged had MCI. Females with some difficulty remembering (54.7%) exceed that of males (45.3%). More than half of the participants who have no education have MCI. As number of people with memory loss declines as they rise education level. Greater percentage of the participant with some difficulty in seeing also have some challenge with remembering (68.1% for severe and 46.3 for moderate). The story is not different from depression as 60.3% of those that are severely depressed also have MCI.

Lastly, majority of the participants who are not engaged in any physical activity have MCI; 52.5% of participant who are currently not working and 55.9% of those who do not engage in any form of exercise have difficulty remembering.

**Table 1.** Cross Tabulation of MCI against some selected variables [N, (%)]

	Mild Cognitive Impairment		
	No	Yes	Total
<b>Total</b>	2840 (56.7)	2171 (43.3)	5011 (100.0)
<b>Age</b>			
Less than 40 years	343 (81.1)	80 (18.9)	423 (8.4)
40 – 60 years	1456 (64.5)	802 (35.5)	2258 (45.1)
Above 60 years	1041 (44.7)	1289 (55.3)	2330 (46.5)
<b>Sex</b>			
Male	1662 (62.8)	983 (37.2)	2645 (52.8)
Female	1178 (49.8)	1188 (50.2)	2366 (47.2)
<b>Highest Education Level</b>			
None	1528 (49.7)	1544 (50.3)	3072 (61.3)
Basic	405 (65.3)	215 (34.7)	620 (12.4)
Secondary	773 (68.1)	362 (31.9)	1135 (22.7)
Tertiary	134 (72.8)	50 (27.2)	184 (3.7)
<b>Difficulty in Seeing</b>			
None	1288 (66.7)	644 (33.3)	1932 (38.6)
Moderate	1403 (53.7)	1209 (46.3)	2612 (52.1)
Severe	149 (31.9)	318 (68.1)	467 (9.3)
<b>Depression</b>			
None	1586 (62.5)	950 (37.5)	2536 (50.6)
Moderate	1185 (51.5)	1116 (48.5)	2301 (45.9)
Severe	69 (39.7)	105 (60.3)	174 (3.5)
<b>Currently Working</b>			
Yes	2182 (60.2)	1443 (39.2)	3625 (72.3)
No	658 (47.5)	728 (52.5)	1386 (27.7)
<b>Exercise</b>			
Yes	110 (85.3)	19 (14.7)	129 (2.6)
No	2152 (44.1)	2730 (55.9)	4882 (97.4)

An independent-samples t-test was conducted to compare SBP and Heart Rate (HR) for those with MCI and those without MCI. There was a significant difference in SBP for those with MCI ( $M = 136.9$ ,  $SD = 25.0$ ) and those without MCI ( $M = 135.3$ ,  $SD = 24.9$ );  $[t(5009) = 2.37, p = .018]$  as shown in Table 2.

There was a significant difference in HR for those with MCI ( $M = 77.8$ ,  $SD = 13.3$ ) and those without MCI ( $M = 76.3$ ,  $SD = 13.5$ );  $[t(5009) = 2.23, p = .026]$ . These results suggest that SBP and HR have an effect on memory loss. Specifically, our results suggest that higher

blood pressure and heart rates make one experience difficulty in remembering.

According to Table 3, age and sex are significant positive predictors of MCI ( $p < .001$ ). The odds of a female having MCI are about 29% higher than a male having MCI. Also, physical activities such as exercise ( $p < .005$ ) and working status ( $p < .05$ ) were also found as statistically significant positive predictors of MCI. The log odds of MCI were 0.9005 higher on average for those who do not do exercise as compared to those who exercise. The odds of a participant who was not currently working having MCI are about 20% higher than those who were working having MCI.

**Table 2.** Summary of independent Sample t-test

Variables	MCI	N	Mean	Std. Dev	t	df	p value
SBP	No	2840	135.25	24.916	2.372	5009	.018
	Yes	2171	136.94	25.019			
Heart Rate	No	2840	76.32	13.497	2.231	5009	.026
	Yes	2171	77.17	13.343			

**Table 3.** Parameter estimates for the Logistic Regression model

Variables	Estimate	Std. Error	z value	p value	Odds Ratio
(Intercept)	-3.2272	.4455	-7.244	.0000	.040
<b>Age</b>					
40 – 60 years	.5967	.1571	3.798	.0001	1.816
Above 60 years	1.1620	.1620	7.173	.0000	3.196
<b>Sex</b>					
Female	.2545	.0748	3.400	.0007	1.290
<b>Highest Educational Level</b>					
Nil	.6806	.2030	3.354	.0008	1.975
Basic	.1205	.2215	.544	.5864	1.128
Secondary	.1414	.2086	.678	.4978	1.151
<b>Difficulty in Seeing</b>					
Moderate	.1516	.0812	1.868	.0618	1.164
Severe	.8828	.1414	6.243	.0000	2.418
<b>Depression</b>					
Moderate	.1280	.0748	1.710	.0872	1.137
Severe	.4206	.1932	2.176	.0295	1.523
<b>Tribe</b>					
Akan	.2922	.0899	3.252	.0011	1.339
Ewe	.7690	.1540	4.995	.0000	2.158
Ga Adangbe	.4857	.1323	3.672	.0002	1.625
Gruma	.0588	.1750	.336	.7367	1.061
<b>Currently Working</b>					
No	.1818	.0837	2.171	.0299	1.199
<b>Exercise</b>					
No	.9005	.2912	3.092	.0020	2.461
<b>SBP</b>	-.0035	.0014	-2.463	.0138	.996
<b>Heart Rate (HR)</b>	.0077	.0026	2.939	.0033	1.008

Again, people with severe difficulty in seeing ( $p < .001$ ) as well as severe depression ( $p < .05$ ) were also found to be significant predictors of MCI. The odds of someone with severe difficulty in seeing having MCI are about 141% higher than those without difficulty in seeing having MCI. The log odds of MCI were 0.4206 higher on average for those with severe depression as compared to those who are not depressed. Participants without education ( $p < .001$ ), SBP ( $p < .05$ ), Heart Rate ( $p < .004$ ) and Tribe ( $p < .005$ ) are also statistically significant in this model.

### 3.1. Model Assessment

According to Table 4, there is a significant improvement in fit in the final model as compared to the null model [ $\chi^2(18) = 435.9, p < .001$ ]. The deviance [ $\chi^2(3719) = 3731.22, p = .4407$ ] and Hosmer and Lemeshow test [ $\chi^2(8) = 2.9066, p = .9401$ ] attest how good the model fit the data.

**Table 4.** Model Fitting Information and Goodness of fit test

Model/Test	-2 Log Likelihood	Chi-Square	df	p value
Null	5106.6			
Final	4670.7	435.9	18	.0000
Deviance		3731.22	3719	.4407
Hosmer and Lemeshow		2.9066	8	.9401

## 4. Discussion

MCI is an ageing challenge across the globe. The study determined the contributing factors associated with MCI in Ghana. The results showed that the prevalence of MCI in Ghana is 40%. Sex was found to be a contributing factor to MCI with females having odds of 29% higher than males. This result corroborates the results of [16]. Age was found to be a major risk factor for MCI and it confirms the result of Deary et al., 2009. Physical activities such as exercise and working status were found to be significant predictor of MCI. This implies that those who do not engage in exercise as well as those who are not working have a higher risk of experiencing MCI as compared to those who engage in some form of exercises or work. This agrees with the results of [16] who found that low physical activity is related to cognitive impairment in the elderly. Exercise is directly related to cognitive impairment. Bherer et al. found that physical exercise has positive correlation with cognitive [17]. Aerobic exercise has also been found to be associated with memory loss [18][19]. It is good to encourage the elderly to engage in exercise and other forms of work that will keep their brains active.

In addition, another important sociodemographic factor that also contributes to MCI was the level of education. This has also been found in many aging studies [20][21][22]. We also found depression to be predicting factor of MCI with the odds of more than 52% higher in those who are depressed. This validates the claim that depression leads to dementia in the aged [23][24]. Likewise, difficulty in seeing is another risk factor associated with MCI. People with some difficulty in seeing (moderate or severe) have a high risk of experiencing MCI. The probability of experiencing MCI is 141% higher in people with severe difficulty in seeing than those who don't have any challenge. According to the Alzheimer's Society, sight and hearing loss are associated with dementia.

Lastly, SBP was also found to be a statistically significant factor that contributes to MCI [25]. Abell et al. examined the relationship between SBP and DBP at age 50 and above with incident of memory loss and found that SBP of 130 mmHg at age 50 is associated with increased risk of dementia [26].

## 5. Conclusions

MCI affects little over 40% of the Ghanaian population. MCI is more common among those who are severely depressed. Additionally, MCI is more common in those who have severe vision problems. It affects women more severely and frequently than it does men. This indicates that women are more prone than men to experience MCI. Additionally, it has been discovered that those with higher degrees of education tend to have better memory than people with lower levels of education or no education. Once again, MCI is a problem for persons who do not engage in physical activities like working or exercising. Therefore, it makes sense that women who are severely depressed, also had some vision problems, and are less educated or have no education, and who do not participate in physical activity have a higher likelihood of developing MCI as they grow older. Age, sex, educational level, difficulties seeing, depression, SBP, HR, exercise, employment status, and tribe are found to be significantly linked with MCI.

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