

# MODELLING THE FACTORS ASSOCIATED WITH DIFFICULTY IN SEEING (VISION LOSS) AMONG THE AGEING POPULATION OF GHANA USING ORDINAL LOGISTIC REGRESSION TO WHO'S GLOBAL AGEING AND ADULT HEALTH (SAGE) GHANA DATA-WAVE 1

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### ABSTRACT

**Introduction:** The study modeled the factors associated with difficulty in seeing (vision loss) among the aged population of Ghana using the WHO study on Global Ageing and Adult Health (SAGE) Ghana Wave-1 data. **Methods:** The sampled data consisted of 4223 participants aged 50 years and above. The respondents were asked to indicate their difficulty seeing things in the last 30 days. The study grouped the responses into three (none, moderate and severe) and analyzed them using the proportional odds model of the ordinal logistic regression. **Results:** we found that more than half (66%) of the aged population of Ghana have some difficulty seeing. The females were more susceptible to experiencing difficulty in seeing (51.8% against 48.2%), with odds exceeding that of males by more than 43%. We also found a significant association between difficulty in seeing and the variables (age, sex, problem with remembering, depression, cataracts, and tobacco intake) using the Pearson chi-square ( $p < .001$ ). Again, we discovered that those with some memory problems tend to have difficulty seeing. Also, the log odds of severe difficulty in seeing was 1.044 higher on average for those 70 years and above than those below 60 years. **Conclusion:** the ordinal logistic regression model found age, sex, a problem with remembering, depression, tobacco intake, cataracts, SBP, and heart rate as significantly linked with difficulty in seeing among the aged population of Ghana at ( $p < .001$ ).

**Keywords:** Seeing, Difficulty, Ordinal, Logistic, Vision Loss

## Introduction

The aging population keeps rising worldwide, specifically in most developing countries. The occurrence of challenges associated with the health of the aged keeps increasing due to the increasing population. The commonest among these is the difficulty in seeing. One of the crucial human senses necessary for life and autonomous functioning is sight. Good vision is necessary for us to carry out our daily duties, but unfortunately, aging often results in eyesight loss for many people (Lauwen, 2021). Difficulty in seeing associated with the aged is a significant global healthcare issue. According to Ganley and Roberts (1983), by age 65, one in three people has an eye condition that impairs vision.

Around a billion individuals worldwide have some degree of difficulty in seeing, primarily with close or distant vision, according to the World Health Organization (WHO) (*Vision Impairment and Blindness*, 2022). More specifically, 217 million individuals have moderate to severe difficulty seeing, and over 36 million are blind (Bechange et al., 2020). The deficiency associated with difficulty in seeing is mainly referred to as age-related macular degeneration (AMD). AMD is a common disorder that affects the central portion of your eyesight. AMD affects 196 million people globally and is the main factor in visual loss in the West (Ratnapriya, 2019). It can lead to blurred vision or loss of central vision.

Seeing is mainly caused by refractive error, cataracts, glaucoma, corneal opacities, diabetic retinopathy, trachoma, and presbyopia, among other conditions (*Vision Impairment and Blindness*, 2022). According to WHO (2013), the majority (90%) of visually impaired people reside in low- and middle-income countries, where a lack of infrastructure, a lack of human resources, and expensive user fees make it difficult to provide ophthalmic services (Bechange et al., 2020). However, 80% of all vision loss may be largely avoided or treated with few measures (Stevens et al., 2013). Seeing impacts on employment and educational chances lower quality of life and raises mortality risk (Bourne et al., 2017; Eckert et al., 2015). Also, due to the inability to read or identify faces, individuals with AMD lose their independence, impacting their quality of life (Lonsdale et al., 2013).

Seeing is linked with smoking, high blood pressure, being overweight, and having a family history of AMD (NHS website, 2021). Reduction in the capacity to carry out everyday tasks, as well as a higher risk of depression, are both linked to vision loss (Shmueli-Dulitzki & Rovner, 1997). WHO (2013) has also asserted that smoking, diabetes, preterm delivery, rubella, and a lack of vitamin A are all risk factors associated with difficulty in seeing (WHO, 2013). Age, gender, and dietary variables are among the significant risk factors for vision loss (Nuertey et al., 2019).

Low and middle-income nations, particularly those in sub-Saharan Africa, such as Ghana, have the highest prevalence of sight-related issues. Despite the burden, there need to be more reports of analyses to understand the frequency and causes of eyesight problems. Therefore, our study filled this information gap by modeling the variables associated with vision loss.

## Methods:

### Data

This study used the Wave 1 Ghana data from WHO Study on Global Ageing and Adult Health (SAGE). In all, 4223 participants aged 50 years and above were considered. The SAGE data comprised 5573 participants, but this study considered only those aged 50 years and above. The data were analyzed using the R statistical software.

### Statistical Model Specification

This study used the proportional odds model similar to that of Singh et al. (2020) in the "Ordinal logistic regression model describing factors associated with the extent of nodal involvement in oral cancer patients and its prospective validation. "Most health, biomedical and epidemiological studies use either the continuation ratio model or the proportional odds model of the ordinal logistic regression class of models. In situations where the parallel regression assumption associated with the proportional odds model fails, many opt for the partial proportional odds model as the best alternative (Long & Freese, 2014b). The proportional odds model is preferred in this study because of its reasonable and significant interpretation in application. When the dependent variable takes on values in a set of ordered categories, the proportional odds model for ordinal logistic regression is a helpful extension of the binary logistic model (Brant, 1990). The proportional odds model was appropriate as participants were requested to indicate their difficulty in seeing in the last 30 days, of which the outcome was ordinal. The response variable (difficulty in seeing) was put into three categories: none, moderate and severe. As a result, the dependence of the response variable on the predictor variables is given by

$$\log \left[ \frac{\Pr(Y \geq y_j | x)}{1 - \Pr(Y \geq y_j | x)} \right] = \alpha_j + x_i' \beta, \quad j = 1, 2, 3$$

Where  $\Pr(Y \geq y_j)$  is the cumulative probability of the event  $(Y \geq y_j)$ ;  $\alpha_j$  are the respective intercept parameters;  $\beta$  is a  $(p \times 1)$  vector of regression coefficients corresponding to the predictor variables.  $(x_i)$ .

### The goodness of fit test

We assessed the general significance of the model using the likelihood ratio statistic given by

$$\chi^2 [i] = 2(\log L_a - \log L_0)$$

Where  $\log L_a$  is the log-likelihood computed using the full estimator,  $\log L_0$  the complement computed using the restricted estimator, and the associated degrees of freedom  $i$  representing the number of restrictions? Also, the model's goodness of fit was measured using the Pearson chi-square test and the Deviance test. Again, the Brant test was employed to test the validity of the proportional odds assumption.

## Results:

The ordinal logistic regression model was fitted to the data extracted. According to Table 1, 56.1% of the population had moderate difficulty in seeing, and 10.5% had severe difficulty in seeing. That is, about 6 out of every ten people in Ghana's aging population have difficulty seeing. Again, 65.3% of participants with a moderate problem with remembering have moderate difficulty seeing. Likewise, 12.5% of them with a moderate problem with remembering have severe difficulty in seeing. In all, 77.8% of people with a moderate problem with remembering also have difficulty seeing.

Furthermore, 42.2% of participants with a severe problem with remembering have moderate difficulty in seeing, while 28.4% of them with a severe problem with remembering also have severe difficulty in seeing. That is, 70.6% of people with a severe problem with remembering also have difficulty seeing. Also, difficulty in seeing is predominant in females compared to males (60.0% against 52.4% for moderate and 12.4% against 8.8% for severe).

Most participants (81.5%) who were 70 years and above had some difficulty seeing. Also, 68.0% of those with difficulty seeing are 60 years and above. Furthermore, 61.4% of those with difficulty seeing (moderate or severe) are also depressed (moderate or severe).

Most of the aged people (65.4%) who take tobacco products (cigarettes, cigars, pipes, and other tobacco products) have difficulty seeing. Lastly, 68.0% of the participants with cataracts have difficulty seeing.

**Table 1: Cross Tabulation of difficulty in Seeing against some selected variables**

	Difficulty in Seeing			Total
	None	Moderate	Severe	
<b>Total</b>	1411 (33.4)	2367 (56.1)	445 (10.5)	4223 (100.0)
<b>Problem with Remembering</b>				
None	799 (51.0)	702 (44.9)	64 (4.1)	1565 (100.0)
Moderate	523 (22.2)	1537 (65.3)	295 (12.5)	2355 (100.0)
Severe	89 (29.4)	128 (42.2)	86 (28.4)	303 (100.0)
<b>Age</b>				
50 – 59 years	761 (45.8)	816 (49.1)	85 (5.1)	1662 (100.0)
60 – 69 years	396 (33.5)	697 (58.8)	93 (7.8)	1186 (100.0)
70 years and above	254 (18.5)	854 (62.1)	267 (19.4)	1375 (100.0)
<b>Sex</b>				
Male	856 (38.7)	1159 (52.4)	195 (8.8)	2210 (100.0)
Female	555 (27.6)	1208 (60.0)	250 (12.4)	2013 (100.0)
<b>Depression Status</b>				
None	918 (46.0)	945 (47.4)	132 (6.6)	1995 (100.0)
Moderate	449 (21.7)	1355 (65.5)	256 (12.8)	2069 (100.0)
Severe	44 (27.7)	67 (42.1)	48 (30.2)	159 (100.0)
<b>Tobacco Intake</b>				
Yes	422 (34.6)	664 (54.4)	135 (11.1)	1221 (100.0)
No	1510 (39.8)	1948 (51.4)	332 (8.8)	3790 (100.0)

<b>Cataracts</b>				
Yes	350 (32.0)	614 (56.1)	131 (12.0)	1095 (100.0)
No	1061 (33.9)	1753 (56.0)	314(10.0)	3128 (100.0)

The Pearson chi-square test from Table 2 shows a significant association between difficulty in seeing and age, sex, problem with remembering, depression, cataracts, and tobacco intake at ( $p < .001$ ).

**Table 2: Pearson Chi-Square value for selected variables**

<b>Variables</b>	<b>Chi-Square Value</b>	<b>df</b>	<b>p-value</b>
Age	350.42	4	<0.001
Sex	62.97	2	<0.001
Problem with Remembering	478.87	4	<0.001
Depression	344.04	4	<0.001
Cataracts	134.44	2	<0.001
Tobacco Intake	134.44	2	<0.001

The ordinal logistic regression model presented in Table 3 shows that a problem with remembering is a statistically positive significant factor that predicts difficulty in seeing ( $p < .001$ ). The odds of a person with a moderate problem with remembering experiencing severe difficulty in seeing is 2.32 times that of someone with no difficulty remembering. Also, the odds of a person with a severe problem with remembering experiencing severe difficulty in seeing is 2.53 times someone with no problem with remembering. Age is also a statistically significant predictor of difficulty in seeing ( $p < .001$ ). The log odds of someone between 60 and 69 experiencing severe difficulty in seeing is 0.30 higher than someone younger than 60. Likewise, the log odds of someone who is 70 years and above experiencing severe difficulty in seeing is 1.04 higher than someone who is less than 60. It implies that aging comes with some difficulty in seeing.

**Table 3: Parameter estimates for Ordinal Logistic Regression model**

<b>Variables</b>	<b>Estimates</b>	<b>p-value</b>	<b>Odds Ratio (OR)</b>	<b>95% CI for OR</b>
<b>Problem with Remembering</b>				
Moderate	.8420	<0.001	2.321	2.014 – 2.674
Severe	.9296	<0.001	2.534	1.917 – 3.348
<b>Age</b>				
60 – 69 years	.3009	.0001	1.351	1.159 – 1.575
70 years and above	1.0443	<0.001	2.841	2.429 – 3.323
<b>Sex</b>				
Female	.3577	<0.001	1.430	1.246 – 1.640
<b>Depression</b>				
Moderate	.7107	<0.001	2.035	1.779 – 2.329
Severe	.9464	<0.001	2.576	1.810 – 3.667
<b>Tobacco Intake</b>				
Yes	.3067	<0.001	1.359	1.165 – 1.585
<b>Cataract</b>				
Yes	1.0630	<0.001	2.895	2.172 – 3.859

<b>Heat Rate</b>		-.0010	.0000	.991	.998 – .995
<b>SBP</b>		.0082	.0000	1.008	1.006 – 1.011
Threshold	None	1.2098	.0000	3.353	2.073 – 5.422
	Moderate	4.5453	.0000	94.187	56.901 – 155.898

Sex is a statistically significant positive predictor of difficulty in seeing ( $p < .001$ ). The odds of experiencing severe difficulty in seeing were 43% higher for females than males. That is, females stand a higher risk of experiencing severe difficulty in seeing than men as they grow. Depression is also a positive predictor that is statistically significant in predicting difficulty in seeing ( $p < .001$ ). The odds of a depressed person experiencing difficulty seeing are twice higher than someone who is not depressed. Also, cataract is a significant contributor to difficulty in seeing, ( $p < .001$ ) as the odds of those with cataract experiencing difficulty in seeing is found to be 2.90 higher than those without cataract. Tobacco intake, heart rate, and systolic blood pressure were also found to be statistically significant predictors of difficulty in seeing at ( $p < .001$ ).

<b>Table 4: Model Fitting Information and Goodness of fit test</b>				
Model/Test	-2 Log Likelihood	Chi-Square	df	p-value
Null	7785.17			
Final	6890.65	894.51	11	<0.001
Deviance		6841.19	8119	1.000
Pearson		8188.62	8119	.291

The model fitting information shown in Table 4 indicates that, comparatively, there is a substantial improvement in fit in our final model to that of the null model [ $\chi^2(11) = 894.51, p < .001$ ]. Also, the Pearson [ $\chi^2(8119) = 8188.62, p = .291$ ] and deviance test [ $\chi^2(8119) = 6841.19, p = 1.000$ ]s indicate that the model fits the data well.

A non-significance of the parallel test indicates that the assumption of proportional odds is satisfied. From Table 5, it is evident that the parallel regression assumption holds.

**Table 5: Parallel Test**

Test	Chi-sq	df	P value
<b>Omnibus</b>	26.2	11	.436
<b>Depression (Moderate)</b>	2.78	1	.139
<b>Depression (Severe)</b>	1.12	1	.223
<b>Problem with Remembering (Moderate)</b>	1.46	1	.212
<b>Problem with Remembering (Severe)</b>	2.24	1	.181
<b>Sex</b>	2.71	1	.142
<b>Age</b>	1.37	1	.241
<b>SBP</b>	0.38	1	.543
<b>Pulse</b>	0.1	1	.751
<b>Tobacco Intake</b>	0.58	1	.454
<b>Cataracts</b>	1.89	1	.176

*H0: Parallel Regression Assumption holds*

**Discussion:**

One of the crucial human senses necessary for life and autonomous functioning is sight. We modeled the factors associated with difficulty in seeing among the aged population of Ghana. The prevalence of difficulty in seeing among the aged population of Ghana was 66.6%. The prevalence of difficulty in seeing among females was higher than among males (51.8% against 48.2%). This finding confirms the result of Seidu et al. (2021), who also found more women (23.45%) with vision difficulties than men (14.67%). They also found that the prevalence of difficulty in seeing was higher among females in Ghana and Togo. Nuertey et al. (2019) also found gender to be associated with difficulty in seeing among the aged population. Women stand a high risk of experiencing difficulty in seeing and, as such, must do well to avoid other contributing factors like tobacco intake and depression, among others, that can be prevented. Another result that aligns with this finding is that of Rius Ulldemolins et al. (2019). They credited the higher female prevalence to gender disparities in health care access.

The age factor also contributes to difficulty in seeing. We found the age groups 60 to 69 years and 70 years and above significant, yet the odds of experiencing severe difficulty in seeing among the 70 years and above group was very high. The result is consistent with Steinmetz et al. (2021), who asserted that more than 80% of the people who have some difficulty seeing are 50 years and over. Also, Seidu et al. (2021) found across Ghana, Togo, and Gambia that there was a higher possibility of vision loss among people 40 years and above. We also found that difficulty in seeing is associated with depression. Previous studies (Virgili et al. (2022); Zhang et al. (2013); Osaba et al. (2019); Parravano et al. (2021) had established a strong relationship between depression and vision loss, and our result was not different from that.

Another factor we found to be associated with difficulty in seeing was cataracts. A cataract is a highly significant contributor to vision loss among the aging population in some studies (López-Sánchez et al. (2019); Tang et al. (2015); Nakamura et al. (2010)). The impact of cataracts on the difficulty in seeing cannot be overshadowed. Cataracts sometimes lead to total blindness (Foster & Johnson, 1990).

Alcohol intake and usage of tobacco products were also found to be significant. López-Sánchez et al. (2019), in their study "The association between difficulty seeing and physical activity among 17,777 adults residing in Spain," found alcohol consumption and smoking as significant predictors of difficulty in seeing. The aged should be educated to desist from tobacco products such as cigarettes, cigars, and pipes, as well as excessive alcohol intake, to reduce their risk of experiencing vision loss. Lastly, the problem with remembering or memory loss was a factor associated with difficulty in seeing. This result corroborates the assertion by the Alzheimer's Society that sight and hearing loss are associated with dementia (Sight and Hearing Loss With Dementia, n.d.).

## Conclusion:

More than half (66%) of the aged population of Ghana have some difficulty seeing. The gender difference was detected for difficulty as the number of women reported with some difficulties in seeing exceeds that of the men. Again, there is an association between difficulty in seeing and the variables; age, sex, difficulty in remembering, depression, cataracts, and tobacco intake. The aged who have some problem with remembering to tend to have difficulty seeing, like those who are depressed. Difficulty in seeing is more severe in those who take tobacco products and those with cataracts. We can infer that women who have difficulty remembering, are depressed, and take tobacco products will have a higher probability of experiencing difficulty seeing as they grow older (60 years and above). Lastly, Age, sex, problems with remembering, depression, tobacco intake, cataracts, SBP, and heart rate are significantly linked with difficulty in seeing among the aged population of Ghana.

## Conflicts of Interest

The author declares no conflicts of interest.

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