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Determinants of active trachoma among rural children aged 1–9 years old in Aw-Bare Wereda, Somali Region of Ethiopia: a cross-sectional study

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Abstract

Introduction Chronic and highly contagious, trachoma is a condition characterized by recurrent bacterial infection with ocular strains of Mycoplasma trachoma. It spreads through fingers, flies, and fomites, especially in situations where there is overcrowding. If untreated, the illness may result in blindness. Trachoma is an ancient disease and has previously been a significant public health problem in many areas of the world, including parts of Europe and North America. There are at least 400 million cases of active trachoma in the world, 8 million of which have resulted in blindness. Trachoma is a serious public health issue that is very common in Ethiopia. Therefore, the objective of this study is to identify the determinants of active trachoma among rural children aged 1–9 years old in Aw-bare woreda, Somali region of Ethiopia.

Method A cross-sectional community-based study involving children aged 1–9 who lived in six selected rural kebeles in the Awbare woreda Somali region and carried out using an ordinal logistic regression model. The study comprised 377 children in total. Our sample youngsters were chosen through a two-stage cluster sampling procedure. Then also chose our sample kebeles by simple random sampling. The main environmental, personal, and demographic factors that influenced the outcomes of active trachoma status were modeled using partial proportional odds modeling and descriptive statistics.

Result The study showed that the prevalence of active trachoma was found to be 47.7%. The covariate secondary level of education of mother OR = 1.357; 95% CI (1.051, 1.75), P-value = 0.0192, Inside house cooking place of children family OR = 0.789:95% CI (0.687, 0.927), P-value = 0.0031, children stay at home OR = 2.203:95%CI (1.526, 3.473), P-value = 0.0057,rich income family OR = 1.335:95%CI(1.166,1.528),P-value = 0.0001,Amount of water fetched per day OR = 2.129,95%CI(1.780,2.547),P-Vaue = 0.0001 were significant effect on active trachoma. PPOM represents the best fit as it has the smallest AIC and BIC. It is also more parsimonious.

Conclusion The mother's educational level, the location where the children spent the majority of their time indoors cooking, the fly density during the interview, the family's income, the child's age in years, the distance to the water

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source, the quantity of water fetched daily, and the number of people sharing a room have all been found to be significant predictors of the child's active trachoma status. Thus, increasing maternal education, access to clean water, and socioeconomic position are all crucial measures in preventing trachoma. Preventing trachoma also involves reducing the number of kids in a room and enhancing activities linked to personal cleanliness, such as giving kids a thorough facial wash to remove debris and discharge from their eyes.

Keywords Active trachoma, Proportional odds model, Ordinal logistic regression, Community-based study, Chronic communicable disease, Stereotype ordered logit models

Introduction

Background of the study

The most common infectious cause of blindness in the world is trachoma, which is especially common in developing countries like Ethiopia. It is brought on by recurrent bacterial infections with eye strains of Mycoplasma trachomasis. The disease is transmitted from one person to another by a fragment of eye tissue contaminated with bacteria. One key contributing factor to the development of disease is overcrowding, particularly in houses. Fingertip contact, direct contact, eye-seeking flies (Musca sorbens), and formits that deposit their eggs on exposed human feces are the main ways that Trachoma is spread. Eight million individuals worldwide suffer from irreversible vision impairment due to trachoma, which the World Health Organization estimates is currently responsible for three to four% of blindness worldwide [1]. Over 400 million people worldwide [2].Blindness rates in industrialized countries are lower than in underdeveloped countries, where they are ten to twenty times higher, and up to 30–50% of the population may be impacted by specific disease issues such as onchocerciasis or the horrible trachoma [3].

Prior to the development of antibiotics as a treatment, this illness was widespread throughout North America and Europe. This fact suggests that the elimination of trachoma is due to the improved living conditions enjoyed by the majority of people on these continents [4].This supports the widely-held notion that trachoma is a traditional disease of the impoverished, primarily affecting individuals who are socioeconomically disadvantaged and lack access to basic amenities like clean water, housing, and sanitation. Trachoma can be transmitted from person to person through flies and direct contact. The only way to spread trachoma is by direct contact with an infected person's eye, nose, or throat secretions [5].The illness can also be spread via fomites, such as contaminated washcloths, blankets, and handkerchiefs. Although there are no reservoirs in animals or insects, C. trachomatis can be spread by Musca sorbents flies.

Particular worry is the loss and impairment of vision in children. In addition to consequences from infections, cataracts are a significant cause for concern. There are two types of cataracts: developing (occurs after the first year of life) and congenital (exist from birth). Sub-Saharan Africa is home to about 90,000 children who are blind from cataracts, and each year about 19,000 babies are born with congenital cataracts. Additionally, studies conducted in Malawi, Ethiopia, and South Africa show that astigmatism, myopia, hypermetropia, and vision disorders affected 2.3 to 2.9% of learners in Sub-Saharan Africa [6]. Active trachoma was found to be a significant public health issue in Ethiopia based on the findings of studies conducted at the national, regional, zonal, and district levels. The prevalence of active trachoma in these studies varied across different parts of the country, ranging from 24.1 to 49% in Baso Liban and Lemma districts to 62.7% and 49% in Amareo and Burji woredas, respectively [7].

Based to a statewide assessment carried out in Ethiopia, 40.14% of children between the ages of one and nine years old have active trachoma [8].When someone contracts trachoma for the first time, they could put off getting help until they experience conjunctival irritation or reinfection; in certain situations, this might result in corneal damage already [9].The numerous levels of health care are not in sync with one another, which results in long wait times.

Acute and chronic forms of trachoma can be distinguished clinically. It is feasible for a person to have both acute and chronic symptoms simultaneously. In places where the disease is endemic, there are often bouts of active illness in childhood and a persistent scream afterwards. Children and their moms are more vulnerable since Trachoma is linked to poverty [10].The conditions in which the vast majority of people currently live have a direct bearing on the prevalence and spread of trachoma. Due to social and economic advancement, communicable diseases like trachoma have decreased in many developed nations. However, the current rates of socioeconomic growth in many of the countries where trachoma is particularly prevalent are so low that passive waiting will not give significant control. The prevalence and severity of trachoma have been proven to be reduced and even eliminated by small, development-oriented improvements, such as the provision and usage of water [11]. The study area has a notable incidence of active trachoma, but no more research has been conducted to ascertain the status of active trachoma. To further explore the issue facing rural communities, active trachoma research has been conducted in institutional settings rather than in rural areas. This is what motivates me to conduct this research and gives me a distinct interest in the study region. The purpose of this study is to investigate the potential cause of active trachoma in children aged 1 to 9 years in the rural Aw-bare Wereda, Somali region of Ethiopia, using ordinal logistic regression.

Data and methodology

Study area

The rural Aw-bare Wereda area served as the study's site. Awbare woreda is one of the nine woredas in the Fafan zone and one of the 96 woredas in the Somali Regional State. It is only 5 km from the international border, 709 miles from Addis Ababa, the capital city, and roughly 74 km from Jigjiga, the regional capital. The weroda shares borders with the city zone in the northwest, Kabribayah woreda of the Fafan zone in the south, north Somaliland, and the southeast. It is situated in the northeastern corner of the area, abutting the north-outonomous Somaliland state. geographically located between latitudes 9.77693805° North and longitudes 43.22816316° East. Its average elevation above sea level is 1590 m. The woreda is 3862 km2 in total and comprises 66 kabeles, of which 7 are urban and 59 are rural kebeles. 339,503 people make up the weroda population overall, of which 187,090 are male and 152,413 are female. 299,753 people out of the entire population reside in rural areas. There are 44,752 households overall that reside in rural areas. The census data also revealed that there were 77,012 children aged 1 to 9 living in the Wereda. There were roughly 31,555 children in the woreda's rural areas between the ages of one and nine.

Study design

The period of April 20–May 25 saw the completion of a cross-sectional study within the neighborhood. This study collected quantitative data from rural children in the Aw-bare Woreda, Somali region, aged 1 to 9 years old, in order to evaluate the prevalence and determinants of active trachoma.

Data collection procedure

This study made use of primary data. In addition, a physical examination and a structured questionnaire were utilized to gather primary data on sociodemographic and health variables. Interviews with the head of the home were used to gather all the data on a child. A child's eyes were examined by qualified nurses. After being written in English, the questionnaire is translated into Somali. Pretesting of the questionnaire was done with children aged 1–9 in a nearby location (not the research area) to make sure the data was comparable.

Target population

The target population for this study was all children 1–9 years of age in the rural area of Aw-bare Wereda Somali region during the time of the study.

Inclusion and exclusion criteria

Inclusion criteria

The study included all children, regardless of gender or ethnicity, between the ages of 1 and 9 at the time of the physical examination and interview (during the study).

Exclusion criteria

Young people who can't be physically examined during the interview. Choose one eligible child using the lottery technique if there are multiple eligible children in the home.

Sampling design, sampling procedure, and sample size

Sampling procedure

Our sample youngsters were chosen through a two-stage cluster sampling procedure. We also chose our sample kebeles by simple random sampling. The main sampling units from which the necessary number of kebeles was chosen were all of the rural kebeles in the Wereda. Every chosen kebele's homes with at least one kid between the ages of one and nine at the time of data collection were the subjects of secondary sampling.

Selection scheme

Kebeles were chosen using a basic random sample method during the initial sampling phase. The district administration office provided the list of kebeles. We choose to adopt the following process because it takes a lot of time for us to obtain a new list of all eligible homes in each kebele in order to choose a sample: We pick a sample of qualified homes from every kebele. Each data collector took up position on the northeast side of the kebele and started walking in a zigzag pattern, looking for an eligible household within each village in the kebele, after introducing themselves to the kebele leaders and other concerned parties and having a local guide. The first participant was then selected from among the qualified households that he or she had discovered along the route. Subsequently, each eligible family was taken in turn, i.e., participants were chosen by hopping from one eligible household to the next. Once the necessary participants have been chosen, the selection procedure comes to a close.

Sample size determination

A crucial component of the research is selecting the right sample size. Sample size is frequently described in terms of variation. Three methods exist for determining population variances where variance is unknown in order to determine sample size [12].Utilize the findings of the pilot research, Utilize data from earlier research on the same or comparable populations, and estimate or speculate about the population's structure with the help of certain logical mathematical conclusions. Using the sample size calculation formula from [12], the sample size (the number of eligible children) is determined: a single formula for population proportion, $n = \mathrm{e}[\frac{\left(z_{\frac{\alpha}{2}}\right)^2}{d^2}[p\,(1-p)]$

Were n = sample size, P = estimated proportion of active trachoma children in study area, Z = score associated with appropriately chosen level of confidence, d = acceptance margin of error e = design effect.

For preliminary information on the estimated prevalence or proportion of active trachoma children in the study area, we have taken prevalence level or proportion of 37% which is approximately similar result that was obtained from previous study [13] we have also assumed a design effect of 4 (for cluster sampling), choosing the margin of error to be 10% and a 95% level of confidence, our estimated sample size was calculated as follows:

$$n = \frac{\left(z_{\frac{0.05}{2}}\right)^2}{(0.1)^2}[0.37\,(1-0.37)] = [4\frac{(1.96)^2}{(0.1)^2}[0.37\,(1-0.37)] \approx 359$$

Adding 5% for expected nonresponse rate the final sample size 1–9 children was

$$n = 359 + 5\%\,[359] \approx 377$$

It consider a number of parameters, including population size, houses that are densely or sparsely populated, time for the entire study, available resources (budget and logistics), and the geographic area to be covered, when determining the proper number of kebeles to sample. We therefore chose to focus our final study on 6 of the 59 rural kebeles in the study area, taking these constraint considerations into account. This indicates that 377 household heads and 377 kids between the ages of 1 and 9 who were drawn from a sample of six kebeles took part in the survey. These six kebeles were chosen at random from the list of all kebeles in the study area using a basic random sampling technique. Thus, they picked the same number of kids from each kebele. An equal number of eligible families, or 63 households from each of the five sample kebele, were chosen for our final study. A selection of 62 suitable families was made from the sixth sample of the kebele. This indicates that 377 homes with 377 children between the ages of 1 and 9 made up our total sample size.

Table 1 Active Trachoma status of child

Dependent variable	Coding and categories
Child's status of active trachoma based on his/her WHO active grading	1 = child has no trachoma 2 = child has moderately active trachoma 3 = child has severely active trachoma

Data collection and instrument

The WHO's streamlined clinical grading system was used to check for trachoma in all 377 samples of children. To evaluate the risk factors, observations and interviews were also conducted. A structured questionnaire was used to gather data, and children in the sampled household, ages 1 to 9, as well as the head of household, filled it out. The evaluation of the child's face was completed prior to the trachoma examination for facial flies. Exams of children's eyes were performed with an instrument. Using the WHO simple grading scheme which is explained below the trachoma grader evaluated each eye for active trachoma while wearing 2.5x loupes and a torch. Each eye's inflammatory trachoma (TF and TI) clinical condition was rated independently. Then, based on which eye was most damaged, an ordinal severity score of active trachoma was assigned to all eligible subjects: 1 = no TF, no TI (no active trachoma); 2 = TF only (moderately active trachoma); and 3 = TI (severely active trachoma). As a result, the WHO standardized grading system was used to quantify the response variable by looking into children's eyes.

Variables of the study

The variables taken into consideration have been derived from various literatures, prior research, and elements that are naturally expected to affect children's trachoma status (ages 1–9).

The dependent variable

The qualitative response variable status active trachoma, which is classified as not active trachoma (no TF, no TI), moderately active trachoma (TF alone), or seriously of active trachoma (TI), is the response (dependent) variable in this study. Every child who took part in this study was therefore categorized as having either severe signs of active trachoma, moderately active trachoma, or no active trachoma at all show Table 1.

As a result Table 2, a child was categorized as having no, moderately, or severe active trachoma if the following criteria were met during examination: A child's active trachoma was graded by standardized ophthalmic nurses using the WHO grading method. The child anthropometric measurement is a valuable tool for determining a kid's trachoma status; it is simple to use and holds true for children of all ages and genders. The WHO standard reference population is used to determine the status of trachoma.

Table 2 The Simplified WHO grading system assessment of trachoma communities

Grade of trachoma	Characteristic to diagnose
trachomatous inflammation-follicular (TF):	The presence of five or more follicles of at least 0.5 mm in the upper tarsal conjunctiva.
Trachomatous Inflammation -Intense (TI	Pronounced inflammatory thickening of the tarsal conjunctiva that obscures more than half of the normal deep tarsal vessels
Trachomatous Scarring (TS	Presence of scarring in the tarsal conjunctiva(TS)
Trachomatous Trachealis(TT):	At least one eyelash rubs on the eyeball, or there is evidence of recent removal of in-turned eyelashes

The independent/predictor variables

The variables that are thought to affect or predict the dependent variable are known as independent variables, or predictor variables. The following are the variables that are thought to be the most prevalent and significant in influencing the dependent variable (state of active trachoma).child's sexual orientation, the child's age, mother's educational background, Face washing frequency: wash your face with soap, Environmental factors where the child primarily resided Livestock in the living room, The kitchen is in the living room, quantity of water retrieved each day, density of flies, trash disposal for waste, Household density, accessibility to latrines, Access to a water supply and family income.

Method of data analysis

Logistic regression can be used in this study to rank the relative importance of the predictor variables, evaluate the interaction effects of the predictors, and predict a response variable based on continuous, discrete, or a combination of these predictor variables. It can also be used to find out whether there is variation in the response variable that is explained by the predictor variables. The outcome variable frequently has two or more alternative values, making it discrete. Logistic regression has largely taken over as the go-to analytical technique in this domain [14, 15].An ordinal logistic regression model was employed in this study. The process of ordinal logistic regression makes it possible to choose the prediction model for dependent variables that are ordered. It explains how a set of explanatory factors and an ordered response variable are related. Any kind of continuous or discrete explanatory variable may be used [16]. In order to find relationships and important determinants of children's active trachoma (status of active trachoma), ordinal logistic regression analysis was used in this study. Due to the ordinarily of active trachoma status, an Ordinal logistic regression model-proportional odds model (POM) was created. If the proportional odds assumption is met, this model can be used to identify predictors of severe, moderate, and no active trachoma status; if not, alternative models such as the partial proportional odds model can be used. Ordinal logistic regression has advantages over traditional logistic regression models for this study. Assessing risk factors for the outcomes of "TF or not" and "TI or not" in relation to active trachoma, or combining TF and TI into a single outcome, "active trachoma or not." These methods are now recognized.

As a data reduction technique, dichotomization of the outcomes produces an odds ratio that could not accurately reflect the underlying link between the risk factors and the two active trachoma grades. A single, more accurate summary of effect estimate across both levels of active trachoma status is obtained by the use of ordinal logistic regression. To achieve our study's goals, the ordinal logistic regression model was used during the data analysis procedure.

An indicator of the degree of correlation between a predictor and the response of interest (the dependent variable's log odds) in a model is the odds ratio. Its range is 0 to infinity. There is no correlation if the odds ratio is one. You can find an estimate for the OR itself as $(-\beta)$. Thus, it is simple to interpret the parameter estimates of a logistic regression in terms of odds ratios. The parameter estimates can be understood by computing additional odds ratios (comparing each group with the reference group) if the explanatory variable has more than two levels.

In a model with many explanatory variables, the odds ratios for each predictor can be computed while maintaining a constant level for the other predictors. Naturally, this only makes sense in the absence of any interactions. Should such be the case, the major impacts should not be evaluated, but rather the interactions. The odds ratio for a continuous explanatory variable can be understood as an increase in the explanatory variable expressed as a unit. For each unit increment of x, the odds of the answer are multiplied by $exp\ (\beta)$, and odds smaller than one denote a lower likelihood of occurrence than non-occurrence.

The maximum likelihood method is utilized to estimate the model coefficients in logistic regression. The unknown parameters' functions are non-linear in the likelihood equations. Using the maximum likelihood method, the ordinal logistic regression model is fitted to the observed answers. The maximum likelihood approach, in general, yields values of the unknown parameters that most closely correspond to the observed and projected probability values. By maximizing the equation and applying iterative methods like the Newton-Rapson method, the estimates can be derived.

The log-likelihood was computed in order to compare the ordinal logistic models. A model that fits data better is one that has a higher log likelihood. Comparing models according to their fit, outcomes, and reasonableness as

Table 4 Cross-classification of predictors and trachoma status

Predictors	Category	n	Status of active trachoma		
			No sign	Moderate	Severe
Sex	Female	167	65.3	16.2	27.5
	Male	210	49.0	21.0	30.0
Age of child in years	3 and below	237	61.2	14.8	24.1
	Above 3	140	37.1	25.7	37.2
Mother's educational level	No education	247	48.6	20.2	31.2
	Primary	91	54.9	15.4	29.7
	Secondary	20	70.0	15.0	15.0
	Higher	19	68.4	21.1	10.5
Having cattle in living house	No	99	51.5	22.2	26.3
	Yes	278	52.5	17.6	29.9
Inside house cooking place	No	318	53.1	17.3	29.6
	Yes	59	47.5	27.1	25.4
child spent most of the time	Street	235	49.4	22.6	28.1
	In home	142	57.0	12.7	30.3
Face washing frequency	Once per day	3	33.3	33.3	33.3
	twice per day	359	52.9	18.9	28.4
	More than twice per day	15	15	20	40
Use of soap to wash face	No	323	51.7	18.6	29.7
	Yes	54	55.6	20.4	24.1
Amount of water fetched per day	Less than 20 L	92	44.6	17.4	38.0
	Between 20–50 L	245	53.1	19.2	27.8
	More than 50 L	31	67.7	16.1	16.1
Number of people sharing one room	1–4	98	53.1	20.4	26.5
	5–10	261	51.7	18.4	29.9
	Ten and above	18	55.6	16.7	27.8
Fly density during interview time	None	173	46.8	18.5	34.7
	1 to 5	122	54.1	21.3	24.6
	Bulk	82	61.0	15.9	23.2
Garbage disposal	Open field	329	53.8	17.6	28.6
	Pit with/out cover	19	40.4	27.7	31.9
Toilet facility	No toilet facility	135	53.3	16.3	30.4
	Toilet without pit	235	51.5	20.4	28.1
	Toilet with pit	7	57.1	14.3	28.6
Income of family	Poor	210	43.3	19.1	37.6
	Middle	48	54.2	20.8	25.0
	Rich	119	67.2	17.6	15.1
Distance of water source (round-trip) in km	No access (> 1 km)	70	1.4	2.9	95.7
	Basic (1 km)	69	4.3	42	53.6
	Intermediate (< 1 km)	328	81.1	16.8	2.1

Table 3 Frequency distribution of active trachoma based on his/her WHO active grading status of children

Status of active trachoma	Frequency	Percent	Cumulative Percent
No sign of active trachoma (No TF and TI)	179	52.3	52.3
Moderately sign of active trachoma (TF only)	71	18.8	71.1
Severe sign of active trachoma	109	28.9	100.0
Total	377	100.0	

determined, for example, by the Baye's Information Criterion (BIC) and the Akaike Information Criterion (AIC), is far preferable. It is best to use models with smaller absolute AIC and/or BIC values [17]. Comparing the adequacy of competing models and, consequently, the merits of keeping a variable in the model can be done using the AIC and BIC criteria.

The difference between the log-likelihood functions for two models is a measure of how much one model improves the fit over the other. The deviance measure is defined as minus twice the log of the ratio of the maximized values of the likelihood function for the full model to the simpler model. The deviation for model comparison is:

$$D = -2\left[\ln\left(L_o\right) - \ln\left(L_c\right)\right] \sim \chi^2\left(k\right)$$

Where is the log likelihood of the simpler model; L_c is the log likelihood of the full model; and k is the degree of freedom, which is the difference in the number of parameters between the full model and the simpler model.If D $>\chi^2(k)$, then the full model improves significantly over the simpler one.

Results

Descriptive statistics

The objective of this study is to determine and analyze the factors that influence children in the rural Aw-bare woreda region of Somalia who are between the ages of one and nine. The analyses comprised 377 children aged 1 to 9 years, of which 210 were male and 167 were female. We examined data from children aged 1 to 9 years. Table 3's findings revealed that 47.7% of children in our sample, aged 1 to 9, had active trachoma overall.Based on each child's WHO active grading, descriptive statistics were employed to determine the prevalence of active trachoma in the sampled population. Below is a cross-tabulation of categorical predictors and active trachoma cases.

Based on their WHO active grading, Table 3 shows the children's active trachoma status. This table shows that at the time of interview in the study region, the prevalence of moderately sign of active trachoma (TF only) and severe sign of active trachoma (28.9%) was 71 (18.8%) and 109 (28.9%), respectively. 179 (52.3%) of the children in the sample do not exhibit any symptoms of active trachoma (TF or TI) (Table 3).

Table 4 displays a cross-tabulation of the categorical predictor variables and the status of active trachoma in children. For male children, the proportions of severe and moderate signs of active trachoma were 30% and 21%, respectively, based on the constructed ordinal active trachoma status. Among the children in the sample who were three years of age or less, 24.1% and 14.8%, respectively, had severe and moderate signs of active trachoma. When comparing children with mild signs of active trachoma to those without signs or those with severe signs, the family's monthly income and the distance traveled to gather water were found to be more variable (Table 4). Similarly, garbage disposal, toilet facilities and other predictors have an influence on active trachoma status among rural children in the study shown in the table below.

Ordinal logistic regression models

Test of parallel regression assumption

In the suggested ordinal logistic regression models, every important explanatory variable (at the 5% significance level) from the uni-variable generalized ordered logistic regression models (Table 5) was included and its significance evaluated. The proportional odds assumptions for the complete model were not maintained, as shown by the Brant test of parallel regression assumption from proportional ordinal model (POM), which produced a Chi-Square value of 71.05 with p-value=0.000. This implied that the impact of one or more explanatory variables was probably going to vary depending on whether binary models were fitted to the cumulative cut points. As a result, generalized ordered logit models, partial proportional odds models, unconstrained continuation ratio models, and stereotype ordered logit models were fitted to the data and model comparisons were conducted instead of proportional odds, continuation ratio, and adjacent category models.

Goodness of fit and model selection

Based on Table 6, it can be inferred that all four full models exhibit significant improvements over their null model (intercept only model), since evidence is presented to refute the null hypothesis that all predictor coefficients are zero (Prob>chi-square=0.000). Because it has the shortest AIC and is more frugal, the PPOM model is the one that, in terms of AIC, represents the best fit. Therefore, parameter estimates of the PPOM are presented and discussed for the relevant predictors (at 5% significance level), and PPOM was utilized to uncover significant determinants of active trachoma.

Table 5 Results of generalized ordered logit model using a single predictor

Predictor	Log-likelihood	LRT	Prob > chi-square
Sex	-8928.513	13.17	0.0003
Age of child in years	-8860.694	148.81	0.0000
Mother's educational level	-8786.118	297.96	0.0000
Having cattle in living house	-8931.878	6.44	0.0112
Inside house cooking place	-8924.153	6.12	0.0134
Child spent most of the time	-8911.468	47.26	0.0000
Face washing frequency	-8934.963	0.27	**0.8726**
Use of soap to wash face	-8932.43	2.06	**0.1515**
Amount of water fetched per day	-8712.4265	243.02	0.0000
Number of people sharing one room	-8925.303	19.59	0.0001
Fly density during interview time	-8847.56	175.08	0.000
Garbage disposal	-8920.92	3.78	**0.0519**
Toilet facility	-8925.07	20.05	0.0000
Income of family	-8787.469	295.26	0.0000
Distance of water source (round-trip) in km	-5141.859	295.26	0.0000

Results of partial proportional odds Model

Table 7 shows the children's status as having no sign of trachoma against moderate and severe active trachoma and as having no indication of trachoma and moderate versus severe active trachoma. In other words, the first panel's coefficients indicate the likelihood that a child does not exhibit any symptoms of trachoma, in contrast to the other two categories of trachoma status. In a similar vein, the second panel compares the moderate and no indication groups to the active trachoma category. Hence, positive coefficients suggest that the respondent is more likely to be in a higher category of the response than the current one, while negative coefficients suggest that the respondent is more likely to be in the current or a lower category, depending on the higher category values on the explanatory variable. The parallel lines assumption was found to be broken by the partial proportional odds model predictors sex (P Value=0.03970),

Table 6 Log-likelihood and likelihood ratio estimates

Model	Obs	LL(null)	LL (model)	DF	Wald chi2	Prob > chi2	AIC	BIC
GOLM	377	-8826.044	-4893.129	19	3295.96	0.000	9824.26	9958.54
UCRLM	377	-8826.044	-4869.698	42	7912.69	0.000	9823.396	10120.230
SORM	377	-8813.758	-4905.019	23	2175.376	0.000	9858.211	10020.760
PPOM	**377**	**-1762.52**	**-9750.19**	**25**	**7877.33**	**0.000**	**9804.19**	**9994.97**

Table 7 Analysis of Maximum Likelihood Estimates for no sign versus moderate and severe active trachoma

Predictors	Categories	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Point Estimate	95% Wald CL	
Intercept	--	1	0.869	0.096	81.474	**< 0.0001**			
Mother's educational level (ref = No education)	Higher	1	0.834	0.210	15.794	**< 0.0001**	2.302	1.526	3.473
	Primary	1	0.145	0.070	4.339	**0.0372**	1.156	1.009	1.324
	Secondary	1	0.305	0.130	5.480	**0.0192**	1.357	1.051	1.751
Inside house cooking place (ref = No)	Yes	1	-0.226	0.077	8.744	**0.0031**	0.798	0.687	0.927
Child spent most of the time (street)	In home	1	0.160	0.058	7.643	**0.0057**	2.302	1.526	3.473
Fly density during interview time (ref = None)	1–5	1	0.367	0.093	15.610	**< 0.0001**	1.443	1.203	1.731
	Bulk	1	0.129	0.114	1.286	0.2569	1.137	0.910	1.421
Income of family (ref = Poor)	Middle	1	0.110	0.079	1.942	0.1634	1.116	0.956	1.303
	Rich	1	0.289	0.069	17.493	**< 0.0001**	1.335	1.166	1.528
Predictors have no parallel slope									
Age of child in years (ref = below 3 years)	above 3 years	1	-0.236	0.089	7.011	**0.0081**	0.790	0.664	0.941
Distance of water source (round-trip) in km (ref = No access->1 km)	Basic (1 km)	1	-0.537	0.125	18.405	**< 0.0001**	0.585	0.489	0.699
	Intermediate (< 1 km)	1	-2.028	0.995	4.154	**0.0415**	0.132	0.097	0.178
Amount of water fetched per day (ref = less than 20lt)	Between 20–50 lt	1	0.364	0.072	25.544	**< 0.0001**	1.439	1.250	1.658
	More 50lt	1	0.920	0.135	46.154	**< 0.0001**	2.509	1.924	3.271
Number of people sharing one room (ref = 1–4)	5–9	1	0.138	0.073	3.550	0.0596	1.148	0.995	1.325
	10 and more	1	-0.051	0.137	0.138	0.7101	0.950	0.727	1.243

child age (P-value = 0.00759), water source distance (round-trip) in kilometers (P-value = 0.000), daily water fetch amount (P-value = 0.00047), and number of people sharing a room (P-value = 0.01298). Therefore, the coefficients of these variables can differ between the two equations in the partial proportional odds model. Every possible predictor, with the exception of sex, was found to be substantially correlated with a child's status for trachoma based on the aggregate PPOM results. The child's bulk fly density, the family's medium income level, and the predictive number of people sharing a room, on the other hand, were not statistically significantly associated with the child's lack of trachoma symptoms as opposed to their moderate or severe active trachoma. Similarly, there was no statistically significant correlation found between the absence of any symptoms and moderate to severe active trachoma in children, and the mother's attendance at secondary and higher education levels, bulk fly density in children, middle-class family income, and five to ten persons sharing a room.

Predictors that do not violate the parallel line assumption

The estimated log chances of a child having no trachoma symptoms versus having moderate and severe active trachoma when other variables are constant were 0.87, according to the PPOM result Table 8. Similarly, when all predictors remain fixed, the estimated log chances of a kid with mild trachoma and no symptom versus severe active trachoma were 2.64. According to the PPOM results, there was a positive correlation between mother educational level and the risk of having no sign and moderate trachoma status. This means that the odds of a child having no sign and moderate trachoma status were 1.16 (CI: 1.01–1.32), 1.36 (CI: 1.05–1.75) and 2.30 (CI: 1.53–3.47) times higher for children whose mother attended primary, secondary, and higher education than for children whose mother did not attend any school.

When comparing children who spent most of their time at home to those who spent most of their time on the streets, the odds of the former group having no symptoms and a moderate case of trachoma were 2.30 (CI: 1.53–3.47) times higher. In contrast to children who live in a home without cooking, the odds of children having no symptoms and a moderate case of trachoma were 0.8 (CI: 0.69–0.93) times lower for those who live in a home with cooking. Children with one to five flies on their face and children from wealthy families had odds of 1.44 (CI: 1.2–1.73) and 1.34 (CI: 1.27–1.53) times higher, respectively, than those with no flies and moderate trachoma status.

Predictors that violate the parallel regression assumption

According to the PPOM results, children below the age of three have no water access (the distance of the source of water in the round-trip is greater than 1 km), basic (the distance of the source of water in the round-trip is 1 km) and intermediate (the distance of the source of water in the round-trip is less than 1 km) water access, and the odds of having no sign of trachoma status are 0.79 (CI: 0.66 = 0.94), 0.585 (CI: 0.49–0.7), and 0.13 (CI: 0.1–0.18) times less than children over the age of three. Additionally, children who had access to 20 to 50 L and more than

Table 8 Analysis of Maximum Likelihood Estimates for no sign and moderate versus severe active trachoma

Predictors	Categories	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq	Point Estimate	95% Wald CL	
Intercept		1	2.640	0.131	409.328	< 0.0001			
Mother's educational level (ref = No education)	Higher	1	0.834	0.210	15.794	< 0.0001	2.302	1.526	3.473
	Primary	1	0.145	0.070	4.339	0.0372	1.156	1.009	1.324
	Secondary	1	0.305	0.130	5.480	0.0192	1.357	1.051	1.751
Inside house cooking place (ref = No)	Yes	1	-0.226	0.077	8.744	0.0031	0.798	0.687	0.927
Child spent most of the time (street)	In home	1	0.160	0.058	7.643	0.0057	2.302	1.526	3.473
Fly density during interview time (ref = None)	1–5	1	0.367	0.093	15.610	< 0.0001	1.443	1.203	1.731
	Bulk	1	0.129	0.114	1.286	0.2569	1.137	0.910	1.421
Income of family (ref = Poor)	Middle	1	0.110	0.079	1.942	0.1634	1.116	0.956	1.303
	Rich	1	0.289	0.069	17.493	< 0.0001	1.335	1.166	1.528
Predictors have no parallel slope									
Age of child in years (ref = below 3 years)	above 3 years	1	-0.332	0.080	17.193	< 0.0001	0.717	0.613	0.839
Distance of water source (round-trip) in km (ref = No access->1 km)	Basic (1 km)	1	-3.601	0.091	1564.384	< 0.0001	0.027	0.023	0.033
	Intermediate (< 1 km)	1	-6.478	0.155	1751.192	< 0.0001	0.002	0.001	0.002
Amount of water fetched per day (ref = less than 20lt)	Between 20–50 L	1	0.756	0.091	68.425	< 0.0001	2.129	1.780	2.547
	More 50 L	1	1.285	0.183	49.327	< 0.0001	3.614	2.525	5.172
Number of people sharing one room (ref = 1–4)	5–9	1	-0.088	0.093	0.895	0.3440	0.915	0.762	1.099
	10 and more	1	-0.375	0.174	4.653	0.0310	0.687	0.489	0.966

50 L of water per day had odds of having no sign of trachoma status that were 1.44 (CI: 1.25–1.66) and 2.51 (CI: 1.92–3.27) times higher, respectively, than children who did not.

Furthermore, the PPOM results indicated that the odds of children having no sign and moderate trachoma status were 0.72 (CI: 0.61 = 0.84), 0.0.027 (CI: 0.023–0.033), 0.002 (CI: 001–002), and 0.69 (CI: 0.49 − 0.1) times less than those of children over the age of three. Children over the age of three have basic (distance of source of water in round-trip is 1 km), intermediate (distance of source of water in round-trip is less than 1 km), and more than ten people sharing one room, respectively, compared to children under the age of three, who have no water access (distance of source of water in round-trip is greater than 1 km), and one to four people sharing 1 room. Additionally, compared to children who received fewer than 20 L of water per day, the odds of children having no sign of trachoma status were 2.13 (CI: 1.78–2.55) and 3.61 (CI: 2.53–5.17) times higher, respectively, for children who accessed 20 to 50 L and more than 50 L of water per day (Table 8). **Marginal effects**.

Presenting data as differences in probabilities, such as a marginal effect (average predicted probability) is a more useful approach than using an odds ratio. We may calculate the marginal effect of each covariate for no sign (no TF and TI), moderate (TF only), and severe (active trachoma) independently using the PPOM.

A child older than three years old had an average higher risk of having no sign (no TF and TI), moderate (TF only), and severe (active trachoma) than a child younger than three years old (48.3%, 21.0%, and 30.8%). In comparison to a kid whose mother has no education, the average chance of a child whose mother attended elementary, secondary, and higher education being no sign, moderate, and severe was (52.7%, 19.1%, 28.2%), (54.4%, 18.5%, 27.2%), and (59.5%, 16.9%, 23.6%), respectively, higher (Table 9).The probability child spent most of the time in home being no, moderate and severely active trachoma was 53% 18.9% and 28.1% higher than child who's spent most of the time on the street.

Discussions

Assessing the causes of active trachoma in rural children aged 1 to 9 years old and its predictors in the Aw-bare woreda Somali region was the main goal of this study. In children aged 1 to 9 years, the total frequency of active trachoma was 47.7%. The current study's proportion of trachoma patients was higher than in other relevant studies, but it was lower than the prevalence in the SNNPR region's Amaro and Burji woredas, which were 62.6% and 48.5%, respectively. This disparity may have been caused by variances in sample size and study population. The variations in endemicity and study period in the Baso Liban and Lemma districts, which were 24.1% and 36.7%, respectively, may be the cause of this.

Comparing the PPOM to GOLM, UCRLM, and SORM, we can conclude that, overall, the PPOM suited the data very well because of its minimal AIC and BIC values. According to the partial proportional odds model,

Table 9 Average marginal effects of a children trachoma severity status

Predictors	categories	Marginal Effect					
		No Sign	*p*-value	Moderate	*p*-value	Severe	*p*-value
Age of child in years	Above 3	0.483	0.000	0.210	0.000	0.308	0.000
Mothers Education level	Primary	0.527	0.000	0.191	0.000	0.282	0.000
	Secondary	0.544	0.000	0.185	0.000	0.272	0.000
	Higher	0.595	0.000	0.169	0.000	0.236	0.000
Inside house cooking place	Yes	0.498	0.000	0.202	0.000	0.300	0.000
Child spent most of the time	In home	0.530	0.000	0.189	0.000	0.281	0.000
Amount of water fetched per day	20–50 L	0.528	0.000	0.190	0.000	0.282	0.000
	More 50 L	0.585	0.000	0.171	0.000	0.243	0.000
Number of people sharing one room	5–9	0.522	0.000	0.192	0.000	0.286	0.000
	10 and more	0.498	0.000	0.202	0.000	0.300	0.000
Fly density during interview time	1–5	0.530	0.000	0.189	0.000	0.281	0.000
	Bulk	0.521	0.000	0.192	0.000	0.287	0.000
Income of family	Middle	0.521	0.000	0.193	0.000	0.287	0.000
	Rich	0.541	0.000	0.185	0.000	0.274	0.000
Distance of water source (round-trip) in km	Basic (1 km)	0.084	0.000	0.365	0.000	0.550	0.000
	Intermediate (< 1 km)	0.006	0.000	0.046	0.000	0.948	0.000

which provides estimated coefficients, standard errors, and p-values of the explanatory variable categories, the mother's educational level, the location where the child spends the majority of their time cooking inside the home, fly density during the interview, the family's income, the child's age in years, the distance to the water source, the amount of water fetched daily, and the number of people sharing a room are all found to be significant predictors of the child's active trachoma status. The log chances of the response variable falling into a higher category as opposed to a lower category are represented by the coefficients of the explanatory variables in the model. The odds ratios and associated confidence intervals are the foundation for interpreting the model estimates in logistic regression. These interpretations are provided as follows.

The study found that a mother's educational level significantly predicts her children's active trachoma status. Specifically, children whose mothers attended primary, secondary, or higher education had odds of having no sign and moderate trachoma status that were 1.16 (CI: 1.01–1.32), 1.36 (CI: 1.05–1.75), and 2.30 (CI: 1.53–3.47) times higher, respectively, than those whose mothers did not attend any education. These results are consistent with a study carried out in the Tigray region and in Jigawa state, Northwestern Nigeria [18, 19].The odds of children having no sign and moderate trachoma status were 0.8 (CI: 0.69–0.93) times lower than children who lived in a house that cooked on the inside compared to children who lived in a house that did not cook on the inside. This study is similar to the study conducted in the Gonji Kollela district west Gojjam zone North West Ethiopia. The presence of an inside cooking place is also significant in children's status of active trachoma [20, 21].

The findings of the current study, a child's primary place of residence is a significant predictor of their status for active trachoma. For example, a child who spends the majority of their time at home has a 2.3-fold increased risk of moderate active trachoma and no sign when compared to a child who spends the majority of their time on the streets. This study was carried out in accordance with Studies [22]. The odds of children having no sign or moderate active trachoma status were 1.44 (CI: 1.2–1.73) times higher than those of children with one to five flies on their face. This could be because children with flies on their face did not wash their face frequently due to a lack of water resources. We can also observe that fly density on child faces during interview times (around) is significantly related with the active trachoma status of children. The outcome agrees with a study conducted in Kano State, Nigeria, by on [4] the prevalence and risk factors for trachoma [23].

Based on the study mentioned above, children over the age of three were 0.79 (CI: 0.66–0.94) times less likely than children under the age of three to have no signs of trachoma. This result is consistent with research from the southern nations, nationalities, and people (SNNP) and Ankober woreda [24].This might be because young children are less capable than older children of taking care of themselves and playing in unclean areas [25].The findings of our study indicate that family income is a significant predictor of a child's trachoma status. The estimated odds of 1.34 (CI: 1.27–1.53) suggest that children from rich families are 1.34 times more likely than those from poor families to have no signs or moderate trachoma status. This may be due to the fact that children from relatively wealthy families will have better access to sanitary materials and care. Other studies have confirmed these findings [21, 25].

Distance of water source is a significant variable. The odds of children have no sign of active trachoma was 0.58(CI:0.49–0.7) times less than children have basic water access (distance of source of water in round-trip is 1 km) compared to the children have no access of water (distance of source of water in round-trip is greater than 1 km) moreover, the odds of children have no sign of trachoma status was 0.13(CI: 0.1–0.8) times less than children have intermediate access of water (distance of source of water in round-trip is less than 1 km) compared to children who have no access of water(distance of source of water in round-trip is greater than 1 km) this study was supported study conducted in Tanzania [21, 26].

The amount of water fetched per day is also significantly related with the active trachoma status of children i.e., the odds of children who have no sign of active trachoma status was 1.44 (CI: 1.25–1.66) times higher than children who accessed 20–50 L of water per day compared to the children who accessed less than 20 of water liters per day and also the odds of children have no sign active of trachoma status was 1.25(CI: 1.92–3.27) times higher than children who accessed more than 50 L per day compared to children who accessed less than 20 L per day, This result was similar to the other study conducted in Girar Jarso Woreda of North Shewa and Baso Liben District of East Gojam which revealed that those households consuming less than 20 L of water per day were more likely to achieve active trachoma [27, 28].

The odds of a child having no sign or a moderately active case of trachoma were 0.69 (CI: 0.49−0.1) times lower in children who shared a room with more than ten people than in children who shared a room with one to four people, according to this study. This suggests that reducing the number of children sharing a room is crucial in preventing active trachoma. Studies were out in the Brazilian Amazon provided evidence in favor of this conclusion [29].

Conclusions

In this study, the factors of active trachoma among rural children in Aw-bare Wereda, Somali Region, aged 1 to 9 years old were evaluated using ordinal logistic regression. The statistical analysis made use of statistical techniques including ordinal logistic regressions and descriptive analysis. To achieve the study's goal, a partial proportional odds model was used to evaluate socioeconomic, individual, and environmental components during the research.

Compared to GOLM, UCRLM, and SOR, PPOM has a lower AIC and BIC value, which indicates that it suited the data quite well. The partial proportional odds model indicates that environmental, personal, and sociodemographic factors are significant predictors of active trachoma. According to the study's findings, a child's active trachoma status can be predicted by a number of factors, including the mother's educational level, where the child spends most of their time cooking inside the home, fly density during the interview, family income, the child's age in years, the distance to the water source, the amount of water fetched each day, and the number of people sharing a room. It was discovered that the quantity of water retrieved each day and lack of access to water were risk factors for active trachoma. Enhancing the water supply may have two advantages: a reduction in trachoma cases and an improvement in the children's standard of living. The results of this study demonstrate that mothers' educational attainment is a significant predictor of trachoma. The prevalence of trachoma in children born to educated moms is lower than that of children born to mothers who have no formal education.

Recommendations

The study's conclusions lead to the following suggestions being made. The study conducted in the Aw-bare Woreda, Somali, region of eastern Ethiopia on children ages 1–9 years revealed a high prevalence of active trachoma, far greater than the WHO eradication criterion. As a result, it is advised that raising maternal education would also benefit the health of the mother's family and offspring, and that having more people share a room and putting more flies on kids' faces will greatly raise the risk of trachoma. Thus, reducing the number of kids in a room and enhancing activities linked to personal cleanliness, such as giving them a thorough facial wash to remove debris and discharge from their eyes, are crucial steps in preventing trachoma.

In order to prevent trachoma, it is important to think about ways to improve the water supply close to homes, encourage regular water consumption, and provide the community with clean drinking water. Improving socioeconomic standing and personal hygiene, particularly for kids aged 1 to 9, can aid in lowering the disease's prevalence. Using a multidisciplinary approach necessitates the deployment of a separate kitchen and cooking room. To lessen the burden of active trachoma, the district health office and other pertinent stakeholders should collaborate to raise awareness of the illness. The government and other relevant organizations ought to take the aforementioned into consideration and take the necessary steps to address issues that lead to trachoma. Further detailed research studies are required to investigate the determinant of active trachoma among rural children aged 1–9 years old in study area.

Limitation of the study

The study's limitations were estimating the economic condition, the distance to the water source, and the daily retrieval volume of water. It was based just on the interviewee's questions and responses from the respondents, which might have been overestimated or underestimated. As a cross-sectional survey, the study does not demonstrate the cause-and-effect link between the risk factors. In addition, the true prevalence of active trachoma may differ depending on the small sample size that was employed.

Abbreviations

AIC	Akaike Information Criteria
BIC	Bayes Information Criteria
CSA	Central Statistics Agency
DV	Dependent Variable
IV	Independent Variable
Logit	Log of Odds
OLR	Ordinal Logistic Regression
OR	Odds Ratio
PO	Proportional Odds
POM	Proportional Odds Model
GOLM	Generalized ordered logit
UCRLM	Unconstrained continuation ratio model
SORM	Stereotype ordered logit models
PPOM	Partial proportional odds model
SAFE	Surgery for trichiasis, Antibiotic against infection, Facial cleanliness, and Environmental Sanitation
TF	Trachomatous inflammation Follicle
TI	Trachomatous inflammation Intense
TS	Trachomatous Scarring
TT	Trachomatous Trichiasis
WHO	World Health Organization
SNNPR	Southern Nations, Nationalities and People

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Author contributions

AOW helped with data collection, design of the analysis and conceptualization of the article. DTM contributed to data collection, paper advice, the design of the analysis, the thorough writing of the article, the critical drafting for significant intellectual interaction, and the submission of the work. The final manuscript was read and approved by all authors.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The Jigjiga University ethical approval committee approved this study. The study was carried out in conformity with applicable rules and regulations. All parents of children provided informed consent. The data used in the current inquiry were secondary, and researchers were only given the patients' ID numbers and crucial factors pertaining to the current analysis during the data collection procedures.

Consent for publication

"Not applicable".

Competing interests

The authors declare no competing interests.

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