Prevalence and associated factors of active trachoma among children aged 1-9 years old in mass drug administration graduated and non-graduated districts in Northwest Amhara region, Ethiopia: A comparative cross-sectional study

Gashaw Melkie¹, Muluken Azage², Genet Gedamu²*

¹ Department of Environmental Health, School of Public Health, Teda Health Science College, Gondar, Ethiopia, ² Department of Environmental Health, School of Public Health, College of Medicine and Health Sciences, Bahir Dar University, Bahir Dar, Ethiopia

*geni_31280@yahoo.com

Abstract

Background
Mass drug administration has implemented to reduce trachoma since 2001, however, trachoma is still the major public health problem in Amhara Region, Ethiopia. However, credible evidence on the prevalence of trachoma and its associated factors after the implementation of mass drug administration is limited.

Objective
To assess the prevalence and associated factors of active trachoma among children aged 1–9 years old in mass drug administration graduated and non-graduated districts in the Northwest Amhara Region.

Methods
A comparative cross-sectional study was conducted from October to November, 2019. A stratified multistage random sampling was used to select 690 households having children aged 1–9 years. Data were collected using a pretested structured questionnaire. Data were entered into Epi-data version 3.1 and exported to SPSS version 20.0 for analysis. Bivariate and multivariable logistic regressions were employed to identify factors associated with active trachoma. Crude and adjusted odds ratios with 95% confidence interval were computed to assess the degree of association between the independent variables and active trachoma.
Results
The overall prevalence of active trachoma was 8.3% (95% CI: 6.2% –10.5%) and showed a significant variation between graduated [3.5% (95% CI: 1.8% –5.6%)] and non-graduated [13% (95% CI: 9.7%–16.8%)] districts. Living in graduated districts (AOR = 7.39, 95% CI: 3.19, 17.09), fly presence in the house (AOR = 3.14, 95% CI: 1.43, 6.89), presence of more than two children in the family (AOR = 3.78, 95%CI: 1.79, 7.98), did not wash face daily (AOR = 6.31, 95% CI: 1.81, 21.98), did not use soap during face washing (AOR = 3.34, 95% CI: 1.37, 8.15), presence of sleep in eyes (AOR = 3.16, 95% CI: 1.42, 7.02) and presence of dirt on child face (AOR = 2.44, 95% CI: 1.08, 5.50) increased the odds of having active trachoma.

Conclusion
The prevalence of active trachoma was high in the study area and showed a significant variation between graduated and non-graduated districts with mass drug administration. Living in non-graduated districts, fly presence in the house, more than two children in a household, did not wash the face daily, did not use soap during face washing, presence of sleep in eyes, and dirt on the child’s face were the significant predictors of active trachoma. Therefore, the identified modifiable factors are the area of intervention to reduce the burden of active trachoma.

Introduction
Trachoma is one of the common infectious diseases that cause blindness due to recurrent ocular infection with *Chlamydia trachomatis* in the world [1, 2]. Children are the main reservoir of C. trachomatis infection [3]. It is a public health problem in 44 countries and 137 million people living in trachoma endemic areas who are at risk of trachoma blindness [4]. It is responsible for the blindness or visual impairment of about 1.9 million people and trachomatous visual loss yields 39 million lifetimes Disability-Adjusted Life Years (DALYs) [5]. Besides, it also causes the potential productivity loss of 2.9 billion dollars per year [5].

Five countries namely Ethiopia, India, Nigeria, Sudan, and Guinea account for 48.5% global burden of active trachoma, and three countries namely China, Ethiopia, and Sudan account for 50% of the global burden of trichiasis [6].

In Ethiopia, trachoma is the second major cause of blindness and the third major cause of low vision [7]. The prevalence of active trachoma among children aged 1–9 years old was 40.1% and it is widely distributed in the country. The highest prevalence was registered in the Amhara region (62.6%) which is higher compared to other regions such as Oromia (41.3%), and Southern Nations, Nationalities, and Peoples (SNNP) (33.2%) [8]. In the Amhara region, impact surveys in 2015 reported the average prevalence of active trachoma was 25.9% (24.9%–26.9%) [9].

Socio-demographic factors such as increased family size and the number of children aged 1–9 years old in the household that creates crowded living conditions increase the transmission of active trachoma [10]. Childhood hygiene behaviors such as ocular and nasal secretions and unclean faces attract flies and provides a vehicle for transmission [11]. Similarly, water scarcity also promotes the transmission which in turn compromises hygienic practices, like face washing. Limited access to latrines increases fecal contamination of the environment which favors fly breading is also a mechanical vector in trachoma transmission [12–15].
Mass Drug Administration (MDA) with prevention of risk factors; Surgery, Antibiotics, Facial cleanliness and Environmental improvement (SAFE) have been the focus areas of intervention in endemic countries, including Ethiopia [16, 17]. The intervention was introduced in the Amhara region in 2001 and expanded to both graduated and non-graduated districts in the current study area in 2007 [9]. As a program success, the graduated district included in this study discontinued the intervention in 2016 by declaring less than 5% prevalence of active trachoma among children aged 1–9 years old. Whereas, other endemic districts (non-graduated) are still struggling to be free of active trachoma [18]. However, to the best of our knowledge, there is no evidence whether graduated districts sustain less than 5% prevalence of active trachoma after stopping MDA. The prevalence of active trachoma has not been well investigated between graduated and non-graduated districts with MDA. Therefore, this study aimed to assess the prevalence and associated factors of active trachoma among children aged 1–9 years old in mass drug administration graduated and non-graduated districts in Central Gondar Zone, Amhara Region, Northwest Ethiopia.

Methods and materials

Study settings and design

A community-based comparative cross-sectional study was conducted in two previously trachoma-endemic districts of Central Gondar Zone, Amhara Region, Ethiopia from October 1, 2019, to November 15, 2019. Gondar is the zonal city town that is located at 750 km in the Northwest direction of Addis Ababa, the capital city of Ethiopia, and 175 km from Bahir Dar, the capital city of Amhara National Regional State. The Zone has one urban and 14 rural districts. Of the rural districts, 8 have not achieved <5% Trachomatous inflammation -follicular (TF) which are considered as non-graduated districts, and the rest districts are graduated. The non-graduated districts are receiving azithromycin every year to achieve <5% TF [18].

Study participants

All children age 1–9 years in Central Gondar Zone were the source population of the study. The study participants were children aged 1–9 years in selected households (HHs) in the study area. Eligibility criteria. All mothers/caregivers who lived in eligible HHs were included in the interview. All children aged 1–9 years old live in the study area during the study period were included.

All mothers/caregivers from eligible HHs who are unable to hear and speak in the study area were excluded from the interview. Children who are blind and who had serious medical sickness were excluded from the study.

Sample size determinations

The sample size was determined using two population proportions formula using Epi–info software with the following assumptions; 95% confidence interval, the proportion of active trachoma in controls (P₁ = 31.8%) and cases (P₂ = 48.0%) [19], 1 to 1 ratio in graduate and non-graduate districts, design effect 2 and 10% non-response rate. The final adequate sample size was 690 HHs (345 from graduated and 345 non-graduated districts) having children aged 1–9 years old.

Sampling technique and procedure

A multi-stage stratified sampling technique was used to select HHs having children aged 1–9 years old in MDA graduated and non-graduated districts. Stratification of the districts was
done based on the presence and absence of a yearly MDA campaign in the district. Two districts, one district from MDA graduated districts (Lay Armachewo) and Wegera from the non-graduated districts, were selected randomly. Eight kebeles (lowest administrative unit in Ethiopia) from each selected district, 22% of the total kebeles of each district, were randomly selected. Proportion to size allocation was made to determine the required sample size for each randomly selected district and kebele. Households that have children aged 1–9 years old were selected using a systematic random sampling technique. To determine the interval of HH in selected Kebele, Kth value was used. If there were two or more children in a single HH, one child was selected using a simple random sampling technique.

**Data collection tools**

Data were collected using a structured questionnaire, observation, and physical examination. The questionnaire was developed in English then translated into Amharic (local language) and then back to English to ensure consistency. Interviewing was conducted by two environmental health professionals, physical examination and grading of trachoma was done by trained and certified nurses, and two supervisors were assigned to manage data collection process. Grading of trachoma was done by assessing diagnostic signs using 2.5X loupes as recommended elsewhere [20]. Environmental health professionals documented the presence of any ocular or nasal secretions and any fly-eye contact during the minutes before the clinical examination. Both eyes were examined for signs of active trachoma (TF) using the WHO Trachoma Grading System [20]. A child was reported as positive for active trachoma if he/she had the signs and symptoms of active trachoma (TF) in either of his/her eyes.

**Study variables**

The dependent variable was active trachoma among children aged 1–9 years old. Independent variable included socio-demographic variables (Maternal and paternal occupation, marital status, level of education of father and mother, age of the child, sex of the child, household wealth index, household size and number of children aged 1–9 years old); Environmental and household factors (source of water, time taken to fetch water, quantity of water used daily, availability of latrine, type of latrine, latrine utilization, presence of feces in the house compound, flies in the house, waste disposal sites, availability of livestock, livestock in the house and overcrowding status); Child’s behavioral factors (Frequency of face washing (determined by asking the mother or caregivers), using soap for washing (determined by asking themother or caregivers), discharge on the eye, discharge from nose, facial cleanliness and presence of flies on child face); Knowledge about trachoma (Knowledge on mode of transmission and knowledge on how to prevent trachoma); and Prevention and control of chlamydia trachomatis infection (Frequency of *Zithromax* prophylaxes dose received, health education about trachoma).

**Operational definitions**

**Active trachoma.** The presence of Trachomatous inflammation follicular (TF) in either of the child’s eyes, the WHO’s criteria/indicator for the elimination of trachoma [21].

**Trachomatous inflammation - follicular (TF).** The presence of five or more follicles in the upper tarsal conjunctiva each at least 0.5 mm in size [20].

**Facial cleanliness.** The absence of ocular discharge, nasal discharge, flies on the face, fly-eye contacts, and/or any dirt on the face at the time of clinical examination [22, 23].

**Any dirt on the child’s face.** The presence of any dust and food on the face at the time of clinical examination.
Sleep in the eyes. The eye discharge collects and crusts in the corners of the eyes and sometimes along the lash line.

Improved water source. The design and nature of its construction, adequately protects the water from outside contamination, in particular from fecal matter, and includes piped water systems, hand pumps, public tap/standpipe, protected well/spring otherwise it is ‘Unimproved water source’.

Improved sanitation facility. Sanitation facility that hygienically separates human excreta from human contact [24] which includes pour-flush latrine, Ventilated improved pit latrine (VIP), pit latrine with slab otherwise ‘Unimproved sanitation type’.

Proper solid waste disposal. Solid waste disposal method that separates household generated solid waste hygienically which includes solid waste in the pit prepared for it, burning near the yard, collected and disposed of by the municipality.

Graduated district. A district achieved <5% TF prevalence among children aged 1–9 years old after successive mass azithromycin treatment and stopped yearly MDA campaign.

Non-graduated district. A district that is not achieving <5% TF prevalence among children aged 1–9 years old after successive mass azithromycin treatment and is under the implementation of the MDA campaign.

Knowledge about trachoma. Mothers/caregivers of children were asked about the signs and symptoms, modes of transmission, and prevention methods of trachoma. Their responses are categorized as good knowledgeable who scored more than 80% questions correctly, fairly knowledgeable who scored 50% to 79.9% questions correctly, and less knowledgeable who scored less than 50% questions correctly.

Data quality control

Training was given for data collectors and supervisors on the purpose of the study, data collection technique, and tool by the principal investigator for two days. Pre-test of the questionnaires on 5% of the sample size on 30 households in Kebeles where the study was not undertaken. The pre-test was part of the training and its findings were discussed during the training day and all the concerns were clarified. Every day after data collection, filled questionnaires were reviewed by supervisors and the principal investigator for ensuring completeness of questions. Incomplete questionnaires were discarded from the analysis.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board of Bahir Dar University College of Medicine and Health Sciences. Permissions letter was also taken from Amhara Public Health Institute (APHI), Central Gondar Zonal Health Department, and Lay-Armacheko and Wegera district health offices. Informed verbal consent and assent were obtained from the sampled children’s parents. The respondents were also informed that they have the full right to withdraw or refuse at any time from the process. Confidentiality of information given by each respondent was kept properly and anonymity was explained clearly for the participants. Children diagnosed with active trachoma were referred to the nearby health center for further investigation and treatment.

Data analysis

Data were entered into Epi-Data version 3.1 and exported to SPSS statistical package version 20.0 for analysis. Descriptive statistics were used to describe the data. The principal component analysis was computed to calculate the wealth status of HHs. Bivariate and multivariable logistic regressions were used to identify predictors of active trachoma. The Hosmer-Lemeshow
test was checked to assess the model fitness (p-value 0.816). A p-value < 0.25 was used as criteria during bivariate analysis to retain variables for the multivariable logistic regression model. The backward stepwise logistic regression model was used to control multi-collinearity and confounding effects. Multicollinearity was checked using variance inflation factors (VIF). Crude and adjusted odds ratios with 95% confidence interval were calculated to measure the degree of association between independent variables and active trachoma. A p-value < 0.05 was considered as a level of statistical significance.

Results
Socio-demographic characteristics
A total of 678 children aged 1–9 years old, 339 from the MDA graduated district, and 339 from the MDA non-graduated district, was participated in the study with a response rate of 98.3%. Nearly half (51.8%) of all the study participants were males with 53.8% and 50.1% in graduated and non-graduated districts, respectively. The mean age (± SD) of children in MDA graduated and non-graduated districts were comparable, 4.65 (± 2.47) and (4.96 (± 2.51) years, respectively. The majority of children (87%) in MDA graduated and (82.3%) in non-graduated districts were from a family with 1–2 children aged 1–9 years old. More than two-thirds of children (69.9%) in MDA graduated and (70.8%) of non-graduated districts were not attending school. Regarding mother’s educational status, 81.1% and 85.0% of mothers in MDA graduated and non-graduated districts, respectively, had no formal education whereas only 13.3% of mothers in MDA graduated and 5.9% of mothers in the non-graduated district, attended secondary level education and above. The mean family size of (± SD) household was 4.67 (±1.49) and 5 (±1.63)in MDA graduated and non-graduated districts, respectively. The mean number of children aged 1–9 years old(± SD) in a given household was 1.79 (± 0.68) and 1.78 (± 0.91) in MDA graduated and non-graduated districts, respectively (Table 1).

Environmental and housing condition of the households
Among all households in the graduated district, 199 (58.7%) had an improved water source, 200 (59.0%) took more than 30 minutes to fetch water from the water source. Of all households in a non-graduated district, 328 (96.8%) had an improved water source and 124 (36.6%) took more than 30 minutes to fetch water from the source. The average daily water consumption was found to be 12.94 liters/person/day and 13.57 liters/person/day for a household in graduated and non-graduated districts, respectively. Among selected households, 243 (71.7%) in graduated and 232 (68.4%) in non-graduated districts had latrine of any type. Of these, 240 (70.8%) and 206 (60.8%) households in graduated and non-graduated districts utilized their latrine, respectively (Table 2).

Prevention and control of chlamydia trachomatis infection
Almost 12.7% of children in the non-graduated district were not receiving azithromycin yet. Of children who received at least one dose of azithromycin, 8.4% of them had not received the required doses in the last two years. Of children aged 4–6 years old in the non-graduated district, only 39 (35.8%) had received three and more doses of azithromycin. Similarly, among children aged 7–9 years old, only 38 (34.2%) had received four and more doses of azithromycin. About 22.7% of mothers in graduated and 19.8% of mothers in non-graduated districts did not hear about trachoma. Nearly 28.3% of mothers in graduated and 72.9% of non-graduated districts had inadequate knowledge related to trachoma (Table 3).
Table 1. Socio-demographic characteristics of participants in mass drug administration graduated and non-graduated district, Central Gondar, Ethiopia, December 2019.

| Variables                        | Graduated | Non-graduated | Total | Chi-square (p-value) |
|----------------------------------|-----------|---------------|-------|----------------------|
|                                  | Frequency (%) | Frequency (%) | Frequency (%) |                       |
| Child age group in Years         |           |               |       |                      |
| 1–3                              | 128       | 37.8          | 119   | 35.1                 | 247   | 36.4 |
| 4–6                              | 116       | 34.2          | 109   | 32.2                 | 225   | 33.2 |
| 7–9                              | 95        | 28            | 111   | 32.7                 | 206   | 30.4 |
| Sex of the child                 |           |               |       |                      |
| Male                             | 181       | 53.4          | 170   | 50.1                 | 351   | 51.8 |
| Female                           | 158       | 46.6          | 169   | 49.9                 | 327   | 48.2 |
| Family size of the HH            |           |               |       |                      |
| 1–5                              | 246       | 72.6          | 232   | 68.4                 | 478   | 70.5 |
| ≥ 6                              | 93        | 27.4          | 107   | 31.6                 | 200   | 29.5 |
| No. of children aged 1-9 years   |           |               |       |                      |
| 1–2                              | 295       | 87            | 279   | 82.3                 | 574   | 84.7 |
| ≥ 3                              | 44        | 13            | 60    | 17.7                 | 104   | 15.3 |
| Children share the same sleeping space | 205 | 60.5 | 155 | 45.7 | 360 | 53.1 |
| Maternal Education               |           |               |       |                      |
| No formal education              | 275       | 81.1          | 288   | 85.0                 | 563   | 83.0 |
| Primary level                    | 19        | 5.6           | 31    | 9.1                  | 50    | 7.4  |
| ≥ Secondary level                | 45        | 13.3          | 20    | 5.9                  | 65    | 9.6  |
| Maternal occupation              |           |               |       |                      |
| Unemployed                       | 43        | 12.7          | 8     | 2.4                  | 51    | 7.5  |
| House wife                       | 241       | 71.1          | 264   | 77.9                 | 505   | 74.5 |
| Others                           | 55        | 16.2          | 67    | 19.8                 | 122   | 18.0 |
| Marital status                   |           |               |       |                      |
| Single                           | -         | -             | 7     | 2.1                  | 7     | 1.0  |
| Married                          | 290       | 85.5          | 300   | 88.5                 | 590   | 87.0 |
| Divorced                         | 32        | 9.4           | 17    | 5.0                  | 49    | 7.2  |
| Widowed                          | 5         | 1.5           | 7     | 2.1                  | 12    | 1.8  |
| Lives separately                 | 12        | 3.5           | 8     | 2.4                  | 20    | 2.9  |
| Relation with the Child          |           |               |       |                      |
| Parent                           | 333       | 98.2          | 309   | 91.2                 | 642   | 94.7 |
| Guardian                         | 6         | 1.8           | 30    | 8.8                  | 36    | 5.3  |
| Child Education                  |           |               |       |                      |
| Not yet Attended                 | 237       | 69.9          | 240   | 70.8                 | 477   | 70.4 |
| Attended                         | 102       | 30.1          | 99    | 29.2                 | 201   | 29.6 |
| Husband Education                |           |               |       |                      |
| No formal education              | 240       | 79.5          | 223   | 72.4                 | 463   | 75.9 |
| Primary level                    | 24        | 7.9           | 58    | 18.8                 | 82    | 13.4 |
| Secondary and above              | 38        | 12.6          | 27    | 8.8                  | 65    | 10.7 |
| Wealth index                     |           |               |       |                      |
| Highest                          | 134       | 39.5          | 92    | 27.1                 | 226   | 33.3 |
| Middle                           | 135       | 39.8          | 91    | 26.8                 | 226   | 33.3 |
| Lowest                           | 70        | 20.6          | 156   | 46.0                 | 226   | 33.3 |
| Place of residence               |           |               |       |                      |
| Urban                            | 69        | 20.4          | 47    | 13.9                 | 116   | 17.1 |
| Rural                            | 270       | 79.6          | 292   | 86.1                 | 562   | 82.9 |

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Table 2. Environmental and housing condition of households in mass drug administration graduated and non-graduated district, Central Gondar, Ethiopia, December 2019.

| Variables                        | Districts |              |              | Total | Chi-square (p-value) |
|----------------------------------|-----------|--------------|--------------|-------|----------------------|
|                                  | Graduated | No-graduated |              |       |                      |
|                                  | Frequency | %            | Frequency | %     | Frequency | %     |
| Water source                     |           |              |            |       | .567                 |
| Improved                         | 199       | 58.7         | 328        | 96.8  | 527       | 77.7  |
| Un-improved                      | 140       | 41.3         | 11         | 3.2   | 151       | 22.3  |
| Time taken to fetch water        |           |              |            |       | .146                 |
| Source in the yard               | 32        | 9.4          | 31         | 9.1   | 63        | 9.3   |
| ≤ 30 minutes                     | 107       | 31.6         | 184        | 54.3  | 291       | 42.9  |
| > 30 minutes                     | 200       | 59.0         | 124        | 36.6  | 324       | 47.8  |
| Presence of latrine              |           |              |            |       | .001                 |
| No                               | 96        | 28.3         | 107        | 31.6  | 203       | 29.9  |
| Yes                              | 243       | 71.7         | 232        | 68.4  | 475       | 70.1  |
| Latrine type                     |           |              |            |       | <.0001                |
| Improved                         | 212       | 62.5         | 175        | 51.6  | 387       | 57.1  |
| Un-improved                      | 127       | 37.5         | 164        | 48.4  | 291       | 42.9  |
| Utilize latrine                  |           |              |            |       | <.0001                |
| No                               | 99        | 29.2         | 133        | 39.2  | 232       | 34.2  |
| Yes                              | 240       | 70.8         | 206        | 60.8  | 446       | 65.8  |
| Presence of feces near main house|           |              |            |       | <.0001                |
| No                               | 200       | 59.0         | 205        | 60.5  | 405       | 59.7  |
| Yes                              | 139       | 41.0         | 134        | 39.5  | 273       | 40.3  |
| Solid waste disposal category    |           |              |            |       | .264                 |
| Proper                           | 185       | 54.6         | 154        | 45.4  | 339       | 50.0  |
| Improper                         | 154       | 45.4         | 185        | 54.6  | 339       | 50.0  |
| Waste evidence near the house    |           |              |            |       | <.0001                |
| No                               | 176       | 51.9         | 181        | 53.4  | 357       | 52.7  |
| Yes                              | 163       | 48.1         | 158        | 46.6  | 321       | 47.3  |
| Presence of livestock            |           |              |            |       | .008                 |
| No                               | 107       | 31.6         | 81         | 23.9  | 188       | 27.7  |
| Yes                              | 232       | 68.4         | 258        | 76.1  | 490       | 72.3  |
| Livestock place of living        |           |              |            |       | <.0001                |
| Outside the room                 | 79        | 34.1         | 57         | 22.1  | 136       | 27.8  |
| Separate room                    | 120       | 51.7         | 151        | 58.5  | 271       | 55.3  |
| same room with family            | 33        | 14.2         | 50         | 19.4  | 83        | 16.9  |
| Animal feces around the house    |           |              |            |       | <.0001                |
| No                               | 156       | 46.0         | 213        | 62.8  | 369       | 54.4  |
| Yes                              | 183       | 54.0         | 126        | 37.2  | 309       | 45.6  |
| Flies observed around the house  |           |              |            |       | <.0001                |
| No                               | 182       | 53.7         | 275        | 81.1  | 457       | 67.4  |
| Yes                              | 157       | 46.3         | 64         | 18.9  | 221       | 32.6  |
| Flies in the house               |           |              |            |       | <.0001                |
| No                               | 218       | 64.3         | 238        | 70.2  | 456       | 67.3  |
| Yes                              | 121       | 35.7         | 101        | 29.8  | 222       | 32.7  |

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Characteristics of children

Of 678 children, 351 (51.8%) were males. Sixteen, 16 (4.7%) in graduated and 27 (8.0%) in the non-graduated district had no the habit of washing their face regularly whereas 117 (34.5%) children in graduated and 82 (24.2%) in the non-graduated district use soap for washing face regularly (Table 4).

Prevalence of active trachoma

The overall prevalence of active trachoma was 8.3% with 95% CI between 6.2% and 10.5% with significant variation between MDA graduated (3.5% 95% CI 1.8–5.6) and non-graduated (13% 95% CI 9.7–16.8) districts.

Factors associated with active trachoma

In bivariate logistic regression analysis, being lived in the non-graduated district, having large family size, number of children aged 1–9 years old in the household, child space sharing, presence of latrine, type of latrine, utilization of the latrine, presence of human feces near the house, presence of livestock, presence of animal feces near a house, waste evidence near the house, fly presence around the house, frequency of face washing per day, using soap when washing child’s face, presence of ocular and nasal discharge, flies on the child’s face, fly-eye contact, presence of sleep eye, presence of dirt on child’s face and face condition of the child were identified variables as the candidate for multivariable analysis at p-value less than 0.25. A p-value < 0.05 was used as cut off point to declare statistical association with active trachoma.

In multivariable logistic regression analysis, being lived in the non-graduated district, number of children aged 1–9 years old in the household, fly presence in the house, frequency of...
child’s face washing habit, using soap when washing child’s face, presence of sleep in eyes and presence of dirt on the face were showed statistically significant association with active trachoma.

The odds of active trachoma among children who live in non-graduated districts were 7.39 times [AOR = 7.39, 95% CI: (3.19, 17.09)] higher compared to the graduated districts. The odds of active trachoma among children from households having flies were 3.14 times higher, [AOR = 3.14, 95% CI: 1.43, 6.89], compared to children from households without having flies. Children from households with more than two children aged 1–9 years had 3.78 times higher odds of active trachoma compared to children who lived from households with 1–2 children [AOR = 3.78, 95% CI: (1.79, 7.98)].

Those children who did not wash their faces per day had 6.31 times [AOR = 6.31, 95% CI: (1.81, 21.98)] higher odds of active trachoma than children who washed their face twice and

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**Table 4. Behavioral conditions of children in mass drug administration graduated and non-graduated district, Central Gondar, Ethiopia, December 2019.**

| Variables                      | Graduated district | Non-graduated district | Total | Chi-square (p-value) |
|--------------------------------|--------------------|------------------------|-------|----------------------|
|                                | Frequency (%)      | Frequency (%)          | Frequency (%) |                      |
| Frequency of face washing per day |                    |                        |       | .0001                |
| ≥ Two times                    | 183 54.0           | 157 46.3               | 340 50.1|                      |
| One times                      | 136 40.1           | 151 44.5               | 287 42.3|                      |
| Not washing                    | 20 5.9             | 31 9.1                 | 51 7.5 |                      |
| Using soap during child face washing |                |                        |       | .0001                |
| Yes, regularly                 | 117 34.5           | 82 24.2                | 199 29.4|                      |
| Yes, some times                | 131 38.6           | 148 43.7               | 279 41.2|                      |
| Never                          | 91 26.8            | 109 32.2               | 200 29.5|                      |
| Dry face after washing with towel |              |                        |       | .0001                |
| Yes, regularly                 | 63 18.6            | 47 13.9                | 110 16.2|                      |
| Yes, some times                | 73 21.5            | 36 10.6                | 109 16.1|                      |
| Never                          | 203 59.9           | 256 75.5               | 459 67.7|                      |
| Ocular discharge               |                    |                        |       | .0001                |
| No                             | 309 91.2           | 298 87.9               | 607 89.5|                      |
| Yes                            | 30 8.8             | 41 12.1                | 71 10.5 |                      |
| Nasal discharge                |                    |                        |       | .0001                |
| No                             | 293 86.4           | 287 84.7               | 580 85.5|                      |
| Yes                            | 46 13.6            | 52 15.3                | 98 14.5 |                      |
| Flies on the face              |                    |                        |       | .0001                |
| No                             | 238 70.2           | 248 73.2               | 486 71.7|                      |
| Yes                            | 101 29.8           | 91 26.8                | 192 28.3|                      |
| Fly-eye contacts               |                    |                        |       | .0001                |
| No                             | 284 83.8           | 284 83.8               | 568 83.8|                      |
| Yes                            | 55 16.2            | 55 16.2                | 110 16.2|                      |
| Sleep in eyes                  |                    |                        |       | .0001                |
| No                             | 273 80.5           | 281 82.9               | 554 81.7|                      |
| Yes                            | 66 19.5            | 58 17.1                | 124 18.3|                      |
| Any dirt on face               |                    |                        |       | .0001                |
| No                             | 276 81.4           | 272 80.2               | 548 80.8|                      |
| Yes                            | 63 18.6            | 67 19.8                | 130 19.2|                      |
| Child’s face condition         |                    |                        |       | .0001                |
| Clean                          | 218 64.3           | 210 61.9               | 428 63.1|                      |
| Unclean                        | 121 35.7           | 129 38.1               | 250 36.9|                      |

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The odds of active trachoma among children who didn’t use soap during face washing were 3.34 times \[AOR = 3.34, 95\% CI: (1.37, 8.15)\] higher than children who used soap. Children who had sleep in their eyes were 3.16 times more likely to have active trachoma than children who did not have sleep in their eyes \[AOR = 3.16, 95\% CI: (1.42, 7.02)\]. Children who had any type of dirt on their face had 2.44 times, \[AOR = 2.44, 95\% CI: (1.08, 5.50)\] higher

Table 5. Bivariate and multivariable logistic regression analysis of factors associated with active trachoma (TF) among children aged 1–9 years old (n = 678), in mass drug administration graduated and non-graduated districts, Amhara Region, Ethiopia, 2019.

| Variables                             | TF      | COR(95% CI)          | AOR (95% CI)         |
|---------------------------------------|---------|----------------------|----------------------|
|                                       | Yes     | No                   |                      |
| Place where live                      |         |                      |                      |
| Non-graduated district                | 44      | 295                  | 4.06 (2.11, 7.84)***  | 7.39 (3.19, 17.09)*** |
| Graduated district                    | 12      | 327                  | 1                    | 1                     |
| Type of latrine                       |         |                      |                      |
| Un-improved                           | 40      | 251                  | 3.70 (2.03, 6.74)***  | 0.43 (0.17, 1.07)      |
| Improved                              | 16      | 371                  | 1                    | 1                     |
| Presence of flies in the house        |         |                      |                      |
| Yes                                   | 33      | 189                  | 3.29 (1.88, 5.75)***  | 3.14 (1.43, 6.89)**    |
| No                                    | 23      | 433                  | 1                    | 1                     |
| Presence of faeces near the house     |         |                      |                      |
| Yes                                   | 35      | 238                  | 2.69 (1.53, 4.73)**   | 2.02 (0.88, 4.61)      |
| No                                    | 21      | 384                  | 1                    | 1                     |
| No. of children aged 1–9 years old    |         |                      |                      |
| ≥ 3                                   | 25      | 79                   | 5.54 (3.11, 9.87)***  | 3.78 (1.79, 7.98)***   |
| 1–2                                   | 31      | 543                  | 1                    | 1                     |
| Frequency of face washing per day     |         |                      |                      |
| Not washing                           | 19      | 32                   | 19.59 (8.40, 45.72)   | 6.31 (1.81, 21.98)**   |
| One time per day                      | 27      | 260                  | 3.43 (1.63, 7.21)     | 2.51 (0.91, 6.96)      |
| ≥ two times per day                   | 10      | 330                  | 1                    | 1                     |
| Use of soap                           |         |                      |                      |
| No                                    | 43      | 157                  | 9.80 (5.13, 18.70)*** | 3.34 (1.37, 8.15)**    |
| Yes                                   | 13      | 465                  | 1                    | 1                     |
| Sleep in the eye                      |         |                      |                      |
| Yes                                   | 34      | 90                   | 9.14 (5.11, 16.33)*** | 3.16 (1.42, 7.02)**    |
| No                                    | 22      | 532                  | 1                    | 1                     |
| Any dirt on child’s face              |         |                      |                      |
| Yes                                   | 33      | 97                   | 7.77 (4.37, 13.80)*** | 2.44 (1.08, 5.50)*     |
| No                                    | 23      | 525                  | 1                    | 1                     |
| Child’s face condition                |         |                      |                      |
| Unclean                               | 48      | 202                  | 12.48 (5.79, 26.86)***| 2.73 (0.93, 7.98)      |
| Clean                                 | 8       | 420                  | 1                    | 1                     |

Note: Hosmer-Lemeshow test model fitness p-value was 0.816.
The variance inflation factor result was between 1 and 2.

\(^{1}\) = Reference category,
\(^{*}\) = statistically significant at \(p<0.05\),
\(^{**}\) = statistically significant at \(p<0.01\) and
\(^{***}\) = Statistically significant at \(p<0.001\)

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more times per day. The odds of active trachoma among children who didn’t use soap during face washing were 3.34 times \[AOR = 3.34, 95\% CI: (1.37, 8.15)\] higher than children who used soap. Children who had sleep in their eyes were 3.16 times more likely to have active trachoma than children who did not have sleep in their eyes \[AOR = 3.16, 95\% CI: (1.42, 7.02)\]. Children who had any type of dirt on their face had 2.44 times, \[AOR = 2.44, 95\% CI: (1.08, 5.50)\] higher
odds of active trachoma compared to those children who had not dirty material on their face (Table 5).

**Discussion**

The overall prevalence of active trachoma among children aged 1–9 years old was 8.3% [95% CI (6.2–10.5)]. This prevalence is lower than the studies conducted in different parts of Ethiopia; Madda Walabu rural district, Southeast Ethiopia (22%), Gondar Zuria district, North Gondar (12.1%), Dera district, South Gondar (15.6%), Baso Liben, West Gojam (17.2%) and Lemo district, Hadiya Zone (13.6%) [25–29]. The prevalence is also lower than studies done in Africa Malawi (17.1%), eastern (24.9%) and western (21.7%) districts of Colombia, South America [30, 31].

Similarly, active trachoma prevalence (13%, 95% CI: 9.7%–16.8%) in MDA non-graduated districts is lower than the regional average report of trachoma impact surveys done in 2015 (25.9%) [9]. Likewise, this finding is lower than previous studies done in different parts of Ethiopia: Zala district of Gamo Gofa Zone (36.7%); 53.9% in Ankober District, North Showa zone (53.9%); the north and South Wollo Zones (21.6%); and Gazegebela district of Wagenema Zone (52.4%) [11, 32–34]. This might be due to the improvements in access to health services interventions given in recent years that can reduce the burden of active trachoma. For instance, successive mass drug distribution with the improvement of environmental factors has been done in the current study area which could decrease active cases. The other difference could be due to the comparative nature of this study that includes the MDA graduated district which may reduce the prevalence of active trachoma in this study.

However, the overall prevalence is higher than the WHO trachoma elimination target (a prevalence of active trachoma (TF) in children aged 1–9 years of old < 5%) [21]. Even though it was planned to eliminate the disease by the year 2020, finding of this study calls the implementation of A, F, and E components of SAFE are mandatory till the prevalence meets the expected target. Similarly, the overall prevalence is higher than Global Trachoma Mapping Project studies before mass antibiotic initiation began in seven districts of the Republic of the Congo (TF prevalence was 2.5%) and in Benue State, Nigeria (TF prevalence was 0.3% to 5.3%) [35, 36]. The later studies done in Congo and Nigeria were done as a baseline survey for mapping the diseases to initiate SAFE interventions. However, this study was done after successive SAFE interventions in the current study area. Therefore, the difference might be due to the level of variations in the endemicity of the study areas.

The prevalence of active trachoma among children aged 1–9 years old in the MDA graduated district was 3.5%, (95% CI: 1.8–5.6) which is in line with WHO recommendations of TF (5%) at the district level [21]. Besides, the finding of this study is consistent with the studies done in two regions of Mali reported TF prevalence of 1.7% (0.8%–2.6%) in Oulesssebougou, 2.9% (1.5%–4.2%) in Nara, and 2.5% (0.9%–4.1%) in Kita districts. However, it is lower than the reported TF prevalence of 11.4% (9.1%–13.7%) in Koulikoro, 14.1% (9.2%–19.0%) in Kolokani, and 15.4% (11.7%–19.0%) in Bafoule districts in the same study [37]. This might be due to trachoma endemicity at baseline which is predictive of return of infection after the antibiotic intervention [38].

This study revealed that the prevalence of active trachoma among children aged 1–9 years old had shown statistically significant differences between MDA graduated and non-graduated districts. The possible explanation for this difference might be due to the lower antibiotic coverage in non-graduated districts than what is recommended by the World Health Organization that is at least 80% of the population should receive antibiotics for eliminations of trachoma. This is confirmed by a previous study done in the Amhara region which reported
administrative reports of the MDA campaign were higher than the population-based self-reported coverage of antibiotic supplementations [39].

This study also revealed similar discrepancies, for instance, children with the age of 4–6 years old in the non-graduated district are expected to receive at least three doses. However, only 39 (35.8%) of them in this age group had received three doses and above. Likewise, among children aged 7–9 years old, only 38 (34.2%) of them had received four doses and above. Therefore, children and mothers who have intimate contact with children missed during mass drug administration campaigns may leave them untreated which then reintroduce infection into treated communities.

The other possible explanation for this difference might be related to the knowledge of mothers/caretakers on signs and symptoms, mode of transmission, and prevention methods of trachoma. Almost twelve percent (11.8%) of mothers/caretakers in graduated districts have good knowledge about trachoma compared to mothers/caretakers of children in the non-graduated district. This is very important to have a good practice of children’s behavioral factors. For instance, 34.5% of mothers use soap regularly for washing their children’s faces in MDA graduated district compared to 24.2% of mothers in the MDA non-graduated district.

In this study, being a child from households with flies in the house was a significant predictor of active trachoma. This might be due to the increased access of Musca sorbens flies that promotes the risk of transmission of active trachoma which is supported by a previous study done in North Gondar, Ethiopia [26].

In this study, children from households with more than two children aged 1–9 years old had also higher active trachoma. This finding is in line with results from cross-sectional studies conducted in Gonji Kollela district, West Gojam Zone, and Zala district, Gamo Gofa Zone, of Ethiopia [10, 32]. The possible explanation for this association might be mother/caretakers are responsible for the caretaking of children, as the number of children in the household increases, it is difficult to get take care of all children and the possibility of sharing fomites enables the exchange of secretions and promotes infection with the causative agent.

Sleep in the child’s eyes and the presence of dirt on a child’s face were also a significant predictor of active trachoma. The possible explanation might be the sleep in the eye and the presence of dirt on a child’s face is observed when children continued without washing their faces for numbers of days. This is supported by the current study and other studies conducted in Ethiopia as those children who had not washed their faces daily were more likely to have active trachoma than children who washed twice and more times per day [26, 34]. This might be due to frequent face washing habit improves the facial cleanliness of children and thereby their face did not receive the vector, eye seeking flies, responsible for the transmission of the causative agent. Like other studies in Ethiopia in Woliso town and Baso Liben districts [27, 40], the use of soap for washing the face was identified as a predictor of active trachoma. Some studies show the prevalence of active trachoma is higher in children who do not use soap compared to children who use soap. Soap utilization while washing the child’s face is a key factor to effectively remove the causative agent discharged with ocular secretions. This interrupts transmission pathways from the reservoir to healthy children.

**Limitations**

Although comparative community based of this study in graduated and non-graduated districts could be the strengths of study; there might be the possibility of social desirability bias such as frequency of washing a child face per day, use of soap, and the possibility of recall bias among respondents answering questions relating to events happening in the past, such as frequency of azithromycin doses the child received in the past years.
Conclusions

Prevalence of active trachoma (TF) among children aged 1–9 years old was high in the study area and had shown a significant variation between MDA graduated and non-graduated districts. The result showed that the prevalence of active trachoma (TF) in the MDA graduated district was below the WHO threshold of 5% to determine trachoma. However, in MDA non-graduated district it is far from the elimination target of trachoma. Living in a non-graduated district, fly presence in the house, being a child from households with more than two children aged 1–9 years old, did not wash face per day, did not use soap while washing face and the presence of sleep in eyes and presence of any dirt on the face were identified as significant predictors of active trachoma (TF) among children aged 1–9 years old. Mass drug administration should be strengthened to reduce the burden of active trachoma. Promotion of identified modifiable behavioral factors such as health education programs for the communities about prevention and control of active trachoma through fly control and keeping facial cleanliness by washing their child’s face with soap are the areas of intervention in reducing active trachoma. The promotion of the utilization of family planning to reduce the number of children aged 1–9 years old in a household is important.

Supporting information

S1 Dataset.
(SAV)

S1 File.
(DOCX)

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Author Contributions

Conceptualization: Gashaw Melkie, Muluken Azage, Genet Gedamu.
Data curation: Gashaw Melkie.
Formal analysis: Gashaw Melkie, Muluken Azage, Genet Gedamu.
Investigation: Gashaw Melkie.
Methodology: Gashaw Melkie.
Project administration: Gashaw Melkie.
Software: Muluken Azage, Genet Gedamu.
Supervision: Muluken Azage, Genet Gedamu.
Validation: Gashaw Melkie.
Visualization: Gashaw Melkie.
Writing – original draft: Gashaw Melkie.
Writing – review & editing: Muluken Azage, Genet Gedamu.

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