• Investigation •

Exploring multi-level risk factors and post-war burdens of trachomatous trichiasis among displaced population in Raya Kobo districts, implication for urgent action

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Abstract

● **AIM:** To estimate post-war burdens of trachomatous trichiasis (TT) and multi-level risk factors among displaced population in Raya Kobo districts, implication for urgent action.

● **METHODS:** A community-based cross-sectional study was conducted among 603 participants from randomly selected 14 displaced slums in the Raya Kobo district. The data was collected from February 16th to March 30th, 2023. Study participants were selected using the multistage sampling technique. A structured questionnaire and ophthalmic loupe with ×2.5 magnificence were used to collect from participants. Multi-level binary logistic regression was used to determine associated factors with TT infection. Adjusted odds ratio (AOR) with 95% confidence interval (CI) were claimed for the strength of association at P<0.05.

● **RESULTS:** We recruited 602 (99.9%) participants for the final analysis. From the total, 126 (20.9%) and 98 (16.3%, 95%CI: 13.5%-19.4%) participants were diagnosed with active trachoma & TT infection, respectively. Being age ≥45y (AOR=7.9, 95%CI: 2.4-25.3), having multiple eye infections (AOR=2.73, 95%CI: 1.47-5.29), poor wealth index (AOR=9.2; 95%CI: 2.7-23.7) and twice face washing per day (AOR=0.082, 95%CI: 0.03-0.21) has identified as individual as factors for TT infection. Whereas, distance between clean water source ≥10 km (AOR=6.5, 95%CI: 3.9-31.3), and latrine availability (AOR=0.35, 95%CI: 0.21-0.58) were the two community-level factors associated with TT infections.

● **CONCLUSION:** The high prevalence of TT infection post-war throughout the study districts indicates a need for urgent clinical intervention in addition to rapid scaling up surgery, antibiotics, facial cleanliness, and environmental improvement (SAFE) strategies, strategy for high-risk population. Age≥45y, distance from the clean water source, poor wealth indexes, and eye infection are identified to be risk factors for TT infection. Furthermore, community-level preventative factors for TT infection are found as latrine availability and face washing practice.

● **KEYWORDS:** trachoma; risk factor; displaced population
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INTRODUCTION

Chlamydia trachomatis is an infectious eye disease caused by *Chlamydia trachomatis*, an obligate intracellular bacterium that causes follicular conjunctivitis, superficial keratitis, and corneal vascularization, and finally caused scarring[1-2]. Epidemiologically, trachoma is the leading cause of blindness worldwide and transmitted by eye-to-eye contact and eye-seeking flies' contacts[3-7]. Etiologically, trachomatous trichiasis (TT) infection is characterized by severe corneal abrasion, inflammation, and scarring on the tarsal conjunctiva due to insufficient secretion of intravitreal biomarkers by multiple infections in childhood accounted synaptic for neural transmission and finally caused irreversible blindness[3]. The eyelid protrusion in miss-segmentally caused repeated blinks and which finally produces florid pans and corneal scarring in the wrong direction[8-9]. Pathologically, TT has an acute phase (common in children, self-limiting infectious phase), and an advanced phase (common in adults, the sequel of multiple infections)[6,10-11].

Approximately 1.3 million people are blind from trachoma, and probably 1.8 million have low vision, which is predominantly reported from Sub-Saharan Africa and Middle East counties[5] According to the World Health Organization (WHO), 157.7

million people were living in active trachoma sites in 2020, with more than 88% of those coming from African nations, including 44.2% (69 802 693) from Ethiopia[12-13]. After an intervention, global antibiotic coverage in 2021 was 44%[13-14]. Globally, 47 countries were identified as active trachoma-endemic countries with 157.7 million inhabitants living in public health hazard areas[3,6-7].

The WHO promotes a multifaceted surgery, antibiotics, facial cleanliness, and environmental improvement (SAFE) method for trachoma prevention, which includes multiple components[4] for reducing the TT burden through antibiotic distribution, TT surgery, and environmental sanitation[4-15]. Despite this technique and achievement were recorded 80% of antibiotics on trachoma-mapped regions and 47.6% TT surgery for confirmed cases; however, ≥10% of patients who underwent TT surgery relapsed to follicular trachoma[16-17].

In a previous Meta-analysis reported in Ethiopia, the pooled prevalence of active trachoma was 26.9% for children[18] and 3.9% for adults[19]. Various studies[15,20-22] have examined why people with TT do not access earlier surgery after TT cases are confirmed as complications. Some of the reasons behind it are fear of surgery, indirect cost of surgery, longer walking distance, family size, and doubt surrounding the outcome[23]. During the war of the Tigray People Liberation Front (TPLF) in the Amhara and Afar regions, more than 1.4 million people were displaced from their homes and enforced to live in refugee camps with 600 000 deaths[24] at the national level. This made the displaced population food insecure, lacked clean water and medical care[25] and easily exposed to communicable and non-communicable diseases including TT infection. Therefor our study aimed to estimate post-war burdens of TT and multi-level risk factors among displaced population in Raya Kobo districts, implication for urgent action.

SUBJECTS AND METHODS

Ethical Approval The study was carried out under the Helsinki Declaration and the ethical review board of Woldia University College of Health Science Research and Community Service, Technology-Transformation, and University-Industry Linkage (RCS, TT & UIL) Office ethically cleared this research to conduct refill number (0018/2015) on 09/02/2015 E.C. Written informed consent was obtained from each participant during data collection.

This study was conducted in Raya Kobo district, North Wollo, Amhara Region North East Ethiopia. This woreda has been located 552 km away from Addis Ababa and 365 km from the regional capital city of Bahirdar[26]. The district has 3 urban and 42 rural Kebeles. All administrative villages (Kebele) are already occupied during the war North Wollos[24]. The region has already lost more than 2347 health institutions that give primary health care to the catchment population.

Study Design and Period The community-based cross-sectional study was employed among randomly selected 14 displaced slums /shantytowns in Raya Kobo District, Ethiopia.

Study Population All individuals who reside from February 16th to March 30th, 2023 among the randomly selected 14 displaced slums post-war TPLF.

Inclusion Criteria All individuals living in Raya Kobo and randomly selected households were interviewed, whereas during participant and post-war TPLF invasion of Raya Kobo District in North East Ethiopia at least a month was included in this study.

Sample Size Determination The sample size was calculated using a single proportion formula since there is no research about TT infection post-war in northern Ethiopia about TT infection with considering the following parameters and the formula of single population proportions: $N=Z^2\times p\ (p-q)/d^2$; Z=1.96 [95% confidence interval (CI)]; p=0.5% (assumption); d=0.05, merging error; $n=3.84\times0.5\times(0.5)/0.0025$, and considering: d=design effect; 1.5 since the study used multistage sampling, nonresponse rate =5%.

We interviewed 603 participants from selected 603 households which already randomly considered 14 slum rebels.

Sampling Techniques and Procedure A multistage sampling process was used to ensure the representation of all residents in the Raya Kobo district to select the study population. First, 14 refuge slums or administrative (villages) were randomly selected by lottery method from the total 45 districts.

Second, the proportional sampling technique was accompanied for each administrative slum based on their baseline population distribution which is available and taken from woreda administrative. Then we determined the sampling fraction (K) for selection of each administrative site based on the value which is given in the formula.

$$K=\frac{\text{Total house hold (HH) in kebele}}{\text{Our final sample size}}=8762/603=12$$

Therefore, based on the baseline proportional sample allocated for each administrative, we interviewed participants after the proportional sample was allocated as follows:

1) Robite Administrative=65HH; 2) Gendetis-Administrative=62HH; 3) Gobye Administrative=30HH; 4) Wormegna Administrative=54HH; 5) Menjello Administrative=50HH; 6) Aradume Administrative=50HH; 7) Adis Kegn Administrative=63HH; 8) Gedemeyu Administrative=25HH; 9) Mendeferesa Administrative=42HH; 10) Ayub Administrative=89HH; 11) Bewa Administrative=21HH; 12) Golesha Administrative=15HH; 13) Buhor Administrative=41HH; and 14) Ameya Administrative=36 participants were selected from each kebele.

Study Variables Dependent variable and TT infection (yes/no).

Independent Variables

Individual level factors These included age, sex, religion, wealth index, number of children, family size, occupation, face washing practice, frequency of face washing, educational status, smoking, and drinking behaviors, face washing frequency, history of epilation, history of annual Zithromax, information about trachoma, information about trichiasis, utilization of soap for face, and repeated eye infection

Community level factors Availability of toilets, residence, distance to the health care center, distance to get water, distance to health facilities, solid waste disposal, and liquid waste disposal, having a kitchen in the living room, and living with a domestic animal were considered as community-level factors.

Operational Definition

Active trachoma diagnosed[27] Diagnosis of active trachoma is accompanied by two clinicians both by the history taken of the respondents and rapid examination of the eye for clinical signs of trachoma involving careful inspection of the cornea, and limbus, eversion of the upper lid, and inspection of the tarsal conjunctiva and finally if the cases are suspected Binocular magnifying loupes (×2.5) and adequate lighting[13,27]. After the trachoma cases were confirmed by ophthalmic loupes with ×2.5 magnificence, grading was accompanied[28].

Trachomatous inflammation (TF)-follicular—which mostly requires topical treatment. Trachomatous-Inflammation-intense (TI) topical and systemic treatments are considered. Trachomatous scarring (TS)-scars are visible in the tarsal conjunctiva part. TT≥1 eyelash miss direction of the eyelash is the referred surgery. Corneal Opacity-a stage during which a person is irreversibly blind.

Laboratory diagnosis of cases Laboratory diagnoses were produced for trachoma-suspected clinical cases with Giemsa-stained smear of chlamydial elementary bodies in epithelial cells using ophthalmic loupes microscope ×2.5 magnificence.

Trachomatous Trichiasis It is a severe form of trachoma infection resulting in one or more eyelashes protruding, missing direction of the eyelash touching the globe in a diffused or a small segmental way[29].

Data Collection Tools Before data were collected to increase the identification and referral system of TT cases during data collection, a novel approach using standard screening questions and a card was used to identify active trachoma and trichiasis cases using. For confirmation purposes, data collectors selected two medical doctors (Dr. Demsewe and Dr. Nardose) holders with Integrated Eye Care Workers (IECWs); which helps to confirm the diagnosed and easily graded trachoma, and TT referral for surgery. Data were collected using a pretested and interviewer-administered structured questionnaire which is adapted from different literature on cross-sectional survey research[11,20,30]. Two medical doctors examined the eyes and recorded their current trachoma and TT status after the interview. Ophthalmic loupes with a magnification of ×2.5 with torch light were used for these examinations and identification of eyes[31].

Data Quality Assurance The quality of data was ensured at the point of data collection and data entry. Emphasis was given to designing questionnaires on the objective of the study and explained to data collectors. A pretest was undertaken on 5%[32] of our final sample at the Habru site with the prepared structured questionnaire before the actual data collection started and the amendment was made to the format. Two data collectors (IECW) and two medical doctor's supervisors had trained for two days on the objective of the study and the contents, consents, and objectives of the research. The investigators examined the completeness and consistency of the completed data if incorrect and their amendment was made by going back to participants based on the questionnaire code and screening participants again.

Data Processing and Analysis The collected data were checked for completeness, entered into Epi Data version 3.1 software program, and exported to STATA version 17 (SE). Descriptive statistics were presented using graphs, tables, frequency, and percentages.

Modeling Building for Final Regression Since our objective is to determine the multilevel factors of TT through multilevel mixed-effects, binary logistic regression used an advanced model to overcome the violation of the independence of observation of the different geographical sites of administrative. We first estimated the null model (Model I) containing only the outcome variables, TT (yes/no). During multilevel mixed-effect logistic regression, we estimated intraclass correlation (ICC) to precede the second step and it was exactly found that 15.2%.

The second (Model II) individual-level variables with outcome variables and selected by a *P*-value <0.25 in the bivariable regression. Finally, build a final model using all individual-level factors with *P*<0.25 and make a model adjustment and minimize confounding. In the third (Model III); community-level variables with dependent variables were regressed and the detected variables had a *P*-value <0.25 in the bivariable and built the final model after adjusting confounding factors.

The final models included (NULL Model+Model II+Model III) using both individual and community level factors were merged using predetermined parameters.

Model Comparisons The final model tested its fitness based on three model classes; the ICC, the likely hood ratio (LR) test, the Akakian information criteria (AIC), and Bayesian information criteria (BIC) test since the model is by nature being nested. The final model III (individual+community) was the best-fit model for this study.

RESULTS

Socio-demographic Characteristics of Participants Six-hundred and two (602) participants were included with an overall response rate of 99.9%. The majority, 361 (60%) of the participants were females and nearly half of 300 (49.8%) of them were within the 30-44 age group. More than half 320 (53.2%) had no formal education, but only 27.1% of participants completed elementary school. The largest proportion of 437 (72.6%) respondents were farmers and 418 (69.4%) of those were rural dwellers as shown in Table 1.

Behavioural Characteristics of Respondents Almost all 561 (93.9%) & 534 (88.7%) respondents had information about trachoma and its TT infection, respectively. Majority, 385 (64.1%) participants had latrine but didn't have 217 (35.9%) participants. Regarding clean water sources, two-in-third 506 (84.1%) of participants travelled ≥30 min to get drinking water sources (Table 1).

Medically Related Characteristics of Factors One in five respondents had a history of eye infection and 44 (7.1%) of them had repeated eye infections. On the other hand, 18 (3%) cases found eye epilation (Table 2).

The Burden of Post-war TT Infection At the end of the study period, 126 (20.93%) respondents had active trachoma infection, of them, 94 (15.6%) were confirmed for TT infection and referred for surgery. This makes the overall prevalence of infection was 16.3% (95%CI: 13.5%-19.4%). More than one-in-fourth 34 (26.9%) of the respondents had age ≤30y and 47 (37.3%) were a poor class of wealth index. Alternatively, the equivalent ratio age class ≥45 and ≤30y had a prevalence of TT infection of 31 (24.8%) during the interview. Regarding the site of TT infection, 7.5% of the cases were left eyes, but 5.6% and 3.2% were in both eyes. Of the total included villages, respondent Ayub village, significantly prevalent cases were reported and both trachoma 13.9% (95%CI: 11.4%-16.9%) and 13.4% (95%CI: 10.2%-15.9%) were reported, respectively (Table 3).

Grading of Trachoma Among detected 126 active trachoma cases, the majority 94 (74.6%) of them were at stage IV, while the remaining 16 (12.7%), 8 (6.3%), 6 (4.7%), and 3 (2.5%) were found stage I, II, III, and V (Table 4)[33].

Multi-level Factors Associated with Trachomatous Trichiasis Infection In Model I (null, empty, or intercept only model), in which neither individual nor community level variables were entered, there was a significant variation in the log-odds of the displaced population for TT (σ^2, U0=0.219, *P*<0.001, 95%CI: 0.187-0.279).

Model II represents the significant variation in log-odds of TT that could be explained by individual variables (σ^2, U0=0.16; *P*=0.001) with ICC=19.8, 95%CI: 11.3-25.1.

In Model III, the community-level factors have a significant

Table 1 Baseline socio-economic and environmental characteristics of respondents for TT burden in Raya Kobo district from February 16th to March 30th, 2023

Category	Frequency	Percent
Sex, male/female	241/361	40.0/60.0
Age		
≤30	204	33.9
30-44	300	49.8
≥45	98	16.3
Marital status		
Single	115	19.1
Married	393	65.3
Divorced	94	15.6
Responsibility		
Head	469	77.9
Family member	133	22.1
Number of children in the house		
No children	27	4.49
One	421	69.9
≥Two	154	25.6
Occupation status		
Farmer	437	72.6
Merchant	99	16.4
Employer	21	3.5
Other	45	7.5
Educational status		
No formal education	320	53.2
Complete elementary	163	27.1
High school & above	119	19.8
Residence		
Urban	184	30.6
Rural	418	69.4
Religious		
Orthodox	384	63.8
Muslim	163	27.1
Protestant	43	7.1
Catholic	12	2.0
Wealth index		
Poor	201	33.3
Medium	200	33.3
Rich	201	33.3
Washing face per day		
Once	97	16.1
Twice	231	38.4
More than three	274	45.5
Using soap, yes/no	487/115	80.9/19.1
Toilet, yes/no	385/217	64.1/35.9
To get drinking water source travelling		
<10 km	506	84.1
≥10 km	96	15.9
Distance to reach health facility		
<30min	508	84.9
≥30min	98	15.9
Waste disposal, yes/no	500/102	83.1/16.9
Types of waste disposal		
Solid	159	26.4
Liquid	140	23.3
Both	303	50.3
Domestic animals, yes/no	212/390	35.2/64.8
Separated kitchen, yes/no	501/101	83.2/16.8
Water source types		
Pipe	284	47.2
Well	171	28.4
Pond	81	13.5
River	66	11.1
Information about trachoma, yes/no	561/41	93.9/6.8
Information about trichiasis, yes/no	534/68	88.7/11.3
TT can cause blindness, yes/no	497/105	82.6/17.4
Can surgery cure trichiasis, yes/no	374/228	62.1/37.9

TT: Trachomatous trichiasis.

Table 2 Medical-related characteristics of the post-war burden of TT infection among people living in Raya Kobo district

Category	Frequency	Percent
Repeated eye infection, yes/no	44/56	7.1/92.5
History of epilation, yes/no	18/584	3.0/97.0
History of TT surgery (*n*=13), yes/no	13/589	6.3/93.7
Place of surgery (*n*=13)		
Health center	4	30.8
Hospital	9	69.2
Medication at surgery (*n*=13)		
Ointment	9	69.2
Both	4	30.8
Infected eyes, yes/no	58/544	9.6/90.4
Trachomatous trichiasis, yes/no	98/504	16.3/83.7
Infected eyelid (*n*=98)		
Right	19	19.4
Left	45	45.9
Both	34	34.7
Mass drug administration, yes/no	527/75	87.5/12.5

variation in the log-odds of TT infection burden that could be explained by community-level factors (σ^2, U0=0.13; *P*=0.001) with ICC=17.3; 95%CI: 0.124-0.238.

In the Model IV (Conjoined model) of both individual and community level factors, after a significant model adjustment, TT infection has a variation with (σ2, U0=0.13, *P*=0.022) with ICC=16.1; 95%CI: 15.9-28.9 (Table 4).

Individual Level Factors During the multilevel logistic regression analysis, individual-level factors including respondents' age, at least once per year, eye infection, and poor wealth index were associated with TT infection occurrence at *P*<0.05. Whereas, twice face washing per day has against TT infection.

1) Accordingly, when the respondents aged ≥45y were 7.92 [adjusted odds ratio (AOR) 7.9, 95%CI: 2.4-25.3, *P*<0.001) times increased odds of TT infection occurrence as compared to those aged <30y.

2) Moreover, respondents with at least one eye infection per year were 3.46 (AOR=3.46: 95%CI: 2.37-16.4, *P*<0.001) time increased the odds of TT infection as compared with the counter group.

3) Compared to the rich wealth index group respondents, those who were poor in an economic class of the displaced population had 9.2 (AOR=9.2, 95%CI: 2.7, 23.7, *P*=0.0001) times increased odds of developing TT infection. Similarly, an individual who washed his/her face two per day were 92% reduced odds of developing TT infection as compared with the counter group (AOR=0.082, 95%CI: 0.03, 0.21; Table 5).

Community Level Factors Among community-level factors, distance to a drinking water source and availability of toilets in the household were significantly associated with TT infection.

1) In this case, the log-odds of TT infection was 65% (AOR=0.35, 95%CI: 0.21-0.58, *P*=0.013) times reduced for having a toilet in their household in contrast with no toilet HHs.

2) Moreover, ≥10 km traveling to get drinking water was 6.5 (AOR=6.5, 95%CI: 3.9-31.3) times increased the likely odds of TT infection as compared with <10 km (Table 5).

DISCUSSION

At the end of the study period, 126 (20.93%) and 94 (15.6%) participants confirmed active trachoma and TT infection. This makes the overall prevalence of TT infection be 15.6% (95%CI: 13.35%-19.25%). This finding is consistent with the previous finding in East Gojam 18.6%[31], and 17.8% reported in their clustered Zone in North Wollo[32-34]. This may be due to similarities in socio-economic and demographic characteristics of the study population since all studies were conducted in the same geographic and climatic zone of North Wollo Zone.

Conversely, the final report of our study is higher than previous findings 3.8% in Oromia[35], 1.1% in Zimbabwe[36], 5.0%-9.9% in Mozambique[14], and 11.1% in Nepal[37]. The reported discrepancy may be due to the final report of our study being compiled post-war among displaced populations, which may increase the estimation in addition to differences in the sample size and environmental characteristics of the comparison groups.

Regarding multilevel factors for TT infection, age ≥45y for study participants was 7.9 (7.9, 95%CI: 2.4-25.3, *P*<0.001) times increased odds of developing TT infection as compared with age <30y. This finding is consistent with the previous study reported in Shewa[15], Tigray, and Southern Sudan[38-39]. This might be because when age gets older; the immune response may decrease and be exposed easily to trachoma infection if the treatment is delayed, corneal abrasion, and scarring on the tarsal conjunctiva would be inevitable.

A significant association was observed between face-washing practices and the prevention of TT infection. In this regard, an individual who washed his/her face twice per day was 92% less likely (AOR=0.082, 95%CI: 0.03, 0.21) to develop TT infection compared to none of the practicing comparison groups. This is consistent with findings reported in Awi Zone, and Southwest Ethiopia[40-41]. This significant package can impact health extension workers on 16 health extensions for the WHO strategy (2018) to eradicate active trachoma from a public health issue, by implementing the acronym "SAFE" where "F" stands for facial cleanliness by preventing the spread of bacteria from individuals, was given in each kebel by health extension.

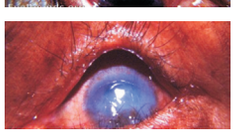
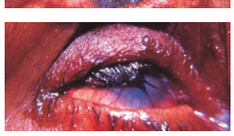
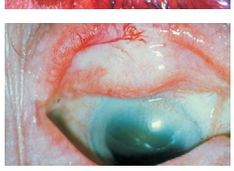
In this report, we investigated that latrine availability in the house hindered 65% (AOR=0.35, 95%CI: 0.21-0.58) time odds of TT infection acquiring compared to those who had no latrine at all. This is consistent with the previous finding in Oromia and Burundi[42-43]. Indeed, access to latrines reduces

Table 3 Post-war burden of trachoma & TT among data collected villages in Raya Kobo district from February 16th to March 30th, 2023 (*n*=602)

No.	Name of village	Sampled population	No. cases	Active trachoma burden (%)	No. cases	Active TT infection (%)
1	Robite	63	10	10.4 (8.4-13.4)	10	10.4 (8.4-13.4)
2	Genetics	64	11	10.6 (9.2-13.3)	11	10.6 (9.2-13.3)
3	Gobye	27	5	4.4 (3.9-6.5)	5	4.4 (3.9-6.5)
4	Wormegna	49	9	8.1 (6.2-10.6)	9	8.1 (6.2-10.6)
5	Menjello	51	8	8.5 (6.5-10.9)	8	8.5 (6.5-10.9)
6	Aradume	39	11	6.5 (4.7-8.7)	3	6.5 (4.7-8.7)
7	Addis Kegn	48	11	7.9 (6.1-10.4)	8	7.9 (6.1-10.4)
8	Gedemeyu	21	10	3.5 (2.2-5.2)	3	3.4 (2.2-5.3)
9	Mendeferesa	44	14	7.3 (5.4-9.6)	6	7.3 (5.4-9.6)
10	Ayub	84	17	13.9 (11.4-16.9)	14	13.4 (10.2-15.9)
11	Bewa	21	8	3.4 (2.2-5.3)	7	3.4 (2.2-5.3)
12	Golesha	14	2	2.3 (1.4-3.9)	2	2.3 (1.4-3.8)
13	Buhor	44	4	7.3 (5.4-9.6)	2	7 (5.4-9.6)
14	Amaya	33	6	5.4 (3.9-7.6)	6	5.4 (3.9-7.6)

TT: Trachomatous trichiasis.

Table 4 Grading of active trachoma diagnosed among the prevalent cases and its severe form of TT infection displaced the population residing in Raya Kobo district[33]

No.	Grading	P/E	Physically presentation of cases	Frequent	Percent
1	Follicular-types of trachomatous inflammation (TF)		During P/E the patient has several small follicles and intense inflammation in the upper tarsal conjunctiva; consistent with trachomatous follicular intense types of inflammation.	16	12.7
2	Intense and condensed trachomatous –inflammation (TF) or follicular hypertrophy predominant		During P/E the cases had during large infiltration and matured pus-like infiltration and mature follicles, papillae, and progressive corneal pannus were observed.	8	6.3
3	Scarring of cicatricle-trachomatous – inflammation (ST)		During P/E all cases present with palpable conjunctiva inflammation and had scare due to marked symblepharon formation inside form pemphigoid.	6	4.7
4	Trachomatous trichiasis (TT)		During P/E cases were presented with conjunctivitis, florid pans, corneal scarring, and extensively swelled and protrude miss-directionally to eyelids.	94	74.6
5	Corneal opacity blinding (COB)		Cases during P/E had a superior quarter of the corneal is pacified because of scaring.	3	2.5

P/E: Physical examination. All images in the Table 4 were adapted from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7652564/.

environmental fecal contamination, which serves as a breeding ground for flies and easily transmits trachomatis to human sites; but, if individuals have clean latrines, the transmission can be easily avoided.

Consistent with earlier research findings[44], cleaning one's face with soap and water has proved crucial in reducing the occurrence of many eyes and associated infections, especially in children. In our report, the odds of having TT infection among the displaced population who had repeated eye infections were threefold increased TT infection compared to no infections throughout the year (AOR=3.7, 95%CI: 2.4-10.4, *P*=0.001). Furthermore, the respondents' poor wealth index was 9.2 (AOR=9.2, 95%CI: 2.7, 23.7, *P*=0001) times the power to increase the odds of developing TT infection as compared with the rich economic class of the counter group. Active trachoma can contribute almost exclusively to the disease of poor families and communities living in developing countries including Ethiopia[36,45].

Consistent with previous findings in Southeast Ethiopia[44], and Sudan[28], our final report indicated, distance to healthcare facilities was a prominent risk factor for the incidence of TT infection. Due to the destruction of more than 2347 healthcare

Table 5 Mixed effect multi-level binary logistic regression for identify factors associated with TT infection among a displaced population in Raya Kobo district

Categories	Model I	Model II AOR (95%CI)	Model III AOR (95%CI)	Model IV AOR (95%CI)
Sex				
Male		Ref		Ref
Female		1.5 (0.28-2.99)		2.29 (0.56-9.3)
Age				
<30		Ref		Ref
30-44		1.4 (0.8-2.7)		1.28 (0.43-3.27)
≥45		1.17 (0.8-3.9)		7.92 (2.47-25.37)[b]
Face washing practice				
Once a day		Ref		Ref
Twice a day		0.17 (0.03-0.85)		0.082 (0.03, 0.21)[c]
≥3 per day		0.89 (0.43-2.3)		0.29 (0.066-1.30)
Eye infection (≥1/y)				
Yes		28.2 (21.5-69)		3.46 (2.37-16.4)[b]
No		Ref		Ref
Wealth index				
Poor		4.47 (2.79-12.39)		9.2 (2.7-23.7)[c]
Medium		2.7 (0.93-3.45)		1.6 (0.5-5.6)
Rich		Ref		Ref
Marital status				
Single		Ref		Ref
Married		0.63 (0.37-1.06)		1.7 (0.72-4.1)
Divorce		1.42 (1.35-5.74)		1.18 (0.4-1.8)
Occupation status				
Farmer		2.0 (1.7-3.2)		3.9 (0.18-8.3)
Merchant		2.51 (0.87-7.2)		0.9 (0.13-3.5)
Employer		1.7 (0.99-4.3)		0.5 (0.06-3.6)
Students		Ref		Ref
Living with animals				
Yes			1.9 (0.2-5.7)	1.9 (0.27-5.7)
No			Ref	Ref
Water source distance				
<10 km			Ref	Ref
≥10 km			8.7 (4.99-39.3)	6.5 (3.9-31.3)[c]
Health facility distance				
<0.5h			1.9 (0.5-3.6)	1.9 (0.5-3.6)
≥0.5h			Ref	Ref
Toilet availability				
Yes			0.45 (0.27-0.604)	0.35 (0.21-0.58)[a]
No			Ref	Ref
Random error with (SE)				
Community variation	0.219 (<0.001)	0.16 (0.001[a])	0.14 (0.001[a])	0.13 (0.01[a])
ICC	15.3 (11.6-22)	19.8 (11.3-25.1)	17.3 (12.4-23.8)	16.1 (15.9-28.9)
PCV	Reference	43.9%	42.1%	53.7%
MOR	2.14	3.7	4.2	5.1

[a]*P*<0.05, [b]*P*<0.001, [c]*P*<0.0001. ICC: Intraclass community coefficient; PCV: Proportional changes in the community-level variance; MOR: Median odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval.

facilities in the war of TPLF and central government, particularly in the Amahar region, the displaced population faced challenges on the infrastructure and health service coverage disparities, which could prevent patients from

obtaining early medical care for eye infections including active trachoma infection[24].

There is a strong relationship between the availability of water in the endemic community or household and the prevalence of active trachoma, especially among children and older age[23,46-47]. Consistent with previous studies, finding in central Ethiopia[17], Southern Ethiopia[23], and Tanzania[46] demonstrated that at ≥10 km far from the site of a drinking water source for an individual living house, the log-odds of having TT infection was 6.5 (AOR=6.5: 95%CI, 3.9-31.3) times increased as compared with the counter group had been lived <10 km. Individuals who lived near water sources had higher hygiene standards, more personal cleanses, and a lower risk of trachoma infection from flies, which is directly related to the likelihood of developing trachoma and TT infection[3-7].

Limitations of the Study The study may be prone to reporting bias since some of the data was collected based on self-reported information and this study did not use the qualitative method to explore other factors contributing to the final results.

In conclusion, The high prevalence of TT infection post-war throughout the study districts indicated a need for urgent clinical intervention in addition to rapid scaling up SAFE strategies, WHO strategies for high-risk individuals. Age ≥45y, distance from the clean water source, poor wealth indexes, and eye infection were identified to be risk factors for TT infection. Latrine availability and face washing were community-level identified preventive factors for TT infection.

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