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Prevalence of active trachoma and its associated factors among children aged 1–9 years in previous leprosarium and non-leprosarium areas in eastern Ethiopia: a community-based comparative study

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Background: Trachoma is a neglected tropical disease that mainly affects impoverished and marginalized communities with inadequate shelter and sanitation. Nevertheless, the prevalence of active trachoma and the specific factors contributing to it among communities residing in former leprosy settlements in eastern Ethiopia are not well explored. Therefore, the objective of this study was to compare the prevalence of active trachoma and its associated factors among children aged 1-9 years in the previous leprosarium and non-leprosarium areas, as well as urban and rural areas in eastern Ethiopia.

Methods: A community-based comparative cross-sectional study was conducted among 580 systematically selected households from January 1 to 30, 2024. Data were collected by interviewing the children's caregivers, observing the child and environment, and conducting a clinical examination of their eyes. Data were entered in EpiData version 4.6 and exported to Statistical Package of Social Science (SPSS) version 26 software for analysis. A chi-square test was also done. The association was presented as an adjusted odds ratio with a 95% confidence interval, and variables with a p-value less than 0.05 were regarded as statistically significant.

Results: The overall prevalence of active trachoma was 12.9% (95% CI: 10.5%-15.3%). The prevalence of active trachoma was 15.6%, 9.8%, 18.3%, and 7.5% among children in previous leprosy and non-leprosy settlements and rural and urban areas, respectively (x^2=5.65, p-value = 0.017). Having eye discharge (AOR = 10.7'; 95% CI: 4.32, 26.51), latrine distance from home of less than 10 m (AOR=3.12; 95% CI: 1.16–8.34), being a rural resident (AOR=4.1; 95% CI: 1.69-

10.18), presence of solid waste around their home (AOR=6.5; 95% CI: 2.14-19.72), and household monthly income less than 5000 Ethiopian birrs (AOR=2.9; 95%CI: 1.04-8.30) were statistically associated with active trachoma in the previous leprosy settlements. In the non-leprosy settlements, children who had eye discharge (AOR = 7.6; 95% CI: 5.37, 58.05), latrine distance from home of less than 10 m (AOR=3.12; 95%CI: 1.11, 8.77), habit of playing with soil (AOR=9.0; 95% CI: 2.92, 28.24), and presence of animal dung (AOR=6.98; 95% CI: 3.44, 48.47) were statistically associated with active trachoma.

Conclusion: In this study, the prevalence of active trachoma among children aged from 1-9 years old was higher than the WHO target for the elimination of active trachoma (<5%) in every district. Therefore, targeted treatments and raising awareness on proper hygiene and sanitation are required to alleviate the problem.

KEYWORDS

active trachoma, children, leprosy, non-leprosy, settlement, Ethiopia

Introduction

Trachoma is caused by the intracellular bacterium *Chlamydia trachomatis* serovars A, B, Ba, and C, and is the leading cause of blindness due to infectious diseases worldwide (1, 2). Active trachoma is recognized by recurrent tarsal conjunctivitis (3). The main route of transmission is the passage of ocular and nasal secretions from person to person on fingers, fomites (such as clothing), and eye-seeking flies (particularly *Musca sorbents*) (4). Children under 9 years of age who reside in situations where there is a high risk of infection may experience the blinding consequences of trachoma (5). Additionally, it causes conjunctival scarring and, sometimes, trichiasis with or without entropion of the inner surface of the eyelids, resulting in blindness (6, 7).

Globally, there are 1,224 areas with > 5% prevalence of follicular trachoma (TF) in children aged between 1 and 9 and a total of 145.6 million people live in these areas and nearly 86% (124.7 million) of these were in Africa (8). Prevalence rates for active trachoma in preschool-aged children in endemic areas can range from 60% to 90% and as individuals age illnesses become less frequent and persist for shorter periods (8). This infection is most prevalent in impoverished rural regions of Africa, Central and South America, Asia, Australia, and the Middle East (9–11). It is endemic in 44 nations across the globe, 33 of which are in Africa (3) and 136 million people are at risk, with the majority being in east and west sub-Saharan Africa, North Africa, and a few endemic coastal states in central Africa (3). Furthermore, it has caused visual impairment in 1.9 million people and contributes to 1.4% of overall blindness cases (8).

The country with the most incidence is Ethiopia, with 10.2 million, followed by Sudan (3.6 million), Tanzania, Kenya, and Niger (2.0–2.1 million each) (12, 13). Ethiopia launched its first trachoma action plan in 2012 and its second master plan in 2016 (14). However, a recent study showed that the prevalence of active trachoma among children in Ethiopia was 26.9 (15), of which the Southern Nation, Nationality and Peoples (SNNP) region had the highest prevalence (35.8%), followed by the Amhara region (30.2%) and other regions (21.4%). A study conducted among school children in the Harari region in eastern Ethiopia in 2016 showed that the prevalence of active trachoma was 1.3%, of which 0.8% was follicular trachoma and 0.5% was follicular and intense (16).

Each year, approximately 1.3 million disability-adjusted life years are lost due to trachoma (17). Trachoma also has a negative impact on affected individuals and communities. In terms of lost productivity, blindness and visual impairment are expected to have an economic cost of between US$2.9 and US$5.3 billion (8). Several poverty-related factors can influence the development of active trachoma. Because trachoma is one of the neglected tropical diseases (NTDs) that affect impoverished communities, there may be a bidirectional causal association between poverty and trachoma (16, 18).

To eliminate blinding trachoma as a public health problem, all countries must reduce the number of active trachoma in children aged 1 to 9 years to less than 5% in all districts (17). In cases where the prevalence of follicular trachoma exceeds 10% among children aged 1 to 9 years, it is recommended that districts implement mass distribution campaigns of either tetracycline eye ointment or oral azithromycin antibiotics (14, 19). In any district where the prevalence of follicular trachoma is between 5% and 10% in children aged 1–9 years, targeted treatments may be used instead of mass treatments (20). To achieve success in the integrated control of NTDs, integrated mapping, the rapid scale-up of interventions, and operational research on the co-implementation of intervention packages are crucial. Therefore, this study was designed to compare

the prevalence of active trachoma and its associated factors among unique communities, identify risk groups, and can be used to guide public health interventions to target areas with high trachoma prevalence and implement effective control measures.

Materials and methods

Study setting

This study was conducted in the Harari Regional State, in 1 and 2 Kebeles, Amir Nur District, and Oromia Regional State, in Bisidimo and Ifadin Kebeles, Babile District, from January 1 to 30, 2024. The Harari Regional State is 523 km away from Addis Ababa to the east. This region has nine districts with 19 urban and 17 rural kebeles.

Amir Nur District is an urban district with 5,380 households and a total population of 24215. There were 4,027 children aged 1–9 years in the district. Gandaa Ferroo village is one of the villages in 1 Kebele, and it was a leprosy settlement area (21).

The other study sites were Babile District, Bisidimo, and Ifadin Kebeles, which are 540 km from Addis Ababa and 23 km from Harar to the east. Bisidimo Kebele is an area around Bisidimo Hospital, and it includes 1,237 households, a total population of 7229, and 2,228 children aged 1–9 years. Bisidimo Kebele is a historical leprosy settlement area (21, 22). Patients with leprosy visited Bisidimo Hospital for treatment and made their residences around Bisidimo Hospital. Ifadin Kebele is a non-leprosy settlement area around Bisidimo Kebele, and it includes 1,381 households with a total population of 6627, and 2,178 children aged 1–9 years.

Study design and populations

A community-based comparative cross-sectional study was conducted. The source population for this study included all households with children aged from 1 to 9 years old who were living at 1 and 2 Kebeles, Amir Nur District, and Bisidimo and Ifadin Kebeles, Babile District. The study population included children aged 1-9 years and their caregivers from the selected households who gave full consent to participate. Children with acute ocular infection, recent ocular treatment, recent ocular trauma, or surgery, whose families or caregivers were not present at home during the data collection period, and those children whose caregivers did not sign consent, were excluded.

Sample size determination and sampling technique

The sample size was determined using a double population proportion formula by considering the prevalence of active trachoma (11.8%) among children aged 1 to 9 years taken from a previous study conducted in Metema district, Ethiopia (23) and the prevalence among 50% at a confidence interval of 95% and 5% margin of error. Furthermore, 10% of the sample size was added to reduce errors resulting from the likelihood of non-compliance, resulting in a final sample size of 598. 1 Kebele, Amir Nur District, and Bisidimo Kebele, Babile District were purposively selected as previous leprosy settlements and the other two kebeles were selected randomly as non-leprosy settlements. The study sites were stratified into leprosy and non-leprosy settlements. Households were selected using a systemic random sampling technique from each selected kebeles by using the family registration book found at the health post as a sample frame [k=10, where k was calculated by dividing the total number of households by the calculated sample size (6200/598 = 10)] and every 10^{th} value was used. In cases where the selected household had no children aged from 1-9 years, the next household was used. All eligible children who were at home during the data collection were included in the study. The number of households was proportionally allocated. The total number of households was almost the same, i.e., 3,105 and 3,095 households in the leprosy and non-leprosy settlement areas, respectively. Finally, the same number of households (299) from both areas were considered using the systematic sampling technique.

Data collection methods and measurement

Data were collected by interviewing children's caregivers using a pretested structured questionnaire, which was adopted from the literature (19, 23–26), observing the child's face, and conducting clinical eye examinations.

During data collection, public health officers and ophthalmic nurses looked for flies on the child's face and if there was at least one fly on the child's face they recorded it as the presence of flies on the child's face. The examiner then looked for discharge from the eyes and nose of children during data collection. If there was eye or nose discharge, they recorded it as discharge on the child's face. If there was no discharge from either the child's eye or nose, the examiner/data collectors were recorded it as a clean face (27). The same procedures were used to examine each eye and all children were examined by two different examiners to correlate the results. Clinical signs of trachoma, such as trachoma follicular (TF), trachomatous inflammation-intense (TI), trachomatous conjunctival scar (TS), trachomatous trichiasis (TT), and corneal opacity were identified by the trained data collectors using a pen torch and a lens with a 2.5x magnifying power. The upper eyelid was slightly pushed upward to expose the lid margins to look for embedded eyelashes. They then looked for inflammation (TF and TI) and scarring on the upper eyelid (TS) (28). An ophthalmologist was ready to check if there were discordant results among data collectors during the data collection. To prevent cross-infection between successive participants, the necessary hygienic measures were taken by cleaning hands with alcohol-based hand gel after each examination.

Methods of data analysis

Data were double-entered, edited, and cleaned using Epidata version 4.6, and exported to the SPSS version 26 program for

analysis. Descriptive statistics were computed and summarized in the tables, figures, and text as frequencies, means, or standard deviations where appropriate.

Potential co-linearity was checked using the multicollinearity model considering tolerance and variance inflation factor (VIF). Bi-variable and multivariable logistic regression analyses were computed to identify the association between the independent variables and the outcome variable. In the bivariate analysis, variables with a p-value ≤ 0.25 were included in the multivariable analysis to control for all confounding variables. The model goodness of fit was tested by the Hosmer–Lemeshow statistic. The model was considered a good fit if it was found to be p >0.05 for the Hosmer–Lemeshow statistic. The association between active trachoma and the independent variables was reported as an odds ratio with a 95% CI and a p-value less than 0.05 was considered statistically significant.

Data quality assurance

The structured questionnaires were prepared in English and translated into local languages (i.e., Afan Oromo and Amharic) by a language expert, and back-translated into English by another language expert to maintain its consistency. Questionnaires were pre-tested 7 days before the actual data collection on 5% of the caregivers of children aged from 1-9 years in Kebele 7, Amir Nur District, who were not included in the actual data collection. The required modifications and changes were implemented based on the results of the pretest. Both supervisors and data collectors received 2 days of training. Supervisors monitored data collectors at each site throughout the data collection process. Data collectors used a pen torch to obtain adequate light for the eye examination and a 2.5x power magnifying lens to see conjunctival follicles that were not seen by the naked eye. The primary investigator also actively monitored the fieldwork every day, ensuring that surveys were fully completed and that the data being recorded made sense.

Ethical consideration

The Institutional Health Research Ethics Review Committee (IHRERC) at Haramaya University College of Health and Medical Science granted ethical approval (Reference number: IHRERC/185/2023). Permission letters were obtained from the Amir Nur District and Babile District administrative offices. The interviews and clinical eye examinations of the chosen children took place in the presence of the children's caregivers after the signed informed voluntary consent was given. Their names and other personal identifiers were not registered to maintain confidentiality. The study's goals, as well as the rights of and advantages for the study participants, were explained. Individuals who were positive for signs of active trachoma (204) were referred to nearby health facilities.

Results

Sociodemographic characteristics

A total of 580 households were included in this study, with a response rate of 96.9%. Among the included households, 290 were from leprosy settlements, and 290 were from non-leprosy settlements. The age range of the caregivers was 15 and 63 years and the mean age (± SD) was 30.68 (± 7.23).

Regarding the educational status of the caregivers, 178 (61.2%) of those who were living in the leprosy settlement and 110 (38.1%) who were living in the non-leprosy settlement area had no formal education. The mean age (± SD) of the children living in leprosy and non-leprosy settlements was 5.23 (± 2.51) and 5.53 (± 2.49) years, respectively. Regarding the children's educational status, 146 (36.8%) from the leprosy settlements and 184 (52.9%) from the non-leprosy settlements attended elementary school (Table 1).

Environmental and water, sanitation, and hygiene (WASH) conditions of the households

In total, 222 (76.8%) and 234 (80.8%) households had latrine coverage in the leprosy and non-leprosy settlements, respectively. Regarding solid waste, 76.1% (222) of the households in the leprosy settlements and 45.0% (223) of the households in the non-leprosy settlements had solid waste around their homes. In the leprosy settlements, 61.1% of households had animal waste in their living compound, while in the non-leprosy settlements, the prevalence was 49.3% (Table 2).

Child-related factors

The prevalence of the habit of sharing clothes was 73.8%, and 60.6% among children living in the leprosy and non-leprosy settlements, respectively. In the leprosy settlements, 78.3% of children played with soil, whereas only 55.7% of children in the non-leprosy settlements did the same. Approximately 63.2% and 65.5% of children in the leprosy and non-leprosy settlements did not use soap for face washing, respectively (Table 3).

Prevalence of active trachoma

The overall prevalence of active trachoma among children who were enrolled in this study was 12.9% (95% CI: 10.5%, 15.3%). The prevalence was found to be 15.6% (95% CI: 12.0%, 19.2%) and 9.8% (95% CI: 6.6%, 12.9%) among children who were living in the leprosy settlements and non-leprosy settlements, respectively. This difference was statistically significant (x^2=5.65, p-value = 0.017). Among the children living in the leprosy settlements, the prevalence

TABLE 1 Sociodemographic characteristics of caregivers and children from leprosy and non-leprosy settlements in eastern Ethiopia in 2024 (n=580).

Characteristics		Leprosy settlement (n=290)		Non-leprosy settlement (n=290)	
		No	%	No	%
Place of residence	Urban	158	54.7%	127	44.0
	Rural	132	45.3%	163	56.0
Age of caregiver (in years)	15-19	2	0.6	6	2.1
	20-24	42	14.5	34	11.7
	25-29	95	32.9	82	28.5
	30-34	81	28.0	76	26.1
	35-39	45	15.6	64	22.0
	40-44	17	5.9	15	5.2
	>45	8	2.8	13	4.5
Marital status of the caregiver	Single	1	0.3	0	0.0
	Married	273	94.5	263	90.4
	Separated/divorced	9	3.1	13	4.5
	Widowed	7	2.1	14	5.2
Educational status of the caregiver	No formal education	178	61.2	110	38.1
	Primary education	38	13.4	85	29.4
	Secondary education	30	10.3	31	10.7
	College & above	64	21.8	44	15.2
Caregiver's occupation	Merchant	55	19.0	44	15.1
	Employed	68	23.5	48	16,5
	Housewife	156	54.0	197	68.0
	Student	6	1.7	1	0.3
	Laborer (labor workers)	5	1.7	0	0.0
Household monthly income (in birrs)	<2000	85	29.3	51	17.5
	2000-5000	146	50.3	153	57.8
	5000 & above	59	20.4	86	29.6
Household family size	<5	105	36.0	167	57.7
	≥5	185	64.0	123	42.3
Child age (in years) (n=745)	1-3	140	35.3	79	22.7
	4-6	131	33.0	117	33.6
	7-9	126	31.5	152	43.7
Child sex (n=745)	Male	205	51.6	175	50.3
	Female	192	48.4	173	49.7
Child educational status (n=745)	Not in school	129	32.5	84	24.1
	KG	122	30.7	80	23.0
	Elementary school	146	36.8	184	52.9

of trachomatous follicular and trachomatous intense was 7.1% (28) and 8.6% (34), respectively. In the non-leprosy settlements, the prevalence of TF and TI cases was 4.3% (15) and 5.5% (19), respectively. Among the urban and rural children screened for active trachoma, 7.5% (95% CI: 3.8%–9.7%) and 18.3% (95% CI: 14.4%–22.2%) were positive, respectively (Figure 1).

There was a statistically significant difference between the urban and rural children (x^2=18.47, P-value = 0.000). Among the

TABLE 2 Households' environmental and WASH conditions in the leprosy and non-leprosy settlements in eastern Ethiopia in 2024 (n=580).

Characteristics		Leprosy settlement (n=290)		Non-leprosy settlement (n=290)	
		No	%	No	%
Latrine in use	Yes	222	76.8	234	80.8
	No	68	23.2	56	19.2
Distance of toilet from home (in meters)	<10	141	48.8	195	67.4
	≥10	81	28.0	39	13.4
Flies in the latrine	Yes	197	68.5	140	48.5
	No	25	8.3	94	32.3
Presence of liquid waste discharge	Yes	67	22.8	52	17.9
	No	223	77.2	238	32.1
Presence of solid waste	Yes	220	76.1	130	45.0
	No	70	23.9	160	55.0
Presence of animal dung	Yes	177	61.1	144	49.3
	No	113	38.9	146	50.3
Source of energy for cooking	Wood	245	84.8	201	69.4
	Electric power	45	15.2	89	30.6
Water source distance (in meters)	<1000	230	79.3	231	79.7
	≥1000	60	20.6	59	20.3
Amount of water per day per person (in liters)	<10	176	60.9	180	61.9
	10-20	106	36.3	103	35.7
	>20	8	2.8	7	2.4

TABLE 3 Childhood-related behavioral factors in the leprosy and non-leprosy settlement areas in eastern Ethiopia in 2024 (n=745).

Characteristic		Leprosy settlement(n=397)		Non-leprosy settlement (n=348)	
		No	%	No	%
Habit sharing clothes	Yes	293	73.8	211	60.6
	No	104	26.2	137	39.4
Habit of playing with soil	Yes	311	78.3	194	55.7
	No	86	21.7	154	44.3
Frequency of face wash	Once	150	37.8	133	38.2
	Twice	172	43.3	83	23.9
	Three times	75	18.9	132	37.9
Use of soap for face wash	Yes	146	36.8	120	34.5
	No	251	63.2	228	65.5
Face hygiene	Clean	198	49.9	196	56.3
	Unclean	199	50.1	152	43.7
Eye discharge	Yes	113	28.5	71	20.4
	No	284	71.5	277	79.6
Nasal discharge	Yes	156	39.3	123	35.3

(Continued)

TABLE 3 Continued

Characteristic		Leprosy settlement(n=397)		Non-leprosy settlement (n=348)	
		No	%	No	%
	No	241	60.7	225	64.7
Flies on face	Yes	214	53.9	158	45.4
	No	183	46.1	190	54.6

children from the leprosy settlements, 23.3% of the rural children and 6.2% of the urban children were positive for active trachoma. In contrast, 10.9% of the rural and 8.5% of the urban children from the non-leprosy settlements were positive for active trachoma. Of the total number of girls who tested positive for active trachoma, 16.7% were from the leprosy settlements (Table 4) and 10.9% were from the non-leprosy settlements (Table 5). Of the children living in the rural areas, 32 (8.4%) tested positive for TF and 37 (9.7%) for TI. Among the urban children screened for active trachoma, 17 (4.7%) had TI and 10 (2.8%) had TF (Figure 2).

Among the children in the leprosy settlement areas

In the bivariate logistic regression, place of residence, caregiver's marital status, household monthly income, habit of sharing clothes, use of soap for washing face, face hygiene, flies on child's face, eye discharge, source of energy for cooking, presence of animal dung, presence of liquid waste, amount of water per day per person, latrine distance, and water source distance were found to have a p-value less than or equal to 0.25 and were selected as candidates for the final multivariable analysis of the leprosy settlements. In the multivariable logistic regression, place of residence, household monthly income, eye discharge, latrine distance, and presence of solid waste were significantly associated with the prevalence of active trachoma at a p-value of less than 0.05 (Table 4). The likelihood of active trachoma among the rural children was 4.15 times (AOR = 4.15, 95% 268 CI: 1.69–10.18) higher than that of the urban children. The children who had discharge in their eyes were 10.7 times (AOR = 10.7, 95% CI: 4.32–26.51) more likely to have active trachoma than their counterparts. The likelihood of active trachoma among the children who were from households that had a latrine less than 10m from home was 3.12 times (AOR = 3.12, 95% CI: 1.17–8.34) higher compared to their counterparts. Children from households that had solid waste around the home were 6.5 times (AOR = 6.51, 95% CI: 2.15–19.72) more likely to have active trachoma compared to those children from households that had no solid waste around the home. The odds of active trachoma among children from households with a monthly income of less than 5,000 birr was 2.9 times (AOR = 2.95, 95%CI: 1.05–8.30) higher compared to their counterparts (Table 4).

Among the children in the non-leprosy settlement areas

In the bivariate logistic regression, a habit of playing with soil, flies on child's face, eye discharge, presence of animal dung, amount of water per day per person, latrine distance, latrine in use, and flies in latrine were found to be a p-value less than or equal to 0.25 and were selected as candidates for the final multivariable analysis for the non-leprosy settlements. Thus, a habit of playing with soil, eye discharge, presence of animal dung, and latrine distance were found to be significantly associated with the prevalence of active trachoma at a p-value less than 0.05 (Table 5). Children who had discharge in their eye were 7.6 times (AOR = 7.66, 95% CI: 5.37–58.06) more likely to have active trachoma than their counterparts. Children who had a habit of playing with soil were 9.1 times (AOR = 9.09, 95% CI: 2.92–28.24) more likely to acquire active trachoma than

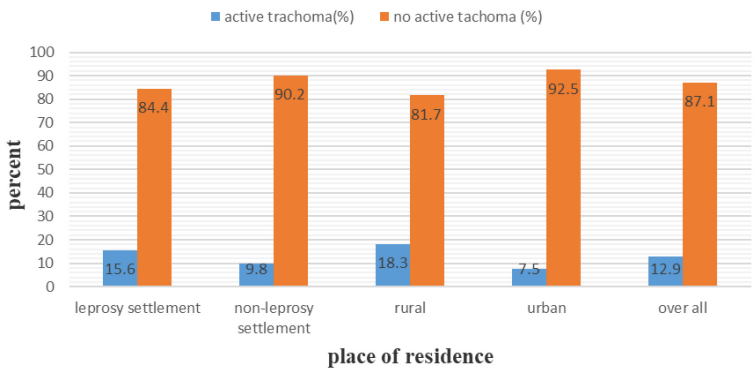

FIGURE 1
Prevalence of active trachoma among children aged 1 years in the leprosy and non leprosy settlements in eastern Ethiopia in 2024.

TABLE 4 Bivariate and multivariable analyses of factors associated with active trachoma among children in the leprosy settlements in eastern Ethiopia in 2024.

Variables	Category	Active trachoma		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Yes (%)	No (%)				
Residence	Urban	11(6.2%)	167(93.8%)	1		1	
	Rural	51(23.3%)	168(76.7%)	4.609(2.32,9.15)	0.000	4.151(1.69,10.18)	0.002
Marital status of caregiver	Married	55(18.6%)	240(81.4%)	1		1	
	Others	7(6.9%)	95(93.1%)	0.322(0.14,0.73)	0.007	3.97(1.19.13.20)	0.204
Caregiver's occupation	Employed	27(26.2%)	76(73.8%)	1			
	Unemployed	35(11.9%)	259(88.1%)	0.473(0.21,1.08)	0.277		
Monthly income (Birrs)	<5000	52(20.2%)	206(79.8%)	3.256(1.598,6.63)	0.001	2.95(1.05,8.30)	0.041
	≥5000	10(7.2%)	129(92.8%)	1		1	
Family size	<5	26(10.7%)	216(89.3%)	1			
	≥5	36(23/2%)	119(76.8%)	2.513(0.85,3.13)	0.345		
Habit of sharing clothes	Yes	57(19.5%)	235(80.5%)	0.206(0.08,0.53)	0.001	0.180(0.06,0.58)	0.103
	No	5(4.7%)	100(95.3%)	1		1	
Face hygiene	Clean	24(12.1%)	174(87.9%)	1		1	
	Unclean	38(19.1%)	161(80.9%)	1.711(0.98,2.98)	0.057	0.672(0.23,1.97)	0.506
Flies on face	Yes	44(20.6%)	170(79.4%)	2.373(1.32,4.28)	0.004	1.630(0.50,5.31)	0.930
	No	18(9.8%)	165(90.2%)	1			
Eye discharge	Yes	36(31.8%)	77(68.2%)	4.639(2.64,8.16)	0.000	5.813(3.73,34.44)	0.000
	No	26(9.2%)	258(90.8%)	1		1	
Source of energy for cooking	Wood	56(10.7%)	285(89.3%)	10.52(1.43,77.69)	0.021	1.322(0.15,11.89)	0.202
	Electric	6(10.7%)	50(89.3%)	1		1	
Animal dung	Yes	35(20.0%)	140(80.0%)	1.806(1.05,3.12)	0.034	1.053(0.47,2.24)	0.758
	No	27(12.2%)	195(87.8%)	1		1	
Liquid waste disposal	Yes	6(8.5%)	65(91.5%)	0.45(0.18,1.08)	0.073	1.918(0.61,5.98)	0.404
	No	56(17.2%)	270(82.8%)	1		1	
Solid waste disposal	Yes	48(16.4%)	245(83.6%)	0.794(0.42,1.51)	0.482	6.505(2.15,19.72)	0.001
	No	14(13.5%)	90(86.5%)	1			
Water source distance (in meters)	>1000	56(14.9%)	319(85.1%)	1			
	≥1000	6(27.3%)	16(72.7%)	2.14(0.80,5.69)	0.129	1.460(0.32,6.64)	0.908
Amount of water used/day/person (in liters)	<10	49(17.6%)	230(82.4%)	1.72(0.89,3.31)	0.104	1.115(0.52,2.38)	0.779
	≥10	13(11.0%)	105(88.9%)	1		1	
Latrine in use	Yes	46(15.4%)	253(84.6%)	1	0.824		
	No	16(16.3%)	82(83.7%)	0.932(0.50,1.74)			
Latrine distance (in meters)	<10m	10(6.4%)	146(93.6%)	4.23(2.17,8.27)	0.000	3.11(1.17,8.34)	0.024
	≥10m	36(25.2%)	107(74.8%)	1			

children who had no habit of playing with soil. The likelihood of active trachoma among children who were from households that possessed latrines less than 10m from home was 3.12 times (AOR = 3.12, 95% CI: 1.11–8.78) higher as compared to their counterparts. Children who were living in households that had animal dung around the home were 6.98 times (AOR = 6.98, 95% CI: 3.45–48.87) higher than children from households that had no animal dung around the home (Table 5).

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TABLE 5 Bivariate and multivariable analyses of factors associated with active trachoma among children in the non-leprosy settlements in eastern Ethiopia in 2024.

Variables	Category	Active trachoma		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Yes (%)	No (%)				
Monthly income (in birrs)	<5000	17(8.9%)	175(91.1%)	0.794(0.39,1.61)	0.524		
	≥5000	17(10.9%)	139(89.1%)	1			
Family size	<5	11(10.7%)	92(89.3%)	1			
	≥5	23(9.4%)	222(90.6%)	0.867(0.41,1.85)	0.711		
Playing with soil	Yes	27(13.9%)	167(86.1%)	3.395(1.44,8.03)	0.005	9.08(2.92,28.24)	0.000
	No	7(4.5%)	147(95.5%)	1		1	
Face hygiene	Clean	17(8.7%)	179(91.2%)	1			
	Unclean	17(11.2%)	135(88.8%)	1.326(0.65,2.69)	0.435		
Flies on face	Yes	20(12.6%)	138(87.4%)	1.822(0.89,3.4)	0.102	1.237(0.34,4.47)	0.746
	No	14(7.4%)	176(92.6%)	1		1	
Eye discharge	Yes	18(25.4%)	53(74.6%)	5.540(2.66,11.56)	0.000	7.67(5.37,58.05)	0.000
	No	16(5.8%)	261(94.2%)	1		1	
Animal dung	Yes	12(7.6%)	145(92.3%)	0.636(0.30,1.33)	0.229	6.98(3.45,48.87)	0.000
	No	22(11.5%	169(88.5%)	1		1	
Water source distance (in meters)	<1000	29(9.4%)	278(90.6%)	1			
	≥1000	5(12.2%)	36(87.8%)	0.692(0.16,3.05)	0.627		
Amount of water used per day per person	<10L	49(17.6%)	230(82.4%)	0.336(0.16,0.69)	0.003	0.433(0.17,1.12)	0.083
	≥10L	13(11.0%)	105(89.0%)	1		1	
Latrine in use	Yes	28(9.9%)	255(90.1%)	1			
	No	6(9.2%)	59(90.8%)	2.391(0.70,8.08)	0.161	0.223(0.14,4.71)	0.301
Latrine distance (in meters)	<10	25(9.9%)	226(94.6%)	0.547(0.24,1.22)	0.142	3.124(1.11,8.78)	0.031
	≥10	6(17.1%)	29(82.9%)	1		1	
Flies in latrine	Yes	21(13.7%)	132(86.3%)	1.957(0.89,4.32)	0.097	0.511(0.16,1.65)	0.262
	No	10(7.5%)	123(92.5%)	1			

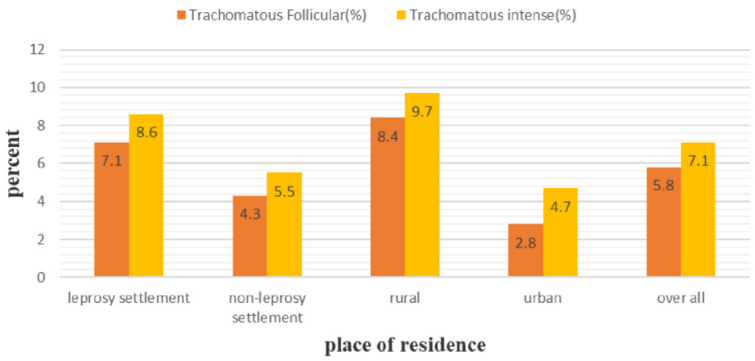

FIGURE 2
Prevalence of trachomatous follicular and trachomatous intense among children aged 1-9 years in the leprosy and non-leprosy settlements in eastern Ethiopia in 2024.

Among the rural children

In the bivariate logistic regression, caregiver's age, family size, child age, female sex, child educational status, habit of sharing clothes, habit of playing with soil, frequency of face wash, use of soap for washing face, face hygiene, eye discharge, nasal discharge, presence of liquid waste, amount of water per day per person, latrine distance, and flies in latrine were found have a p-value less than or equal to 0.25 and were selected as candidates for the final multivariable analysis for the non-leprosy settlements. Factors such as sex of the child, a habit of sharing clothes, face hygiene, eye discharge, presence of liquid waste, and flies in the latrine were significantly associated with the prevalence of active trachoma at a p-value less than 0.05 (Table 6). The likelihood of active trachoma among girls was 2.8 times (AOR=2.88, 95% CI: 1.38-6.03) higher than boys. Children who had discharge in their eyes were 9.26 times (AOR = 9.26, 95% CI: 4.05–21.15) more likely to have active trachoma as compared to those who had no discharge in their eyes. The likelihood of active trachoma among children with an unclean face was 3.3 times (AOR = 3.3, 95% CI: 1.47–7.49) higher than their counterparts. Children who shared clothes were 3.4 times (AOR = 3.44, 95% CI: 1.22–9.77) more likely to have active trachoma than their counterparts. Children who were living in households that had liquid waste around the home were 4.5 times (AOR = 4.46, 95% CI: 1.20–16.61) more likely to have active trachoma compared to children from households who did not. Active trachoma among children who had flies in the latrine was 7.8 times higher than their counterparts (AOR=7.85, 95% CI: 2.40-25.69) (Table 6).

Among the urban children

In the bivariate logistic regression, child age, caregiver's educational status, family size, a habit of sharing clothes, frequency of washing face, face hygiene, flies on child's face, eye discharge, source of energy for cooking, presence of liquid waste, and amount of water per day per person were found to have a p-value less than or

TABLE 6 Bivariate and multivariable analyses of factors associated with active trachoma among rural children in eastern Ethiopia in 2024.

Variables	Category	Active trachoma		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Yes (%)	No (%)				
Caregiver's age (in years)	<35	58(17.5%)	274(82.5%)	0.77(0.37,1.59)	0.142	1.042(0.98,1.10)	0.176
	≥35	11(21.5%)	40(78.4%)	1		1	
Family size	<5	28(14.8%)	161(85.2%)	1		1	
	≥5	41(21.1	153(78.9%)	1.159(1.02,1.32)	0.030	1.058(0.44,2.56)	0.900
Child age (in years)	1-3	19(13.3%)	124(86.7%)	1		1	
	4-9	50(20.8%)	190(79.2%)	1.717(0.97,3.05)	0.065	1.036(0.87,1.23)	0.689
Sex of child	Male	28(15.6%)	152(84.4%)	1		1	
	Female	41(20.2%)	162(79.8%)	1.34(0.81,2.33)	0.239	2.855(1.38,6.03)	0.008
Sharing clothes	Yes	62(20.5%)	241(79.5%)	2.683(1.18,6.12)	0.019	3.449(1.22,9.77)	0.020
	No	7(8.8%)	73(91.2%)	1		1	
Playing with soil	Yes	62(19.4%)	257(80.6%)	1.96(1.48,16.02)	0.009	3.210(0.809,12.3)	0.097
	No	7(10.9%)	57(89.1%)	1		1	
Frequency of face wash	Once	32(13.9%)	198(86.1%)	0.502(0.29,0.85)	0.010	0.952(0.55,1.64)	0.860
	Twice/three	37(24.2%)	116(75.8%)	1		1	
Use of soap for face wash	Yes	26(30.9%)	58(69.1%)	1		1	
	No	43(14.4%)	256(85.6%)	2.669(1.52,4.69)	0.001	1.277(0.58,2.82)	0.545
Face hygiene	Clean	40(15.6%)	216(84.4%)	1		1	
	Unclean	29(22.8%)	98(77.2%)	1.59(0.94,2.73)	0.086	3.327(1.48,7.49)	0.004
Flies on face	Yes	51(18.6%)	222(81.4%)	1.174(0.65,2.12)	0.594		
	No	18(16.4%)	92(83.6%)	1			
Eye discharge	Yes	40(30.3%)	92(69.7%)	2.22(1.95,5.69)	0.000	9.265(4.05,21.15)	0.000
	No	29(11.6%)	222(88.4%)	1		1	

(Continued)

TABLE 6 Continued

Variables	Category	Active trachoma		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Yes (%)	No (%)				
Nasal discharge	Yes	24(12.1%)	174(8.9%)	0.429(0.25,0.74)	0.002	0.966(0.38,2.43)	0.941
	No	45(24.3%)	140(75.7%)	1		1	
Liquid waste disposal	Yes	7(10.3%)	61(89.7%)	0.468(0.20,1.07)	0.073	4.466(1.20,16.61)	0.026
	No	62(19.6%)	253(80.4%)	1		1	
Latrine distance (in meters)	<10	19(11.3%)	149(88.6%)	0.34(0.18,0.63)	0.001	1.001(0.93,1.07)	0.973
	≥10	32(27.5%)	84(72.4%)	1		1	
Flies in latrine	Yes	43(16.3%)	221(83.7%)	0.292(0.11,0.75)	0.011	7.855(2.40,25.69)	0.001
	No	8(40%)	12(60%	1		1	

equal to 0.25 and were selected as candidates for the final multivariable analysis for the non-leprosy settlements. Thus, a habit of sharing clothes, eye discharge, and the presence of liquid waste were significantly associated with the prevalence of active trachoma at a p-value less than 0.05 (Table 7). Children who shared clothes were 4.6 times (AOR = 4.60, 95% CI: 1.60–13.17) more likely to have active trachoma than children who did not share clothes. The likelihood of active trachoma among children with eye discharge was 8.6 times (AOR = 8.56, 95% CI: 4.62– 333 74.57) higher than that of children with no discharge from their eyes. Children who were living in households that had liquid waste around the home were 2.9 (AOR = 2.98, 95% CI: 1.53–11.09) times more likely to have active trachoma compared to children from households that had no liquid waste around the homes (Table 7).

TABLE 7 Bivariate and multivariable analyses of factors associated with active trachoma among urban children in eastern Ethiopia in 2024.

Variables	Category	Active trachoma		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Yes (%)	No (%)				
Caregiver's age (in years)	<35	21(7.3%)	266(92.7%)	0.482(0.14,1.65)	0.244	1.019(0.96,1.07)	0.518
	≥35	6(8.3%)	66(91.7%)	1		1	
Caregiver's educational status	No formal education	11(10.6%)	92(89.4%)	1.816(0.82,4.06)	0.146	0.832(0.29,2.33)	0.726
	Formal education	16(6.2%)	243(93.8%)	1		1	
Family size	<5	15(5.7%)	250(94.3%)	1		1	
	≥5	12(12.4%)	85(87.6%)	2.353(1.06,5.23)	0.036	0.805(0.29,2.23)	0.676
Sharing clothes	Yes	22(10.9%)	179(89.1%)	3.835(1.42,10.36)	0.008	4.603(1.61,13.17)	0.004
	No	5(3.1%)	15696.9%)	1		1	
Face hygiene	Clean	11(11.6%)	84(88.4%)	1		1	
	Unclean	16(5.9%)	251(94.1%)	0.758(0.49,1.17)	0.207	0.438(0.09,2.13)	0.306
Flies on face	Yes	10(10.1%)	89(89.9%)	1.626(0.72,3.68)	0.244	3.475(0.72,16.77)	0.121
	No	17(6.5%)	246(94.5%)	1		1	
Eye discharge	Yes	11(21.2%)	41(78.8%)	4.930(2.14,11.35)	0.000	8.568(4.62,74.57)	0.000
	No	16(5.2%)	294(94.8%)	1		1	
Source of energy for cooking	Wood	19(10.7%)	159(89.3%)	4.222(2.00,8.88)	0.000	0.848(0.50,1.44)	0.541
	Electric	8(4.3%)	176(95.7%	1		1	
Liquid waste disposal	Yes	6(7.0%)	66(93%)	0.157(0.02,1.17)	0.072	2.984(1.53,11.09)	0.019

(Continued)

TABLE 7 Continued

Variables	Category	Active trachoma		COR (95% CI)	P-value	AOR (95% CI)	P-value
		Yes (%)	No (%)				
	No	21(7.2%)	269(92.8%)	1		1	
Water source distance	<1000m	21(6.0%)	327(94%)	1			
	≥1000m	6(42.8%)	8(57.2%)	11.678(5.34,16.28)	0.946		
Amount of water used per day per person	<10L	8(17%)	39(83%)	3.196(0.84,2.04)	0.112	0.995(0.97,1.02)	0.701
	≥10L	19(6%)	296(94%)	1		1	
Flies in latrine	Yes	19(11.4%)	147(88.6%)	1.470(0.59,3.66)	0.407		
	No	8(5.7%)	133(94.3%)	1			

Discussion

Trachoma is an NTD caused by infection with conjunctival strains of *C. trachomatis* and is the leading cause of preventable blindness worldwide. This study aimed to assess the prevalence and associated factors of active trachoma among children aged from 1-9 years in previous leprosy and non-leprosy settlement areas. In this study, the overall prevalence of active trachoma was 12.9% (95% CI: 10.5%, 15.3%), with 15.6% in the leprosy settlements and 9.8% in the non-leprosy settlements. In addition, the prevalence of active trachoma among rural and urban children was 18.3% and 7.5%, respectively. Factors such as being a rural resident; household with low monthly income; being female; the presence of solid waste, liquid waste, and animal dung around their home; toilet distance from home; the presence of flies in the toilet; a habit of playing with soil; a habit of sharing clothes; facial hygiene; and eye discharge were statistically associated with active trachoma.

In this study, the overall prevalence of active trachoma was 12.9%. This is in line with the finding in the Metema District (11.8%) (23). However, this study's finding is lower than the previous findings reported in the Lare District, Southwest Zone (21.6%) (29), Deguatemben, Tigray (21.5%) (30), Tigray Region (26.1%) (3), Ebinat District, South Gondar Zone (36.1%) (31), Ethiopia (24%) (7), South Sudan (63.3%) (32), and the Sagar District, Madhya Pradesh, India (16.36%) (33). This difference might be due to better accessibility to health facilities and religious-based personal hygiene practices in this study area (34). However, the findings of this study were higher than the WHO threshold for the elimination of active trachoma and also the findings of studies conducted in the Dangila District (6.1%) (35), Dire Dawa (4.3%) (34), the Brazilian state of Roraima (4.5%) (36), Brazil (3.4%) (37), Dholpur state in India (2.1%) (38), India (6.8%) (39), China (5.2%) (40), Nepal (4.3%) (41), Kwara State in Nigeria (1.3%) (42), and Sana, Yemen (9.1%) (43). This could be attributed to the difference in the implementation of the Surgery for trichiasis, antibiotics for active disease, facial hygiene, and environmental improvement (SAFE) strategy, study setting, study period, and age of study population (44, 45). Although the WHO recommends a reduction of TF cases to less than 5% among children aged 1–9 years to eliminate blinding trachoma, the prevalence of active trachoma in the leprosy and non-leprosy settlements in this study was 15.6% and 9.8%, respectively. This difference was statistically significant (x^2=5.65, p-value = 0.017). This could be explained by poorer quality of life in the leprosarium group than the general population (46). The results of this study show that living in a leprosy settlement as a rural resident was strongly linked to having active trachoma. This may be due to the NTDs (trachoma and leprosy in this case) being associated with poverty, which can attributed to the inequity in access to preventive chemotherapy and morbidity management, stigma and discrimination, poor housing conditions, and low socioeconomic status of the community residing in the leprosy settlement (44, 47–49).

The current study found that prevalence of active trachoma was 18.3% and 7.5% among children in rural and urban areas, respectively. There were statistically significant differences in the prevalence of active trachoma between the rural and urban children (x^2=18.47, p-value = 0.000). This could be explained in the rural area by poor access to clean water sources (leading to reliance on unsafe water from rivers, ponds, or unprotected wells), inadequate water supply (individuals may prioritize water for drinking and cooking over personal hygiene activities such as face washing), lack of access to latrines or inadequate sanitation facilities, and poorer housing conditions in rural households (50, 51).

In both the leprosy and non-leprosy settlements, a latrine distance of less than 10 m from the home was significantly associated with the risk of trachoma. This finding is similar to other studies conducted in the Zala District, Gamo Gofa Zone (19) and the Ebinat District, South Gonder Zone (31), in Ethiopia. This might be due to the proximity of latrines to homes influencing community sanitation practices and overall cleanliness. If latrines are close but not well maintained or utilized correctly, this could contribute to a higher prevalence of active trachoma due to the persistence of unsanitary conditions in the surrounding area (52). In this study, eye discharge was significantly associated with active trachoma in both settings, indicating that the infected discharge from the nose and eye transmitted infection via fingers, flies, or fomites (44) and through direct contact with nasal and ocular secretions. This finding is in line with studies conducted in the Dera District (53) and Dangila District (35).

In this study, having a family monthly income of less than 5,000 Ethiopian birr was significantly associated with the occurrence of active trachoma among children in the leprosy settlements. This

finding is congruent with other similar studies conducted in the Dire Dawa (34), Gondar (54), and Harari regions (16). This could be due to the fact that economic constraints among the leprosarium community may impact a family's ability to afford basic hygiene and sanitation resources, such as clean water, soap, and sanitation facilities (34).

In this study, having solid waste around the home was significantly associated with the prevalence of active trachoma among children in the leprosy settlements. This is explained by the fact that disposing of solid waste in an open field attracts a high number of eye-seeking flies, which leads to a high chance of transmission of active trachoma among children (55).

This finding is in line with the findings of studies conducted in Arba Minch (56), Lemo District, southern Ethiopia (29) and Gondar Zuria District, North Gondar (54).

In this study, having animal dung in their living compound was significantly associated with active trachoma among children in the non-leprosy settlements. This result is in line with a study conducted in Arba Minch (56). It is possible that this association results from children being exposed to more flies, which breed in exposed animal and human feces, and can spread trachoma (57). In this study, having a habit of playing in soil was significantly associated with the occurrence of active trachoma among children in the non-leprosy settlements. This is explained by the fact that when children play in soil and touch their faces, particularly their eyes or nose, they can introduce the pathogens into their mucous membranes, increasing the risk of infection.

This study showed that having an unclean face was significantly associated with active trachoma among rural children. This is in line with the findings of a study done in Arba Minch (56). A possible explanation is that unclean faces attract eye-seeking flies (*Musca sorbens)*, which are potential mechanical vectors of *C.trachomatis* infections (57). In this study, having a habit of sharing clothes was significantly associated with active trachoma. The primary ways that trachoma is transmitted is through direct contact with secretions from the eyes, nose, and throat; however, sharing towels, handkerchiefs, or clothing can also result in direct contact which could be the explanation for the above finding (44).

In this study, liquid waste around the home was significantly associated with the prevalence of active trachoma among the rural and urban children. This result is the same as a study in the Dambia District, Northwest Ethiopia (24). A potential reason for this is that improper garbage disposal practices create an environment conducive to fly reproduction. This study revealed that the presence of flies in the toilet was significantly associated with the occurrence of active trachoma among rural children. This finding in line with the findings of studies in the Wadla District, northern Ethiopia (58) and Dire Dawa (34). This could be because flies are attracted to decaying organic matter, including feces, and their presence in and around toilets can facilitate trachoma transmission (59). In this study, being female was significantly associated with the prevalence of active trachoma among rural children. It is clear that regardless of age, women have a higher likelihood of having trachomatous trichiasis by adulthood than men (60, 61). The differences in risk of infection between girls and boys are similar to those between adult women and men. This could be explained by the proximity of women and girls to children, which exposes them to more repeated infections than men (61).

The strength of this study is that it was conducted in leprosy and non-leprosy settlement areas. Furthermore, it considered both urban and rural children. However, the study might have some limitations; the cross-sectional nature of study design does not confirm a definitive cause-and-effect relationship. In addition, a bacteriological laboratory test was not used for confirmation of clinical diagnoses. There are also some limitations related to the diagnostic tools such as the magnifying lens. While magnifying lenses can be helpful for basic eye examinations, they are limited in magnification, illumination, field of view, and specialized features. Even though the data collectors were trained prior to data collection, there is observation or interpretation bias.

Conclusions

This study investigated the prevalence of active trachoma and its associated factors among children between 1 and 9 years old who were living in previously identified leprosy settlements and non-leprosy settlements. The findings revealed that the prevalence of active trachoma was 12.9%. This finding was higher than the WHO threshold (<5%) for the elimination of active trachoma in every district. According to this study, children living in the leprosy settlements had a higher prevalence of active trachoma than children living in the non-leprosy settlements. In addition to this, the children in the rural areas had a higher prevalence of active trachoma than the children in the urban areas. The study further revealed factors such as place of residence, presence of liquid waste, toilet distance less than 10m from the home, and eye discharge were factors that increased the occurrence of active trachoma in both settlements. Community-based behavioral change campaigns to promote hygienic practices; discourage the sharing of clothes; raise awareness of the risks of playing with soil, exposure to animal dung, and inappropriate latrine utilization should be enacted. This study provides an insight into the districts that require targeted drug distribution campaigns with appropriate eye ointment or antibiotics.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by The Institutional Health Research Ethics Review Committee at Haramaya University College of Health and Medical Science were granted ethical approval (IHRERC) (Reference number: IHRERC/185/2023). Permission letter was obtained from Amir Nur District and Babble District administrative offices. The interview and clinical eye examination of the chosen children were taking place

in the presence of the children's caregivers after the signed informed voluntary assent was found. Their names and other personal identifiers were not registered to maintain confidentiality. The study's goals, as well as the rights and advantages of study participants, were explained. Individuals with positive for sign of active trachoma was linked to nearby health facilities. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

FW: Data curation, Formal Analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing, Conceptualization, Investigation. MG: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing, Funding acquisition, Project administration, Resources, Writing – original draft. GK: Conceptualization, Data curation, Formal Analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing. AD: Conceptualization, Data curation, Formal Analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing. SM: Data curation, Formal Analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – review & editing. TR: Conceptualization, Formal Analysis, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – review & editing. UU: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – review & editing. KU: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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