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Prevalence of active trachoma among 1–9 years of age children in Ethiopia: a systematic review and meta-analysis

Yordanos Sisay Asgedom ,[1] Tsegaye Melaku ,[2] Amanuel Yosef Gebrekidan ,[3] Mengistu Meskele,[3] Gedeon Asnake ,[4] Afework Alemu ,[5] Amelework Gonfa Efa,[6] Kirubel Eshetu Haile,[7] Gizachew Ambaw Kassie[8]

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For numbered affiliations see end of article.

Correspondence to
Dr Yordanos Sisay Asgedom; yordusisay@gmail.com

ABSTRACT

Objective The objective of this study is to determine the pooled prevalence of active trachoma among 1–9 years old children in Ethiopia.

Design A systematic review and meta-analysis were employed in accordance with the Preferred Reporting Items for Systematic Reviews.

Data sources Medline/PubMed, Scopus, Web of Science, African Journal of Online and Google scholar databases were systematically explored to find studies published in English until July 2023.

Eligibility criteria The following criteria apply: (1) condition (Co): studies examined the prevalence of trachoma among children (1–9) years old; (2) context (Co): studies conducted in Ethiopia; (3) population (Pop): studies that were done among children (1–9) years old; (4) study type: observational studies and (5) language: studies published in English.

Data extraction and synthesis The data were extracted using a Microsoft Excel spreadsheet. DerSimonian-Laird random effect model was used to estimate the pooled prevalence of active trachoma among 1–9 years old children. Cochrane Q-tests and I^2 statistics were used across studies to assess heterogeneity. To identify possible publication bias, Egger's test was performed.

Primary outcome Prevalence of active trachoma among children aged (1-9 years old)".

Results Overall, a total of 42 articles with 235 005 study participants were included in the final analysis. The estimated pooled prevalence of active trachoma using random effect model was 24% (95% CI 20% to 27%). The subgroup analysis by region revealed that the highest prevalence of trachoma was 36% (95% CI 13% to 58%) in the Tigray region, and publication year revealed the prevalence of trachoma was decreasing from 32% to 19% after 2015.

Conclusion In this review, the pooled prevalence of active trachoma was found to be high in Ethiopia compared with WHO threshold level. This underscores the need for increased focus on high-risk age groups to decrease trachoma and to achieve the elimination of trachoma from the country by 2030.

STRENGTH AND LIMITATIONS OF THIS STUDY

⇒ It follows the recommended updated Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.
⇒ We also rigorously searched the literature in different databases and identified eligible studies.
⇒ One limitation of this systematic review and meta-analysis is that it only includes cross-sectional studies that report the proportion of trachoma cases.
⇒ This review has not assessed associated factors.

INTRODUCTION

Globally, trachoma is the leading infectious cause of blindness. Trachoma has been named one of 20 neglected tropical diseases (NTDs) by the WHO.[1 2] Children are the primary reservoirs of infection. Children aged 1–9 years are more likely to have an active trachoma.[3] Due to their tendency for close contact with others, children are frequently infected with *Chlamydia trachomatis*.[4]

The poorest of the poor are primarily affected by trachoma.[5] The WHO 2021 report shows that trachoma is responsible for 1.9 million people with blindness and visual impairment; moreover, approximately 125 million people live in trachoma-endemic areas worldwide.[1] Around 3.8 million cases of blinding trachoma and 27.8 million cases of active trachoma have been reported in Africa, which is one of the most affected continents.[6] Ethiopia has the world's highest trachoma burden, with 76.2 million people living in endemic areas at risk of contracting the disease. Among Ethiopian children, active trachoma is ranged from 10.3%[7] to 74.3%.[8] For children aged 1–9 years living in endemic areas, the prevalence of trachomatous inflammation-follicular (TF) <5% is the elimination target set by WHO. However, the prevalence in Ethiopian children is higher than the target. If TF is ≥5% among children aged 1–9 years, a Surgery for Trichiasis, Antibiotics, Face Washing and Environmental

improvement strategy (SAFE) strategy which includes Antibiotics, Face washing, and Environmental Improvement (A, F, and E) is recommended.[9] Globally, an estimated US$8 billion in annual product loss is attributed to this disease.[1]

Direct personal contact such as shared towels, flies, clothes and fingers that interact with the infected person's eyes or nose is known for transmission of trachoma infection. The scarcity of safe drinking water access and sanitation systems has spread *C. trachomatis* infections. Corneal scarring and eyelid deformities can occur after inflammation and recurrent infections; if not treated, eyelid inversion (entropion) and the lashes turning inward (trichiasis) occur as late complications. Trichiasis and permanent damage to the cornea frequently result in irreversible blindness.[1]

Eliminating trachoma by 2020 through the implementation of the SAFE strategy (surgery for in-turned eyelashes, antibiotics to clear the infection, and facial cleanliness and environmental improvement to reduce infection transmission) was set by the WHO and other concerned organisations.[1] Ethiopia intended to eliminate trachoma through the SAFE strategy by implementing a national trachoma action plan in 2012 and a second master plan for 2016 to 2020.[10 11] Despite significant development, trachoma elimination was not met by December 2020 and it was pushed back to 2030 to align with the sustainable development goals.[1]

Despite the fact that numerous studies have been conducted in Ethiopian children (1–9 years) to assess the prevalence of trachoma and systematic review and meta-analysis in 2019,[12] our reason for undergoing this systematic review and meta-analysis is that many studies have been published since then, and our study aimed to address specific stastistical limitations in the previous studies. As a result, this study aimed to deliver a comprehensive updated nationwide prevalence of trachoma infection among children and geographical locations and to assess the ongoing preventive and control measures impact in the country.

Furthermore, the government and other concerned bodies may contribute by focusing on preventive measures such as improving access to water and sanitation, specifically in areas of high trachoma infection prevalence.

Research question

What is the pooled prevalence of trachoma infection among children (1–9 years old) in Ethiopia?

METHODS

Reporting

We performed our analyses according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[13] The article screening was based on the PRISMA 2020 statement, and the selection process has been shown using a PRISMA P flow diagram. The finding is presented using the standard PRISMA checklist (online supplemental table 1). The review protocol is not registered in PROSPERO.

Search strategy and study identification

To estimate the prevalence of trachoma among children (1–9) years old in Ethiopia, a systematic review and meta-analysis were performed. After an initial exploration of Google Scholar, Medline and SCOPUS with limited parameters, a follow-up search was conducted using all identified keywords and index terms across several databases, including Medline, PubMed, SCOPUS, Web of Science and African Journal Online (AJOL). All studies conducted on trachoma prevalence among children in Ethiopia were retrieved. The search included all articles published from database inception to 31 July 2023. English-language studies were only searched. Medical subject headings (((((“Magnitude”) OR “prevalence” OR “burden”) AND “Trachoma”) OR “Eye infection” OR “Trachomatous intense” OR “Trachomatous follicular”)) AND Ethiopia) were used in various combinations as the primary search keywords (online supplemental table 2). During the systematic review and meta-analysis, we followed the PRISMA guidelines.[13]

Eligibility criteria

We used the condition, context and population (CoCoPop) framework for the search and meta-analysis of eligibility criteria.

Inclusion criteria

The following criteria were used to include studies in this systematic review and meta-analysis.

- Condition (Co): we include studies that examine the prevalence of trachoma among children (1–9) years old.
- Context (Co): studies conducted in Ethiopia were included.
- Population (Pop): studies that were done among children (1–9 years).
- Study type: observational studies.
- Language: studies published in English were included.

Exclusion criteria

We excluded studies other than children (1–9 years) as well as those with different outcomes of interest, qualitative studies, case reports, case series, review papers, conference proceedings and abstracts.

Outcome measurement

This study aimed to gather and analyse data from various studies conducted in Ethiopia to determine the pooled prevalence of trachoma among children aged 1–9 years. We used a systematic approach to identify the relevant studies and extract data from them. Then, we employ statistical methods to combine the data from different studies to estimate the overall pooled prevalence of trachoma among children (1–9 years old) in Ethiopia. The prevalence of trachoma, defined here as TF or trachomatous inflammation intense, among children

was the major outcome of this review. We calculated the prevalence of trachoma in children by adjusting for the proportion of each age group (1-year increments) with active trachoma (TF) based on the local population distribution of 1–9 years old from the latest census data.

Data extraction and quality assessment

The Endnote citation manager (V.X8, for Windows, Thomson Reuters, Philadelphia, Pennsylvania, USA) was used to import the retrieved studies, and then duplicates were removed. Two independent reviewers screened all the articles for eligibility criteria. The reviewers began by screening the abstracts and titles, followed by full-text screening. The quality of the articles was assessed using the Newcastle-Ottawa Quality Assessment Scale (adapted for cross-sectional studies).[14] Disagreements were resolved by a third investigator. The articles were critically appraised by the following criteria from the tool: representativeness of the sample (one score maximum), sample size (one score maximum), non-respondent (one score maximum), ascertainment of exposure (two score maximum), comparability of outcome based on study design (two score maximum), outcome assessment (two score maximum) and statistical analysis (one score maximum). All the included studies assessed through the tool with a score of ≥5 were included in this systematic review and meta-analysis (online supplemental table 3). After quality rating, no study was dismissed. During our quality assessment, 19 studies score 8, 17 studies score 7, 5 studies score 9 and 1 study score 6 out of 10. Overall, the distribution of scores in the quality assessment indicates that the majority of studies were of good-to-high quality, with only a few studies showing lower scores. Two investigators used a standardised extraction format prepared in Microsoft Excel. The excel spreadsheet includes the name of the first author, publication year, study design, region, study area, gender, sample size, number of cases and trachoma prevalence.

Statistical analysis

Data were extracted in Microsoft Excel format and analysed using STATA software V.16.0 (Stata Corp., LLC, Texas, USA). We used forest plots to report the estimated pooled prevalence of the study with a CI to provide a visual summary of the data. Effect sizes were expressed as a proportion with 95% CI around the summary estimate. The data were first presented using a narrative synthesis of the included studies. We assumed no, low, medium and high heterogeneity across studies if the I^2 values were 0%, 25%, 50% and 75%, respectively. A meta-analysis using a random effects model was performed to analyse the pooled prevalence with 95% CIs since significant heterogeneity was detected between studies. The heterogeneity of each outcome measure was assessed using both X^2 and I^2 statistics to determine dispersion. A metaregression analysis was performed to investigate the source of heterogeneity. A funnel plot and Egger's regression test were conducted to assess publication bias. In addition, a leave-one-out sensitivity analysis was performed to evaluate the small study effect by excluding each study one at a time. The analysis was performed to assess the effect of each study on the pooled prevalence of trachoma, and subgroup analysis was performed to ensure consistency of the pooled results. Statistical significance was considered at $p < 0.05$.

Patient and public involvement

The public or patient was not involved in the design, conduct, reporting or dissemination plans of this review.

RESULTS

Search results

Our searching strategy initially identified 453 articles, and 340 duplicates were excluded by using the endnotes citation manager. Finally, 68 studies were further excluded after reviewing the title and abstract, and then the full text of 45 articles was reviewed for the necessary criteria. Excluding three articles as they were not reported outcomes of interest, finally, 42 studies that fulfilled the inclusion criteria were considered for the final analysis to estimate the overall pooled prevalence of trachoma among children (1–9 years) in Ethiopia. Figure 1 illustrates the process of the literature review, screening and eligibility assessment of the study articles.

Included studies characteristics

A total of 42 cross-sectional studies (235 006 children) were included in this systematic review and meta-analysis (online supplemental table 4). The spanned publication period was from 2005 to 2023. The sample size of the included studies ranges from 178[15] to 62 869.[16] With regard to study sites, 16 of the primary studies included from the Amhara region,[2 16–30] 9 from the SNNPR region[31–39] and 6 studies were included from Oromia,[15 40–42] and 3 from Tigray,[43–45] respectively. However, one study each reported from Afar,[46] Somali,[47] Harari,[48] Diredawa,[8] Gambela,[49] BenshangulGumuz[50] and nationwide[51] (table 1).

The pooled prevalence estimates of trachoma among children in Ethiopia

The pooled prevalence of trachoma among children (1–9 years old) in Ethiopia was identified in 42 studies. Of a total of 235 006 children, 45 711 were infected with trachoma. Statistically significant heterogeneity was observed (I^2=99.8%; $p < 0.0001$). We used a random effect model to estimate the pooled prevalence of trachoma among children (1–9 years), which was 24.1% (95% CI 20.67% to 27.40%) (figure 2).

Subgroup analysis

To identify the potential source of heterogeneity, a subgroup analysis was executed based on the study area (region) and publication year. Based on the subgroup analysis by the study, in the region of Ethiopia, the highest prevalence of trachoma was reported in Tigray at 35.81 (95% CI 13.84 to 57.78), followed by SNNP at

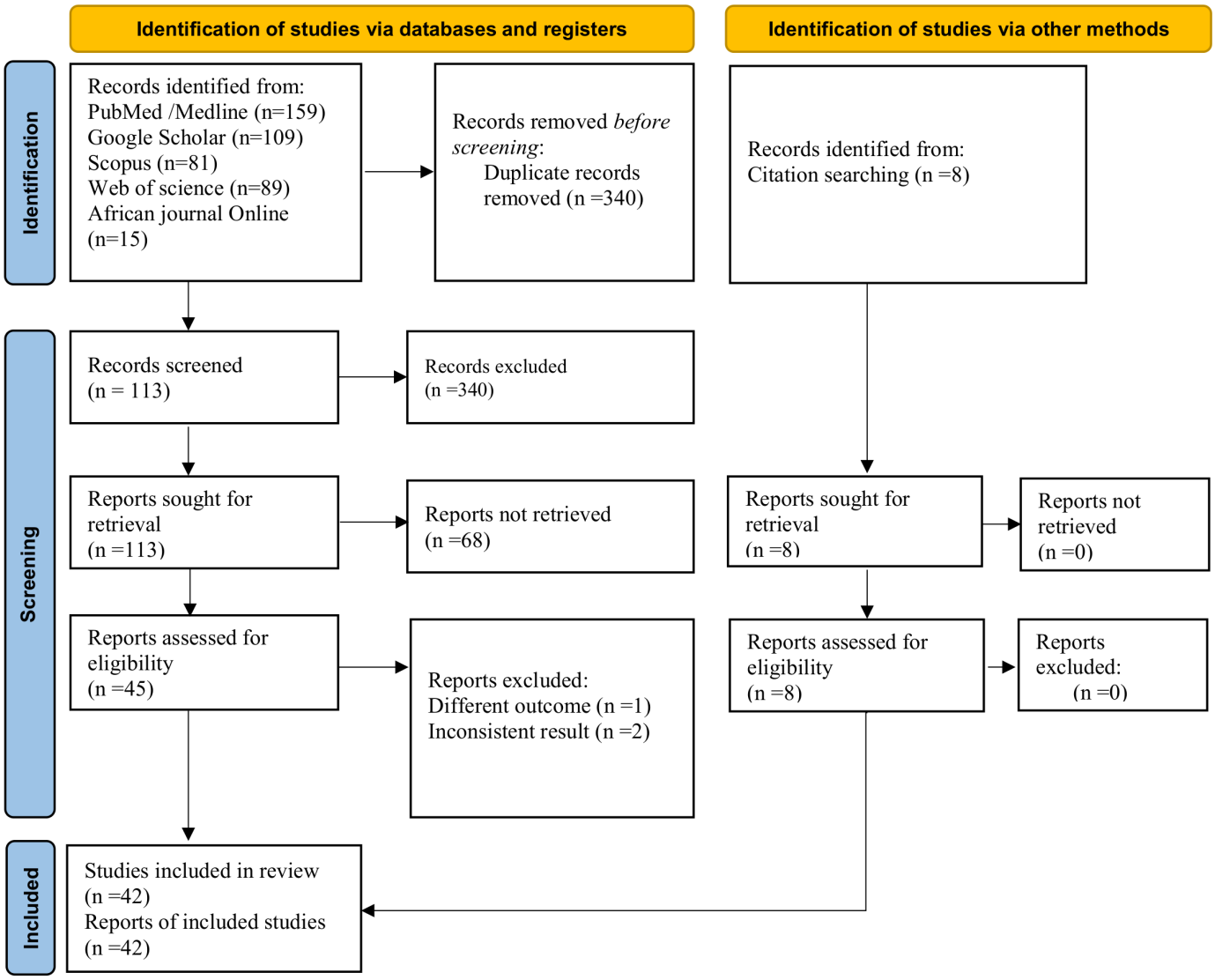

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of screened articles and the selection process of studies on pooled prevalence of trachoma infection among 1–9 years of age children in Ethiopia 2023.

28.98 (20.14 to 37.82). Subgroup analysis by publication year was performed to overlook the trends over 10 years in the pooled prevalence of trachoma among children in Ethiopia. The results of the subgroup analysis revealed a significant difference in the pooled prevalence of trachoma among children, with rates of 32.53% (95% CI 24.32% to 40.76%) before 2015 and 19.93% (95% CI 16.35% to 23.51%) since 2015 (table 2).

Publication bias assessment

The funnel plot was visually inspected to assess potential publication bias, which was statistically supported by Egger's test. The symmetrical distribution of the included publications in a large inverted funnel indicated the absence of a publication bias (online supplemental figure 1). The Egger tests revealed no publication bias among the studies included to estimate the pooled prevalence of trachoma infection among children in Ethiopia, with p values of (p=0.260).

Metaregression

Metaregression was used to identify factors associated with the pooled prevalence of trachoma among children (1–9 years old). For the metaregression, publication year, region and sample size were considered. The analysis revealed a significant correlation between the pooled prevalence of trachoma among children (1–9 years) and publication year (p <0.001) but no significant correlation with sample size or region (online supplemental table 5).

Sensitivity analysis

By excluding each study individually, a leave-out-one sensitivity analysis was used to determine the effect of a single study on the pooled prevalence of trachoma among children (1–9 years) in Ethiopia. Our finding revealed that no single study had a significant impact on the pooled prevalence of trachoma among children (1–9 years) in Ethiopia (figure 3).

Table 1 Summary of 42 included studies on the pooled prevalence of trachoma among 1–9 years of age children in Ethiopia, 2023

Author's	Publication year	Region	Study area	Sample	Male (n)	Female (n)	No of cases (n)	Prevalence %
Abashawl *et al*[49]	2016	Gambela	Region-wide	3238	NA	NA	557	17.2
Adamu *et al*[50]	2016	Benishangul Gumuz	Region-wide	7417	3212	4205	616	8.3
Adera *et al*[31]	2016	SNNP	Region-wide	41 155	NA	NA	11 647	28.3
Admassu *et al*[32]	2013	SNNP	Guragie	768	386	382	175	22.8
Admasu *et al*[33]	2015	SNNP	Dawro	267	113	154	61	22.9
Alambo *et al*[39]	2018	SNNP	Areka	586	317	269	222	37.9
Alemayehu *et al*[60]	2015	Amhara	Dera	671	351	320	105	15.6
Alemayehu *et al*[34]	2005	SNNP	Guragie	2788	NA	NA	1561	56.5
Anteneh *et al*[17]	2016	Amhara	Gazegibela	601	268	333	315	52.4
Asres *et al*[18]	2016	Amhara	Gondar	586	285	301	71	12.1
Assefa *et al*[48]	2017	Harari	Harari	1722	804	918	22	1.3
Belsti *et al*[61]	2021	Southwest	Lare	610	283	327	132	21.6
Bero *et al*[40]	2016	Oromia	Regionwide	41 642	NA	NA	9744	23.4
Brhane *et al*[51]	2007	Nationwide	Nationwide	9289	NA	NA	3725	40.1
Duale *et al*[47]	2018	Somali	Region-wide	23 620	11 462	12 158	3543	15
Ejigu *et al*[62]	2013	Southwest	Kersa	305	154	151	77	25.2
Emerson *et al*[19]	2008	Amhara	Region wide	5485	NA	NA	1794	32.7
Ferede *et al*[20]	2017	Amhara	Dembia	681	NA	NA	121	18.2
Gedefaw *et al*[21]	2013	Amhara	Dangila	409	215	194	49	12
Genet *et al*[22]	2022	Amhara	Dangila	704	337	367	43	6.1
Golovaty *et al*[23]	2009	Amhara	Ankober	507	219	288	275	53.9
Kassahun *et al*[42]	2012	Oromia	Mojo	431	NA	NA	97	22.5
Kedir *et al*[35]	2020	SNNP	Silte	561	279	282	165	29.4
Kemal *et al*[41]	2019	Oromia	Medawalebu	406	215	191	89	22
Kessete *et al*[30]	2021	Amhara	Metema	752	352	400	88	11.8
Ketema *et al*[24]	2012	Amhara	Baso Liben	792	391	401	191	24.1
Mehari *et al*[36]	2014	SNNP	Guragie	735	366	369	47	6.4
Mekonnen *et al*[15]	2022	Oromia	Arsi Negele	178	93	85	39	21.91
Mengistu *et al*[37]	2016	SNNP	Zala	611	286	325	224	36.7
Mesfin *et al*[43]	2006	Tigray	Regionwide	1526	NA	NA	903	59.2
Mesfin *et al*[2]	2005	Amhara	Ebinet	1244	601	643	527	42.4
Mohammed *et al*[8]	2005	Diredawa	Goro	826	438	388	278	33.7
Negash *et al*[46]	2018	Afar	Regionwide	6339	NA	NA	611	9.6
Nigussie *et al*[25]	2015	Amhara	Gonji Kolella	618	353	265	143	23.1
Nigusu *et al*[26]	2022	Amhara	Tarimaber	736	380	356	116	15.8
Oswald *et al*[16]	2017	Amhara	Region wide	62 869	NA	NA	6035	9.6
Reda *et al*[44]	2020	Tigray	Deguatemben	502	257	245	108	21.5
Sadik *et al*[45]	2016	Tigray	Regionwide	10 023	NA	NA	2676	26.7
Shiferaw *et al*[27]	2013	Amhara	Makisegnit	420	209	211	100	23.8
Shimelash *et al*[28]	2022	Amhara	Debretabor	394	70	324	39	9.9
Tadesse *et al*[29]	2017	Amhara	Wollo	1358	638	720	293	21.6
Woldekidan *et al*[38]	2019	SNNP	Lemo	574	NA	NA	87	15.2

NA, Not Applicable ; SNNP, Southern Nation Nationalities and peoples.

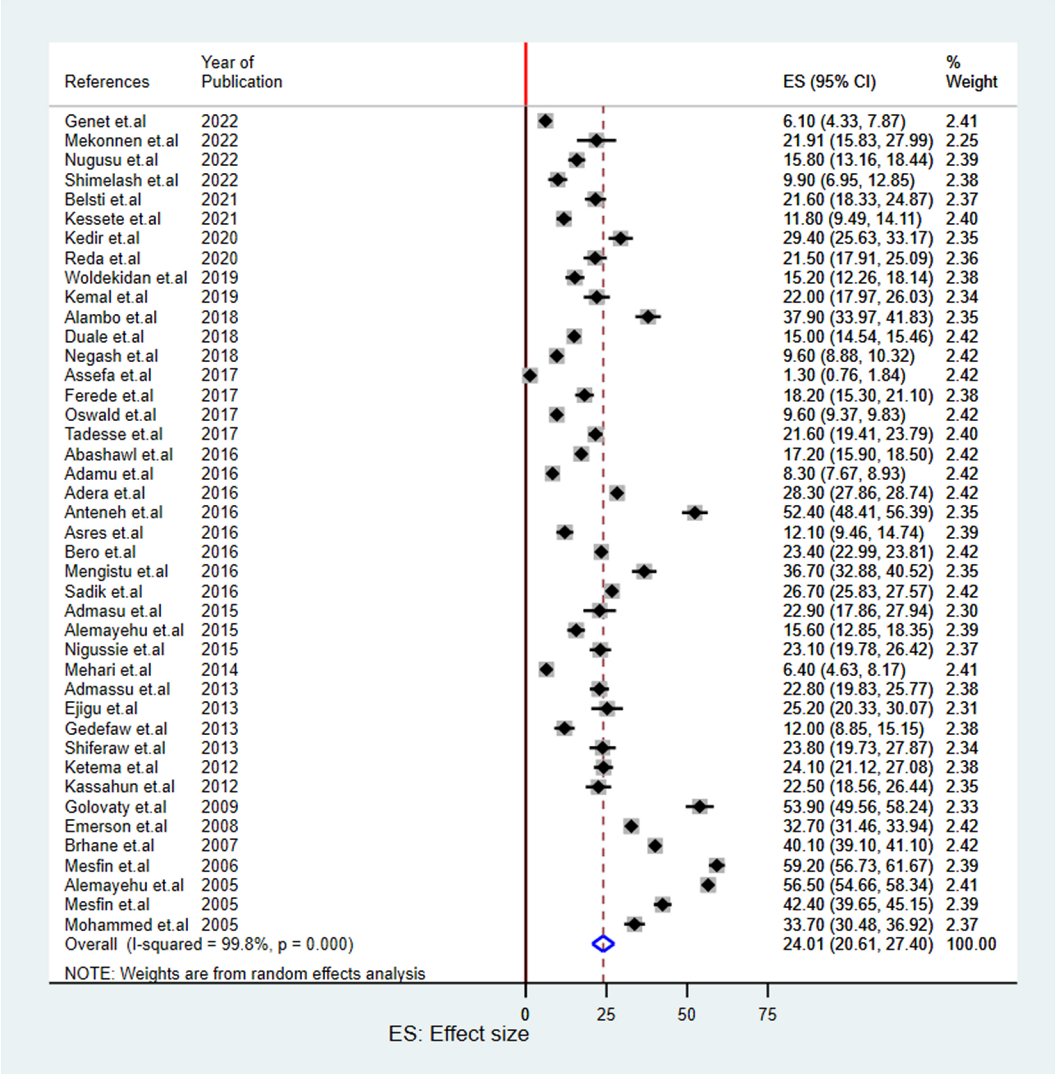

Figure 2 Forest plot depicting pooled prevalence of trachoma among 1–9 years of age children in Ethiopia 2023.

DISCUSSION

The purpose of this systematic review and meta-analysis is to add national data on the prevalence of trachoma infection among Ethiopian children to eliminate the disease. Although different studies from different regions have been published in the country, the data on trachoma

Table 2 Subgroup analysis on the pooled prevalence of trachoma infection among children (1–9 years) in Ethiopia, 2023

Subgroups	Number of studies	Prevalence (95% CI)	I^2	P value
Regions				
Amhara	16	23.02 (16.7 to 29.31)	59.5	0.001
SNNPR	10	28.58 (20.14 to 37.82)	99.5	0.001
Oromia	6	23.36 (22.96 to 23.75)	0.00	0.107
Tigray	3	35.81 (13.84 to 57.78)	59.7	0.100
Others	7	15.29 (7.33 to 23.26)	59.9	0.600
Overall	42	24.01 (20.61 to 27.40)	59.8	0.001
Publication year				
≥2015	28	19.71 (16.27 to 23.15)	99.8	0.001
<2015	14	32.53 (24.31 to 40.76)	99.5	0.001
Overall 42	42	24.01 (20.61 to 27.40)	59.8	0.001

NA, Not Applicable ; SNNPR, South Nation and Nationalities people.

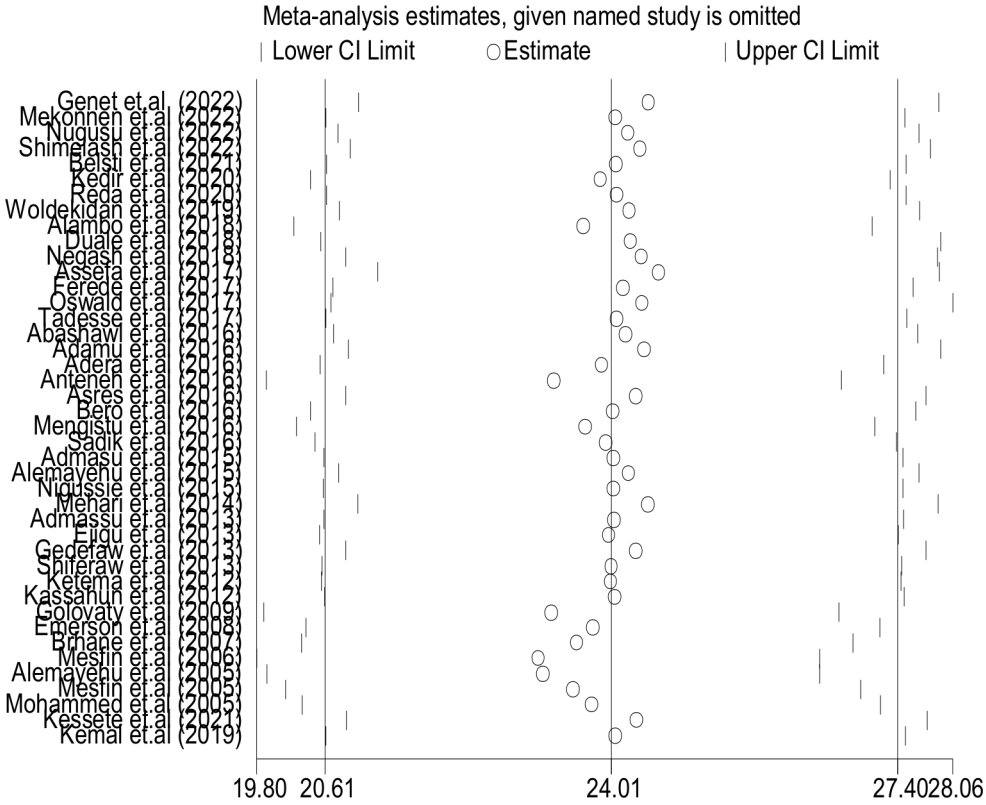

Figure 3 Leave-one sensitivity analysis on the studies included in the pooled prevalence of trachoma among 1–9 years of age children in Ethiopia 2023.

infections have to be organised and updated every time. Therefore, updating the information has the potential to inform and help develop different strategies by targeting highly endemic areas.

The pooled overall prevalence of trachoma (24.01%) observed in the current review is comparable with a study from Colombia,[52] but higher than the study done in the Democratic Republic of Congo,[53] Nigeria,[54] Uganda,[55] Brazil[56] and Kenya.[57] This prevalence is lower than studies from South Sudan[58] and Guinea.[59] The disparity among the findings might be due to environmental factors such as the level of participants' hygiene, sanitation, access to functional latrines, and clear water supply, and recent studies were included in our review that reported an ongoing sustainable water, sanitation, and hygiene (WASH) programme and mass drug administration (MDA) with azithromycin which might reduce trachoma prevalence among children in Ethiopia, unlike the South Sudan study, which lacks MDA and targets SAFE strategy.[58]

The subgroup analysis of this review also shows a statistically significant (p=0.01) difference among regions. Trachoma was highly prevalent in Tigray and SNNP, followed by Oromia and the Amhara regions. Trachoma infection is related to inadequate hygiene, a low standard of living, inadequate access to water and inadequate access to sanitation. In the Tigray region, trachoma prevalence is high, which might also be related to extreme climatic events that favour a decline in water availability during dry periods, which affects personal hygiene. Another reason for the difference is attributed to baseline and intervention disparities in the communities. MDA with azithromycin once a year is needed based on the review findings (24%), and Ethiopia is known to require intervention based on the WHO 2021 report (1).

Though the decline is not statistically significant (p =0.30), our results from this review revealed studies conducted between 2005–2014 and 2015–2022, which show a decrease in the prevalence of trachoma from 32% to 19%. The expansion of MDA and WASH programmes might be attributed to the decrease in prevalence. This review has the implication of revealing the national burden of trachoma infection among children, who are a special population and account for one-third of the national population. Moreover, this large magnitude of trachoma infection shows a significant gap in the implementation of WHO designed and national elimination strategies. Last but not least, from a research perspective, we recommend conducting operational studies on the topic.

Strengths and limitations of the study

The current meta-analysis has several strengths. It provides a comprehensive overview of trachoma among Ethiopian children in accordance with the most recent PRISMA guidelines. We conducted a thorough search of the literature using multiple databases and found eligible studies. Although the meta-analytic techniques used in this study were strong, the results should be interpreted

with caution due to the study's limitations. First, there was significant heterogeneity in trachoma prevalence in Ethiopia. However, this heterogeneity can be attributed to factors such as publication year and sample size. Second, all the included studies were cross-sectional, which, owing to the nature of the study design, makes it challenging to demonstrate a cause-and-effect relationship. Moreover, this systematic review and meta-analysis has not assessed associated factors of trachoma among children in Ethiopia.

Conclusions

An effort has been made to eliminate trachoma infection, which is still highly prevalent across the Ethiopian regions. Even though the decline is not statistically significant, we saw decreased trachoma prevalence in Ethiopian children. Trachoma is highly prevalent in Tigray, followed by SNNPR. Moreover, trachoma remains a significant public health concern among adults in Ethiopia. The prevalence of trachoma in this population is alarmingly high, highlighting the urgent need for continued efforts to improve access to clean WASH practices. Despite the effort made by the country to eliminate trachoma infection, according to the WHO risk classification, it remains a public health problem in the country. The output of this review will offer valuable data to the Ministry of Health, policy-makers and concerned bodies that work on eliminating trachoma infection in the country. Trachoma infection is highly prevalent based on this review, and it underlines the need for improved prevention and control strategies for one of the NTDs in Ethiopia.

Author affiliations
[1]Department of Epidemiology, Wolaita Sodo University, Sodo, Ethiopia
[2]Institute of Health, Jimma University, Jimma, Ethiopia
[3]School of Public Health, Wolaita Sodo University, Sodo, Ethiopia
[4]Midwifery, Hawassa University, Hawassa, Southern Nations, Ethiopia
[5]Department of Medicine, Wolaita Sodo University, Sodo, Ethiopia
[6]Department of Medicine, SNNPR, Sodo, Ethiopia
[7]Department of Nursing, Wolaita Sodo University, Sodo, Ethiopia
[8]Wolaita Sodo University, Sodo, Ethiopia

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Contributors Conceptualisation: YSA, TM and GAK. Data curation: YSA, TM, GAK, MM and AYG. Investigation: YSA, AA and AGE. Methodology: YSA, TM, GAK and KEH. Software and writing: YSA, GAK and TM. Validation: YSA, MM, GAK and AYG. Writing – review and editing: all the authors read and approve the manuscript. YSA: The guarantor accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish. Please indicate in your contributor statement the initials of the author acting as guarantor.

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ORCID iDs
Yordanos Sisay Asgedom http://orcid.org/0000-0001-5226-1200
Tsegaye Melaku http://orcid.org/0000-0001-8373-5309
Amanuel Yosef Gebrekidan http://orcid.org/0000-0003-0960-3759
Gedeon Asnake http://orcid.org/0000-0002-6347-8648
Afework Alemu http://orcid.org/0000-0001-5862-2521

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