Global progress toward the elimination of active trachoma: an analysis of 38 countries

Kristen K Renneker, Mariamo Abdala, James Addy, Tawfik Al-Khatib, Khaled Amer, Mouctar Dieng Badiane, Wilfrid Batcho, Lucienne Bella, Clarisse Bougouma, Victor Bucumi, Tina Chisenga, Tran Minh Dat, Djore Dézoumbé, Balgesa Elshafie, Mackline Garae, André Goepogui, Jaouad Hammou, George Kabona, Boubacar Kadri, Khumbo Kalua, Sarjo Kanyi, Asad Aslam Khan, Benjamin Marfo, Sultani Matendechero, Aboulaye Meite, Abdellahi Minnih, Francis Mugume, Nicholas Olobio, Fatma Juma Omar, Isaac Phiri, Salimato Sanha, Shekhar Sharma, Fikre Seife, Oliver Sokana, Raebwebwe Taoaba, Andeberhan Tesfazion, Lamine Traoré, Naomi Uvon, Georges Yaya, Makoy Yibi Logora, P J Hooper, Paul M Emerson, Jeremiah M Ngondi

Summary

Background Global elimination of trachoma as a public health problem was targeted for 2020. We reviewed progress towards the elimination of active trachoma by country and geographical group.

Methods In this retrospective analysis of national survey and implementation data, all countries ever known to be endemic for trachoma that had either implemented at least one trachoma impact survey shown in the publicly available Trachoma Atlas, or are in Africa were invited to participate in this study. Scale-up was described according to the number of known endemic implementation units and mass drug administration implementation over time. The prevalence of active trachoma—follicular among children aged 1–9 years (TF_{1-9}) from baseline, impact, and surveillance surveys was categorised and used to show programme progress towards reaching the elimination threshold (TF_{1-9} <5%) using dot maps, spaghetti plots, and boxplots.

Findings We included data until Nov 10, 2021, for 38 countries, representing 2097 ever-endemic implementation units. Of these, 1923 (91·7%) have had mass drug administration. Of 1731 implementation units with a trachoma impact survey, the prevalence of TF_{1-9} had reduced by at least 50% in 1465 (84·6%) implementation units and 1182 (56·4%) of 2097 ever-endemic implementation units had reached the elimination threshold. 2 years after reaching a TF_{1-9} prevalence below 5%, most implementation units sustained this target; however, 58 (56·3%) of 103 implementation units in Ethiopia showed recrudescence.

Interpretation Global elimination of trachoma as a public health problem by 2020 was not possible, but this finding masks the great progress achieved. Implementation units in high baseline categories and recrudescent TF_{1-9} might prolong the attainment of elimination of active trachoma. Elimination is delayed but, with an understanding of the patterns and timelines to reaching elimination targets and a commitment toward meeting future targets, global elimination can still be achieved by 2030.

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International Trachoma Initiative, The Task Force for Global Health, Decatur, GA, USA (K K Renneker MPH, P J Hooper MA, P M Emerson PhD); **Mozambique Ministry of Health, Maputo, Mozambique** (M Abdala MD); **Ghana Ministry of Health, Accra, Ghana** (J Addy MD, B Marfo MPH); **Yemen Ministry of Health, Sana'a, Yemen** (T Al-Khatib MBBS); **Egypt Ministry of Health, Cairo, Egypt** (K Amer MD); **Senegal Ministry of Health, Dakar, Senegal** (M D Badiane MD); **Benin Ministry of Health, Porto Nova, Benin** (W Batcho MBA); **Cameroon Ministry of Health, Yaounde, Cameroon** (L Bella MD); **Burkina Faso Ministry of Health, Ouagadougou, Burkina Faso** (C Bougouma MPH); **Burundi Ministry of Health, Bujumbura, Burundi** (V Bucumi PhD); **Zambia Ministry of Health, Lusaka, Zambia** (T Chisenga MD); **Vietnam Ministry of Health, Hanoi, Vietnam** (T M Dat MD); **Chad Ministry of Health, N'Djamena, Chad** (D Dézoumbé MD); **Sudan Ministry of Health, Khartoum, Sudan** (B Elshafie MD); **Vanuatu Ministry of Health, Port Vila, Vanuatu** (M Garae Cert—Business Admin); **Guinea Ministry of Health, Conakry, Guinea** (A Goepogui CES Opthamalogie); **Morocco Ministry of Health, Rabat, Morocco** (J Hammou MD); **Tanzania Ministry of Health, Dodoma, Tanzania** (G Kabona MD); **Niger Ministry of Health, Niamey, Niger** (B Kadri MD); **Malawi Ministry of Health, Lilongwe, Malawi** (K Kalua PhD); **The Gambia Ministry of Health, Banjul, The Gambia** (S Kanyi MSc-CEH);

Introduction

Trachoma, the world's leading infectious cause of blindness, is caused by chronic conjunctival infection by *Chlamydia trachomatis*. The surgery, antibiotic, facial cleanliness, and environmental improvement (SAFE) strategy is used for the control of trachoma.[1] The antibiotic component is achieved through mass drug administration of azithromycin in implementation units with a prevalence of active trachoma (defined as trachomatous inflammation—follicular among children aged 1–9 years [TF_{1-9}]) of at least 5%.[1] WHO recommends at least three annual rounds of mass drug administration before a trachoma impact survey when baseline TF_{1-9} is 10–29% and at least five annual rounds of mass drug administration before a trachoma impact survey when baseline TF_{1-9} is 30% or greater.[2] Additionally, country programmes might also choose to treat areas with a baseline TF_{1-9} of 5–9% with one round of mass drug administration,[3] and areas with a baseline TF_{1-9} of 50% or greater with seven rounds of mass drug administration before a trachoma impact survey.[4] To monitor for recrudescence, trachoma surveillance surveys should be done in formerly endemic implementation units at least 2 years after the TF_{1-9} prevalence is below 5% and no additional rounds of mass drug administration have taken place.[3] In 1996, WHO launched the WHO Alliance for the Global Elimination of Trachoma by 2020 (GET2020).[5] A major goal of GET2020 was the reduction of TF_{1-9} to below 5% in every formerly endemic implementation unit worldwide; this target was chosen by WHO as a proxy, believed to equate to no vision loss from trachoma, thus achieving elimination of active trachoma as a public health problem.[6] Countries have had varied

Pakistan Ministry of Health, Islamabad, Pakistan (A A Khan PhD); **Kenya Ministry of Health, Nairobi, Kenya** (S Matendechero MPharm); **Côte d'Ivoire Ministry of Health, Abidjan, Côte d'Ivoire** (A Meite MD); **Mauritania Ministry of Health, Nouakchott, Mauritania** (A Minnih MD); **Uganda Ministry of Health, Kampala, Uganda** (F Mugume MBChB); **Nigeria Ministry of Health, Abuja, Nigeria** (N Olobio MSc); **Zanzibar Ministry of Health, Zanzibar Town, Zanzibar** (F J Omar MSc-CEH); **Zimbabwe Ministry of Health, Harare, Zimbabwe** (I Phiri MD); **Guinea-Bissau Ministry of Health, Bissau, Guinea-Bissau** (S Sanha MD); **Nepal Ministry of Health, Kathmandu, Nepal** (S Sharma BSc); **Ethiopia Ministry of Health, Addis Ababa, Ethiopia** (F Seife MPH); **Solomon Islands Ministry of Health, Honiara, Solomon Islands** (O Sokana MPH); **Kiribati Ministry of Health, Tarawa, Kiribati** (R Taoaba PG-CEC); **Eritrea Ministry of Health, Asmara, Eritrea** (A Tesfazion MPH); **Mali Ministry of Health, Bamako, Mali** (L Traoré MD); **DR Congo Ministry of Health, Kinshasa, DR Congo** (N Uvon MD); **Central African Republic Ministry of Health, Bangui, Central African Republic** (G Yaya PhD); **South Sudan Ministry of Health, Juba, South Sudan** (M Y Logora Dip); **RTI International, Washington, DC, USA** (J M Ngondi)

Correspondence to:
Ms Kristen Renneker
International Trachoma Initiative, The Task Force for Global Health, Decatur, GA, USA
krenneker@taskforce.org

For the **Trachoma Atlas** see https://www.trachomaatlas.org/

Research in context

Evidence before this study

We searched PubMed, internet search engines, and WHO reports using the search terms "trachoma" and "trachoma elimination", for all articles published in English until Feb 26, 2020. Although countries are validated as having eliminated trachoma as a whole, elimination targets exist at the implementation-unit level. Implementation-unit level analysis is typically only published as a part of region-specific or country-specific studies. Recrudescence based on trachoma surveillance survey results by country has not been analysed on a global scale.

Added value of this study

To the best of our knowledge, this is the first global analysis of progress towards active trachoma elimination targets. Including data from 38 countries, we described scale-up according to the number of known-endemic implementation units and mass drug administration over time. We categorised trachoma prevalence from baseline, trachoma impact surveys, and trachoma surveillance surveys to show programme progress, and we used the results of trachoma surveillance surveys to assess the country-level rate of recrudescence. Overall, we found that the trachoma programme is scaling down and the prevalence of trachomatous inflammation—follicular in 1–9-year-olds (TF_{1-9}) is declining: of 2097 ever-endemic implementation units, 1923 (91·7%) have had mass drug administration; TF_{1-9} prevalence has decreased by at least 50% in 1465 (84·6%) implementation units with a trachoma impact survey, and 1182 (56·4%) ever-endemic implementation units reached the elimination threshold (TF_{1-9} prevalence <5%). The proportion of implementation units with recrudescence (trachoma surveillance survey result of $TF_{1-9} \geq 5\%$) was highest in Ethiopia, indicating a substantial risk of recrudescence in that country and therefore to the success of the global programme. Additionally, 12 (32%) of 37 included countries with a trachoma impact survey had not yet had any trachoma surveillance survey.

Implications of all the available evidence

Binary country-level validation of trachoma as a public health problem obscures the implementation unit-level success achieved in the reduction of active trachoma. Although great progress has been made towards elimination, the timeline will be longer than was initially thought. The global programme will need to consider if the current strategy is adequate, especially in places with high levels of active trachoma, which are at risk of needing additional years of treatment and increased levels of recrudescence once mass drug administration is stopped.

progress towards achieving this elimination goal. The number of people at risk of blindness from trachoma has reduced by 90%, based on 2002 and 2018 global estimates.[7] By January, 2022, 11 countries (Cambodia, China, The Gambia, Ghana, Iran, Laos, Mexico, Morocco, Myanmar, Nepal, and Oman) have been validated by WHO as having eliminated trachoma as a public health problem.[8–11] Several other endemic countries have reported attaining the elimination goals and are in the process of preparing their dossiers for assessment and potential validation. This figure represents at least one validated country in every trachoma-endemic WHO region, showing the effectiveness of the SAFE strategy in various settings.[8] However, some countries have been working to eliminate trachoma for 20 years or more and have still not attained elimination.[12,13] In these countries and others, progress has been slow despite adherence to the SAFE strategy. Although remarkable progress has been made in reducing the number of people at risk of trachoma, the goal of global elimination of trachoma as a public health problem by 2020 was not achieved. We aimed to show that elimination of active trachoma can be analysed at the implementation-unit level to show country-level progress towards this binary goal even if countries have not yet met it.

Methods

Study setting

In this retrospective analysis of national survey data, all known trachoma-endemic countries that had either implemented at least one trachoma impact survey shown in the publicly available Trachoma Atlas or were in Africa were invited to participate in this study. We included data from baseline surveys, trachoma impact surveys, and trachoma surveillance surveys until Nov 10, 2021. Ethics approval was not required because this analysis was not considered human-subject research.

Data sources

The International Trachoma Initiative (ITI) maintains the database for GET2020 in partnership with WHO. The database contains information about trachoma prevalence surveys and SAFE implementation activities. Although all trachoma survey data included in this analysis measure TF_{1-9} in accordance with the WHO simplified clinical grading system for trachoma,[1] some variation exists in the survey design, sampling methodology, and data source for any given survey result, especially for surveys done before 2013, the beginning of the Global Trachoma Mapping Project.[14] However, most surveys from 2013 onwards followed a standardised approach to measure TF_{1-9} in a cross-sectional, population-based prevalence survey.[15] Prevalence surveys in the GET2020 database were categorised as being either baseline, trachoma impact survey, or trachoma surveillance survey; by definition, a trachoma impact survey can only occur after implementation (otherwise the survey was categorised as a

new baseline survey and the older baseline survey was marked as "historic" and was not included in this analysis). SAFE implementation activities since 2014 were reported routinely by countries in the annual Trachoma Elimination Monitoring Form (TEMF), which collects implementation-unit-level information on implementation of the of the SAFE strategy. The TEMF was sent annually to all countries with a history of any trachoma prevalence, suspected prevalence, or activity, and typically has a high rate of completion, with 52 (78%) of 66 TEMFs completed for the most recent reporting period (2020). All included endemic countries had completed their TEMF at the implementation-unit level. The data sources for activities before 2014 included previous annual applications for Zithromax (azithromycin; Pfizer, Borgo San Michele, Italy, and Barceloneta, Puerto Rico) submitted to ITI and personal correspondence between ITI, WHO, national

	Status (WHO Global Health Observatory[16])	Implementation units ever endemic (TF_{1-9} ≥5%; n=2141)*	Implementation units currently endemic (TF_{1-9} ≥5%; n=954)*	Implementation units with trachoma impact survey (n=1735)*	Met inclusion criteria†	Included
Asia						
Afghanistan	Known to require interventions	8	8	0	No	No
Cambodia‡	Validated as having eliminated	No data	No data	No data	No	No
China	Validated as having eliminated	No data	No data	No data	No	No
India‡	Known to require interventions	No data	No data	No data	No	No
Iran	Validated as having eliminated	No data	No data	No data	No	No
Iraq	Thought to not require interventions, claims to have eliminated	No data	No data	No data	No	No
Laos‡	Validated as having eliminated	No data	No data	No data	No	No
Myanmar‡	Validated as having eliminated	No data	No data	No data	No	No
Nepal	Validated as having eliminated	19	0	19	Yes	Yes
Oman	Validated as having eliminated	No data	No data	No data	No	No
Pakistan	Known to require interventions	16	7	9	Yes	Yes
Saudi Arabia	Thought to not require interventions, claims to have eliminated	No data	No data	No data	No	No
Vietnam	Known to require interventions	30	0	30	Yes	Yes
Yemen	Known to require interventions	30	25	6	Yes	Yes
Eastern Africa						
Chad	Known to require interventions	39	3	39	Yes	Yes
Eritrea	Known to require interventions	25	1	25	Yes	Yes
Ethiopia	Known to require interventions	796	543	593	Yes	Yes
Kenya	Known to require interventions	33	16	31	Yes	Yes
Somalia	May require interventions, investigation needed	No data	No data	No data	No	No
South Sudan	Known to require interventions	28	26	12	Yes	Yes
Sudan	Known to require interventions	29	15	19	Yes	Yes
Uganda	Known to require interventions	57	5	57	Yes	Yes
Tanzania	Known to require interventions	77	9	77	Yes	Yes
Zanzibar	Known to require interventions	1	0	1	Yes	Yes
Latin America						
Brazil‡	Known to require interventions	No data	No data	No data	No	No
Colombia	Known to require interventions	6	6	1	No§	No
Guatemala	Known to require interventions	2	0	2	Yes	No
Mexico‡	Validated as having eliminated	No data	No data	No data	No	No
Peru	Known to require interventions	4	4	0	No	No
Venezuela	May require interventions, investigation needed	No data	No data	No data	No	No
Northern Africa						
Algeria	Known to require interventions	No data	No data	No data	No	No
Egypt	Known to require interventions	4	4	0	Yes	Yes
Libya	May require interventions, investigation needed	No data	No data	No data	No	No
Tunisia	Thought to not require interventions, claims to have eliminated	No data	No data	No data	No	No

(Table continues on next page)

	Status (WHO Global Health Observatory[16])	Implementation units ever endemic (TF_{1-9} ≥5%; n=2141)*	Implementation units currently endemic (TF_{1-9} ≥5%; n=954)*	Implementation units with trachoma impact survey (n=1735)*	Met inclusion criteria†	Included
(Continued from previous page)						
Oceania						
Australia	Known to require interventions	7	4	0	No	No
Pacific Islands						
Fiji	Known to require interventions	4	4	0	No	No
Kiribati	Known to require interventions	24	24	24	Yes	Yes
Micronesia	May require interventions, investigation needed	No data	No data	No data	No	No
Nauru	Known to require interventions	1	1	1	No§	No
Papua New Guinea	Known to require interventions	12	12	0	No	No
Solomon Islands	Known to require interventions	46	46	46	Yes	Yes
Vanuatu	Known to require interventions	6	6	6	Yes	Yes
Southern Africa						
Angola	May require interventions, investigation needed	No data	No data	No data	No	No
Botswana	May require interventions, investigation needed	No data	No data	No data	No	No
Burundi	Known to require interventions	10	0	10	Yes	Yes
Central African Republic	Known to require interventions	30	25	5	Yes	Yes
DR Congo	Known to require interventions	72	44	29	Yes	Yes
Malawi	Known to require interventions	44	0	44	Yes	Yes
Mozambique	Known to require interventions	71	25	61	Yes	Yes
Namibia	May require interventions, investigation needed	No data	No data	No data	No	No
Zambia	Known to require interventions	45	15	45	Yes	Yes
Zimbabwe	Known to require interventions	21	10	14	Yes	Yes
Western Africa						
Benin	Known to require interventions	8	0	8	Yes	Yes
Burkina Faso	Known to require interventions	61	0	61	Yes	Yes
Cameroon	Known to require interventions	22	2	22	Yes	Yes
Côte d'Ivoire	Known to require interventions	52	30	22	Yes	Yes
The Gambia	Validated as having eliminated	15	0	15	Yes	Yes
Ghana	Validated as having eliminated	18	0	18	Yes	Yes
Guinea	Known to require interventions	20	0	20	Yes	Yes
Guinea-Bissau	Known to require interventions	12	0	12	Yes	Yes
Mali	Known to require interventions	61	0	61	Yes	Yes
Mauritania	Known to require interventions	20	0	20	Yes	Yes
Morocco	Validated as having eliminated	5	0	5	Yes	Yes
Niger	Known to require interventions	98	13	98	Yes	Yes
Nigeria	Known to require interventions	125	21	120	Yes	Yes
Senegal	Known to require interventions	27	0	27	Yes	Yes
Togo‡	Thought to not require interventions, claims to have eliminated	No data	No data	No data	No	No

Data are n, unless otherwise indicated. GET2020=WHO Alliance for the Global Elimination of Trachoma by 2020. TF_{1-9}=trachomatous inflammation—follicular in children aged 1–9 years. *Number of implementation units in the GET2020 database; "no data" includes countries with data outside of the GET2020 database. †Inclusion criteria were at least one trachoma impact survey in GET2020 database or in Africa. ‡Data showing TF_{1-9} prevalence of at least 5% outside GET2020 database. §Trachoma impact survey added to database after country contact deadline so was not included in the analysis.

Table: **Active trachoma status and characteristics of countries considered for inclusion**

programmes, and implementing partners. For distributions and survey data, the implementation unit was defined as an administrative unit at which trachoma activities take place, typically containing 100 000–250 000 people.[2] When an activity took place at a different implementation level over time, the larger implementation level was split retrospectively so that the smaller-level results were applied to each unit so that comparisons could be made across the timepoint of baseline and trachoma impact survey.

Data cleaning

To abstract the known prevalence of active trachoma in an implementation unit in a given year, surveys were considered to have taken place on Jan 1 of the survey year, and this endemicity status continued until another survey was done. Mass drug administration was considered to have taken place in a given implementation unit in a given year if one or more doses of azithromycin were reported as distributed in that implementation unit during the year. The first year of intervention was considered to be the year of the first mass drug administration after a baseline survey. Countries were assigned into geographical groups (table). To avoid a sparsely filled central Africa geographical group, countries in central Africa were split between the southern Africa (Burundi, Central African Republic, and DR Congo), western Africa (Cameroon[17,18]), and eastern Africa (Chad) groups.

Data analysis

For this analysis, we focused on the A component (antibiotic distribution) of the SAFE strategy. To describe programmatic scale-up, we plotted the numbers of known-endemic implementation units and known-endemic implementation units that received mass drug administration by year. To show the progress towards reaching the elimination threshold, we developed a dot map to show the spatial-temporal distribution of endemic implementation units at baseline and the most recent reported prevalence in Africa, the continent with the largest burden of trachoma. Spaghetti plots were used to show progress towards elimination by showing implementation-unit-level survey results over time, and number of years since first mass drug administration by baseline TF_{1-9} prevalence category, stratified by the geographical group. Boxplots were used to show the median and IQR of implementation-unit-level TF_{1-9} prevalence at baseline and most recent reported prevalence by country for all implementation units with at least one trachoma impact survey (ie, beyond baseline survey). We used boxplots to show the median and IQR of the implementation-unit-level percentage decrease in TF_{1-9} prevalence from baseline to most recent reported prevalence by country. To show progress towards maintaining elimination thresholds, we plotted a bar chart showing the number of trachoma surveillance survey results above and below the elimination threshold by country.

All data cleaning and analyses were done in R (version 3.6.1) and figures were produced with the package ggplot2. Maps were created using ArcGIS Desktop (version 10.7.1).

Role of the funding source

There was no funding source for this study.

Results

38 countries, representing 2097 ever-endemic implementation units, consented to participate (table). Of these endemic implementation units, 1923 (91·7%) have ever reported having mass drug administration, with the remaining 174 (8·3%) endemic implementation units not yet having received mass drug administration. Of these implementation units with mass drug administration, 1731 (90·0%) had at least one impact assessment, of which 1465 (84·6%) had experienced a decline in TF_{1-9} of at least 50%, and 1182 (68·3% of implementation units with trachoma impact survey and 56·4% of implementation units ever known to be endemic) had reached the elimination threshold. Figure 1 shows the scale-up and scale-down of the global programme over time from 1999 to data from 2021 prevalence surveys and 2020 reported implementation. The number of known-endemic implementation units in a single year reached a peak of 1532 in 2015 and had subsequently been on a downward trajectory. 915 implementation units were known to be endemic as of November, 2021, representing a 40·3% decrease from the peak known endemic in 2015 and a 56·4% decrease from the cumulative number of implementation units ever endemic (figure 1).

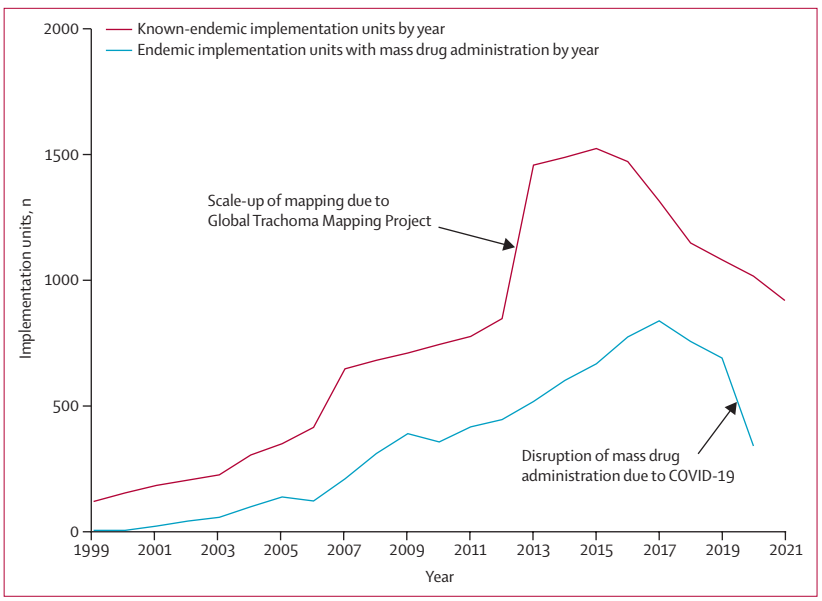

Figure 1: **Scale-up and scale-down of the global trachoma programme over time**

Figure 2 shows a dot map of Africa comparing the prevalence of TF_{1-9} at baseline and most recent reported prevalence (regardless of whether the most recent reported prevalence was from a baseline survey, trachoma impact survey, or trachoma surveillance survey). All implementation units in Africa with a baseline survey (n=3273) were included in both maps (figure 2). The overall TF_{1-9} prevalence decreased substantially across the continent, especially in western and southern Africa, compared with that of baseline (figure 2). However, TF_{1-9} was still comparatively high in Ethiopia (figure 2).

The implementation-unit-level progress towards elimination over time is shown in the appendix (p 2) and

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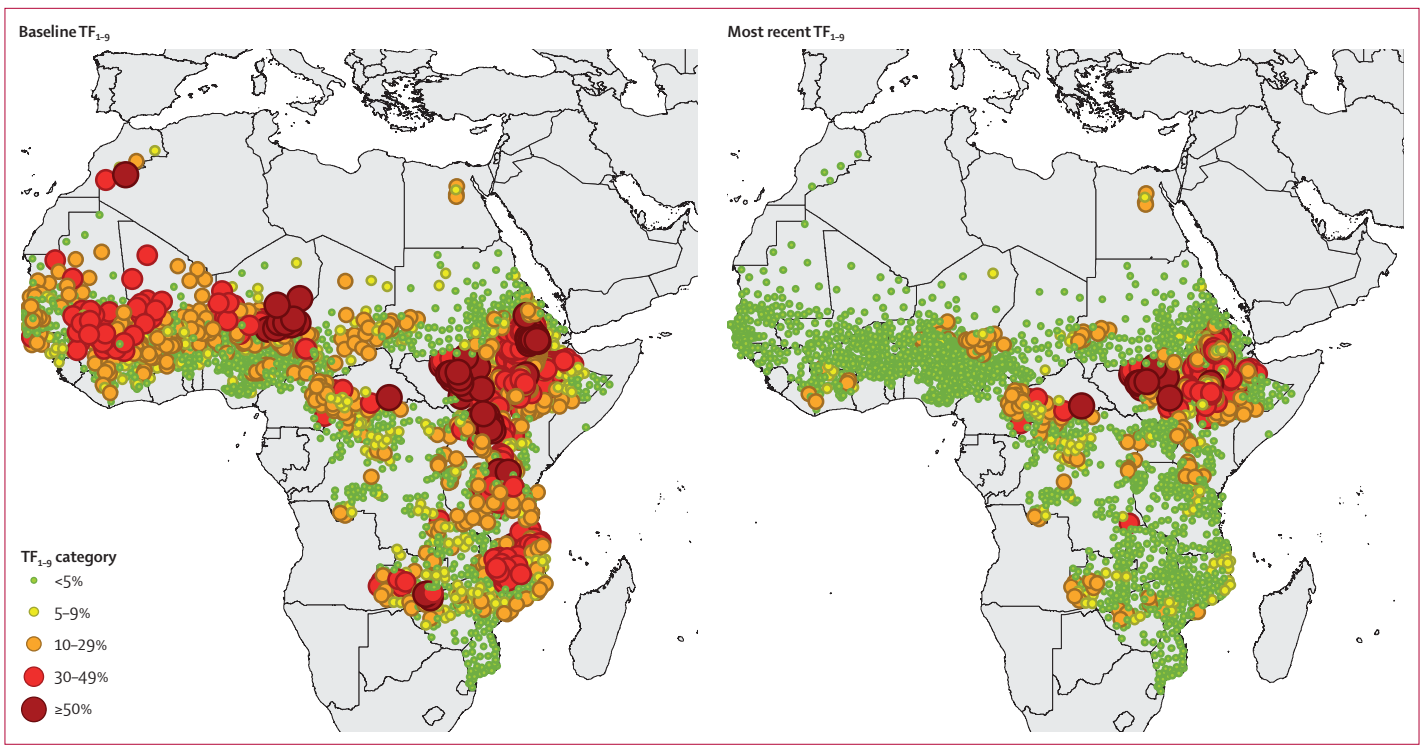

Figure 2: **Prevalence of TF_{1-9} at baseline and most recent reported prevalence**
Includes data for 3273 implementation units in Africa with a baseline survey. Most recent TF_{1-9} presented regardless of most recent survey type. TF_{1-9}=trachomatous inflammation—follicular among children aged 1–9 years.

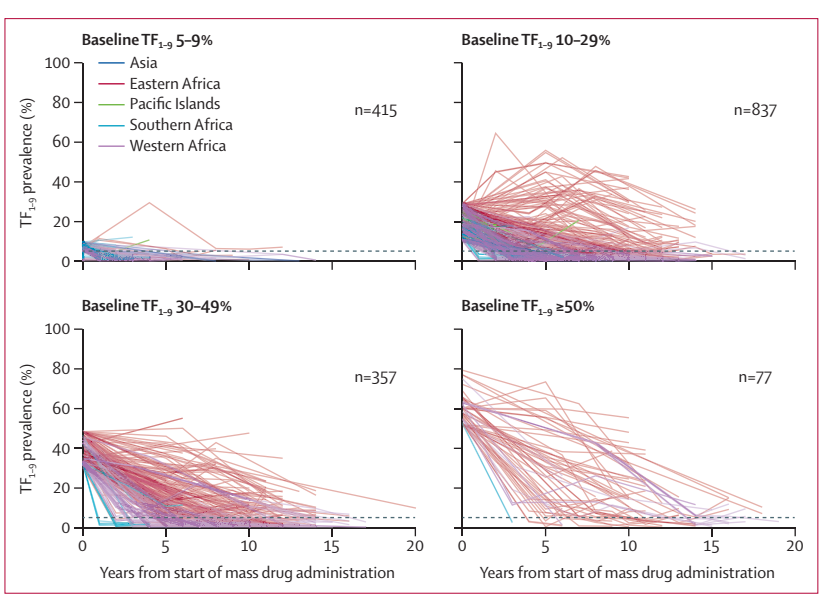

Figure 3: **Progression of TF_{1-9} prevalence over time by baseline trachomatous inflammation and geographical group**
Dashed line represents TF_{1-9} elimination threshold (5%). TF_{1-9}=trachomatous inflammation—follicular among children aged 1–9 years.

figure 3. Overall, the prevalence of TF_{1-9} decreased over time across the global programme; however, the rate of decline varied on the basis of geographical group (appendix p 2). Stratifying by baseline TF_{1-9} category, low-prevalence implementation units were more likely to attain the elimination threshold than were those in medium and high categories, and did so in a shorter period of time (figure 3).

The appendix (p 3) shows the median (IQR) TF_{1-9} prevalence at the implementation-unit level at baseline compared with most recent reported prevalence at a trachoma impact survey or trachoma surveillance survey by country for all implementation units that had a survey beyond baseline. This comparison restricted to implementation units that were still above the elimination threshold at most recent reported prevalence is shown in the appendix (p 4). Overall, the most recently reported median prevalence at the implementation-unit level was lower than the baseline median prevalence in every country included (appendix p 3), and substantial declines had occurred even for implementation units that had not met the elimination threshold (appendix p 4).

Figure 4 shows the median (IQR) percentage decrease in TF_{1-9} prevalence at the implementation-unit level from baseline to most recent reported prevalence by country for all implementation units that had a survey beyond baseline. Overall, the median percentage decrease in prevalence from baseline to most recently reported survey was 85·7% (IQR 66·3–94·4; figure 4). All countries that were included had experienced a decrease from baseline to most recent reported prevalence (figure 4). This comparison restricted to

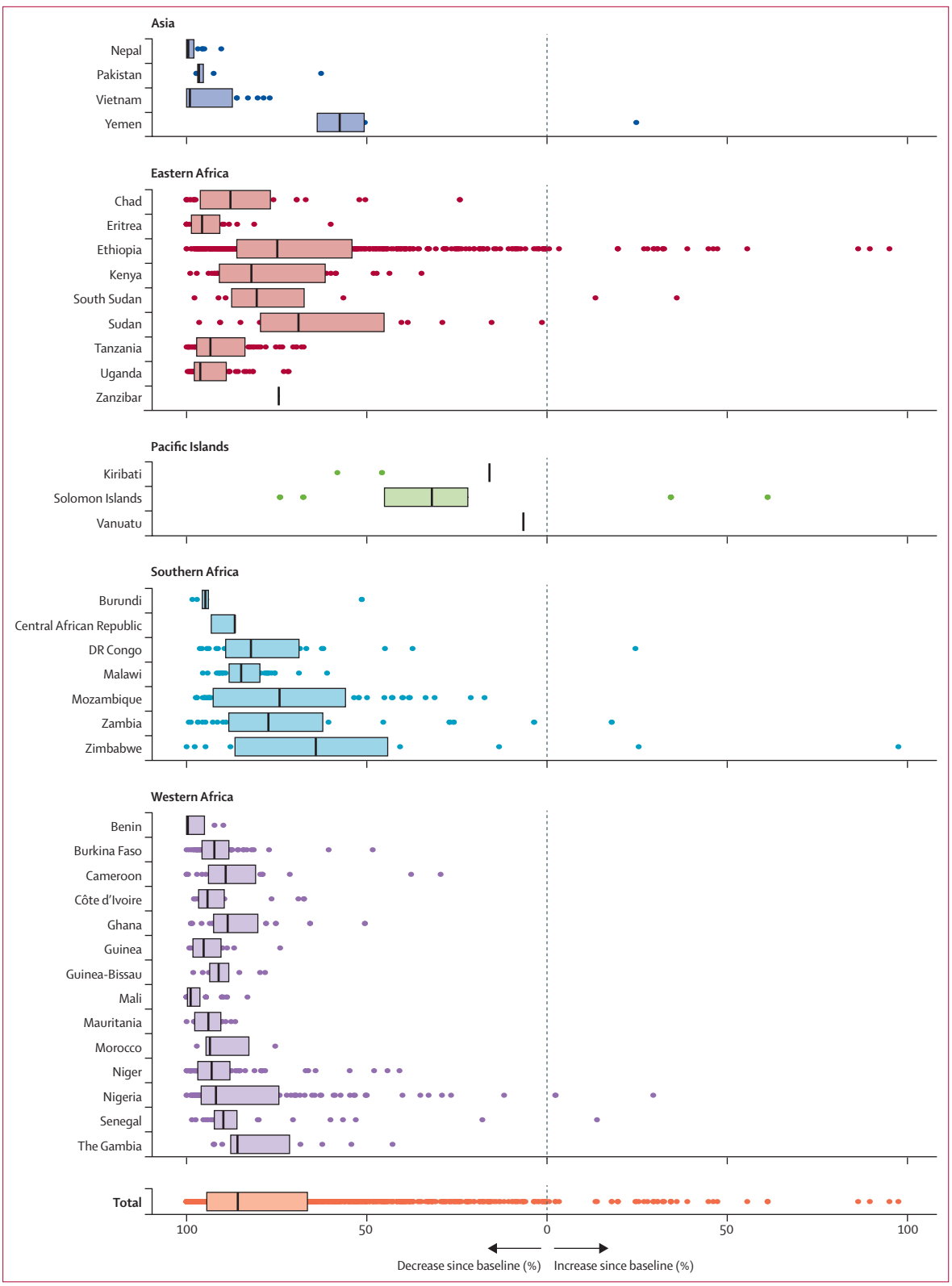

Figure 4: **Percentage change of TF_{1-9} in implementation units since initial baseline survey**
Data are median (IQR). All implementation units with trachoma impact survey regardless of most recent reported prevalence (n=1731). TF_{1-9}=trachomatous inflammation—follicular among children aged 1–9 years.

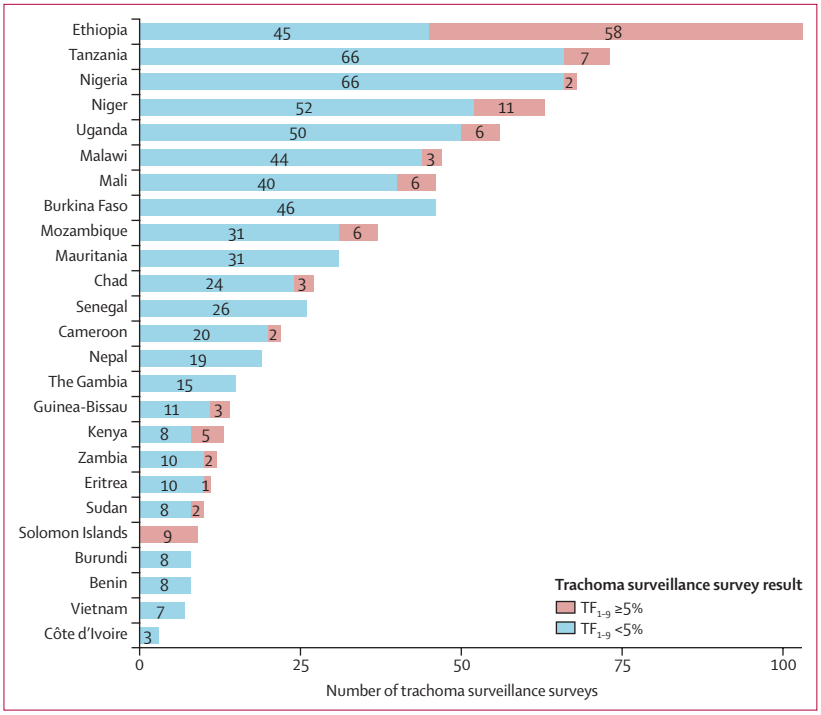

Figure 5: **Trachoma surveillance survey result by country (n=774)**
TF_{1-9}=trachomatous inflammation—follicular among children aged 1–9 years.

implementation units above the elimination threshold at most recent reported prevalence is shown in the appendix (p 5). Even with this restriction, most countries (16 [84%] of 19) had achieved a decrease in median TF_{1-9} from baseline to most recent reported prevalence (appendix p 5).

Figure 5 shows the number of trachoma surveillance survey results above and below the elimination threshold for the 25 countries with any trachoma surveillance survey. Most countries (16 [64%]) had a small percentage of trachoma surveillance survey results above the elimination threshold, but in Ethiopia, over half (58 [56·3%] of 103) of trachoma surveillance survey results were above the elimination threshold.

Discussion

The global goal of elimination of trachoma as a public health problem was not accomplished by the year 2020. Despite missing this goal, our implementation-unit-level analysis provides additional evidence of the progress of the global programme.

Programmatic scale-up over time showed that in 2015, the maximum number of implementation units known to be trachoma endemic had been reached, and this number had subsequently been decreasing as more implementation units attained the elimination threshold for TF_{1-9} than were discovered through new mapping. The increase in the number of known endemic implementation units starting in 2013 was due to widespread baseline mapping through the Global Trachoma Mapping Project.[14] In its first 10 years, the global programme reported achieving service delivery in up to 30% of the known endemic implementation units, which had increased to over 60% of known endemic implementation units by 2017. The decrease in the rate of identifying new endemic implementation units coupled with the increase in the proportion of those implementation units that were offered intervention suggests that there will be an accelerated rate of implementation units eliminating active trachoma in the coming few years. The number of known-endemic implementation units receiving mass drug administration in 2020 was lower than in previous years, largely because of a temporary halt in programme activities due to the COVID-19 pandemic. The highest rate of mass drug administration occurred in 2018, with 68% of known-endemic implementation units receiving mass drug administration. Endemic implementation units not receiving mass drug administration fall into two categories: those that were due for a mass drug administration but did not receive one (for various operational factors including funding, inaccessibility due to conflict, or competing health programme priorities) or implementation units pending a trachoma impact survey, and therefore not due for mass drug administration. Approximately two-thirds of implementation units not receiving mass drug administration fall into this second category (unpublished), and a lack of mass drug administration in these districts should not be considered a failure of the programme.

We found that the reduction in TF_{1-9} prevalence had been most marked in western and southern Africa, with substantial active trachoma remaining in eastern Africa, particularly Ethiopia. In many places, particularly those with remaining active trachoma, higher baseline prevalence tends to be more difficult to eliminate, with many of the implementation units with TF_{1-9} of at least 50% at baseline still having a most recent prevalence of above 10%.

Additionally, most implementation units showed a downward slope in TF_{1-9}, indicating that TF_{1-9} was decreasing over time. Most ever-endemic implementation units had a trachoma impact survey. All of the 37 countries in our study that had at least one trachoma impact survey had a decrease in the median most recent reported TF_{1-9} compared with that at baseline. Almost all countries with a current trachoma impact survey result of TF_{1-9} prevalence of at least 5% had this decrease even in those implementation units with TF_{1-9} prevalence of at least 5% at trachoma impact survey. Additionally, the size of these decreases was substantial, with 92% of countries with at least one trachoma impact survey experiencing a median decrease of 50% or more in TF_{1-9} between baseline and trachoma impact survey. These data suggest that most countries are on a trajectory to eliminate active trachoma as a public health problem, even if that

milestone was not reached by the end of 2020. Furthermore, there is evidence that active trachoma tends to decline slowly on its own, probably because of improvements in water and sanitation,[19,20] so in selected settings, no further treatment might be necessary to reach the elimination goals.

The 366 endemic implementation units that had no trachoma impact survey were either waiting to complete the recommended number of mass drug administration rounds, or had completed their mass drug administration rounds and were awaiting trachoma impact survey. The countries with the greatest number of implementation units with a TF_{1-9} of at least 5% without a trachoma impact survey were Ethiopia, DR Congo, Côte d'Ivoire, Central African Republic, and Yemen.

24 countries have had at least one implementation unit with a trachoma surveillance survey result of TF_{1-9} below 5%, which shows promising progress toward sustaining the elimination threshold for TF_{1-9}. However, because the threshold for stopping antibiotic distribution is neither the elimination of the disease nor the organism, there is always a slight risk of recrudescence. The trachoma impact surveys are powered to detect a prevalence of TF_{1-9} of 4–6% with a 90% power,[2] so there is always a small risk that sampling variation or misclassification of clinical signs (TF) incorrectly categorised an implementation unit as being below that threshold. 25 countries had a trachoma surveillance survey, of which 16 (64%) had at least one recrudescent implementation unit. The country-level median proportion of implementation units with recrudescence was 12%, with two outliers: 100% for the Solomon Islands and 56% for Ethiopia. The Solomon Islands combined implementation units for trachoma surveillance surveys; therefore, the nine implementation units represent only two distinct surveys, but Ethiopia had 103 trachoma surveillance surveys. The proportion of recrudescent implementation units in Ethiopia could be due, in part, to the country's high baseline prevalence of TF_{1-9}, and was consistent with the evidence that areas with higher prevalence are more likely to experience recrudescence.[21–24] The high rate of trachoma surveillance surveys with a result greater than 5% in Ethiopia indicates a substantial risk of recrudescence in that country and therefore to the success of the global programme. Greater understanding of the effect of enhanced intervention in highly endemic implementation units in Ethiopia, along with the limitations of TF_{1-9} in measuring infection in low-prevalence settings[25] is warranted.

The implementation units that have reached the goal of TF_{1-9} prevalence below 5% at a trachoma surveillance survey might include those where active trachoma was easiest to control. Only 25 (66%) of 38 countries included had reached their first trachoma surveillance survey. Although there is a time component to reaching a trachoma surveillance survey (programmes with relatively late starts might simply have not have had the opportunity to reach a trachoma surveillance survey), this finding might also indicate areas that are struggling to reach the pre-trachoma surveillance survey milestone of a TF_{1-9} prevalence below 5% at trachoma impact survey. Such areas might be experiencing so-called persistent trachoma, which has been identified as a major endgame challenge.[26] More research is needed to understand these implementation units.

There are several limitations to this study. The results presented here are necessarily a sample of the true global programme. Almost all implementation units that met inclusion criteria were included; however, the inclusion criteria were purposefully chosen to include countries with data in the GET2020 database. Countries without data had either validated elimination or claimed to have eliminated, or might require intervention but more investigation was needed. For countries that might require intervention, the application of our conclusions to these implementation units might be difficult. A few survey records—particularly for baselines done before 2012—have unknown methodologies, and thus the accuracy of these baselines is not verifiable. Given changes in global guidance over time and different years of trachoma programme inauguration and scale-up, we could not compare across all countries for all time periods. This variability has been greatly reduced since the adoption of standardised survey methodology in 2012 and confidence in survey results since then has been high.[14,15] Additionally, this analysis looked only at active trachoma, whereas the criteria for elimination of trachoma also requires demonstration of a reduction of the prevalence of trachomatous trichiasis unknown to the health system to below 0·2% in every implementation unit. The definition of a mass drug administration as any reported doses of azithromycin distributed was purposefully selected to be agnostic to coverage because this information can be difficult to verify.

Further research should look at the efficacy and practicality of methods for enhanced programme delivery to achieve goals of elimination and possibly future eradication of trachoma.[27] The risk factors contributing to recrudescence should be explored in more depth to ensure the gains made as a programme are protected and sustained. Finally, new targets for global elimination should be forecasted to guide programmes and serve as a community-wide goal.

Global elimination of trachoma as a public health problem by 2020 was not achieved; however, the binary nature of country-level validation can obscure the tremendous steps forward being made at the level of implementation, which is why analysis at the implementation-unit level is so valuable in revealing progress that might otherwise be masked. Although great progress has been made towards global elimination, the timeline will be longer than was initially thought. Especially as goals are redefined in the WHO road map for neglected tropical diseases 2021–30,[28] the global programme will need to consider if the current strategy

is adequate, especially in places with high prevalence of active trachoma, which are at risk both of persistent trachoma thus needing additional years of treatment and increased levels of recrudescence once mass drug administration is stopped. To reach the global goal of elimination as a public health problem, every country must be validated, including vulnerable and hard-to-reach communities, such as those in the Amazonas region in South America and areas affected by conflict. Global elimination might be delayed, but with an understanding of the barriers to reaching targets and a global commitment towards achieving future targets, elimination will not be denied.

Contributors

PME, PJH, JMN, and KKR conceived of the project and drafted and revised the manuscript. KKR managed the data. KKR conducted the analysis with consultation from PME, PJH, and JMN. MA, JA, TA-K, KA, MDB, BE, WB, LB, CB, VB, TC, TMD, DD, AG, MG, JH, BK, GK, KK, SK, AAK, BM, AMe, AMi, FM, NO, FJO, IP, FS, SSa, SSh, OS, SM, RT, AT, LT, NU, GY, MYL approved data for inclusion and verified the data for their respective countries. KKR and JMN accessed and verified the complete dataset. All authors reviewed the draft and approved the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The data used in this analysis belong to each individual country included. Data on TF_{1-9} prevalence category and post-2010 mass drug administration history are publicly available on the Global Atlas of Trachoma (https://www.trachomaatlas.org/). Any request for study data not available on the Global Atlas of Trachoma (TF_{1-9} point prevalence and pre-2010 mass drug administration history) must be made directly with countries and will be assessed on a case-by-case basis at each country's discretion. A data dictionary is available on request from the corresponding author.

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