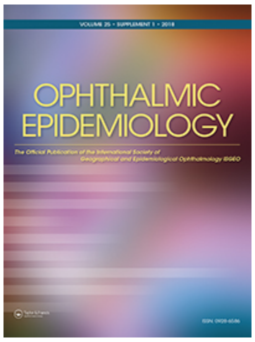

Ophthalmic Epidemiology

ISSN: 0928-6586 (Print) 1744-5086 (Online) Journal homepage: https://www.tandfonline.com/loi/iope20

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To cite this article: Caleb Mpyet, Nasiru Muhammad, Mohammed Dantani Adamu, Mohammad Ladan, Rebecca Willis, Murtala Muhammad Umar, Joel Alada, Aliyu Attahiru Aliero, Ana Bakhtiari, Rebecca Mann Flueckiger, Nicholas Olobio, Christian Nwosu, Marthe Damina, Anita Gwom, Abdullahi A Labbo, Sophie Boisson, Sunday Isiyaku, Adamani William, Mansur M. Rabiu, Alexandre L. Pavluck, Bruce A. Gordon, Anthony W. Solomon & for the Global Trachoma Mapping Project (2018) Impact Survey Results after SAFE Strategy Implementation in 15 Local Government Areas of Kebbi, Sokoto and Zamfara States, Nigeria, Ophthalmic Epidemiology, 25:sup1, 103-114, DOI: 10.1080/09286586.2018.1481984

To link to this article: https://doi.org/10.1080/09286586.2018.1481984

OPHTHALMIC EPIDEMIOLOGY
2018, VOL. 25, NO. S1, 103–114
https://doi.org/10.1080/09286586.2018.1481984

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Impact Survey Results after SAFE Strategy Implementation in 15 Local Government Areas of Kebbi, Sokoto and Zamfara States, Nigeria

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ABSTRACT

Purpose: To determine prevalence of trachoma after interventions in 15 local government areas (LGAs) of Kebbi, Sokoto and Zamfara States, Nigeria.

Methods: A population-based impact survey was conducted in each LGA using Global Trachoma Mapping Project (GTMP) protocols. In each LGA, 25 villages were selected, except in Arewa LGA, where we selected 25 villages from each of four subunits to obtain finer-resolution prevalence information. Villages were selected with probability proportional to size. In each village, 25 households were enrolled and all consenting residents aged ≥1 year were examined by GTMP-certified graders for trachomatous inflammation—follicular (TF) and trachomatous trichiasis (TT). Information on sources of household water and types of sanitation facilities used was collected through questioning and direct observation.

Results: The number of households enrolled per LGA ranged from 623 (Kware and Tangaza) to 2488 (Arewa). There have been marked reductions in the prevalence of TF and TT since baseline surveys were conducted in all 15 LGAs. Eight of the 15 LGAs have attained TF prevalences <5% in children, while 10 LGAs have attained TT prevalences <0.2% in persons aged ≥15 years. Between 49% and 96% of households had access to water for hygiene purposes within 1 km of the household, while only 10–59% had access to improved sanitation facilities.

Conclusion: Progress towards elimination of trachoma has been made in these 15 LGAs. Collaboration with water and sanitation agencies and community-based trichiasis surgery are still needed in order to eliminate trachoma by the year 2020.

ARTICLE HISTORY
Received 29 September 2017
Revised 26 April 2018
Accepted 24 May 2018

KEYWORDS
Blindness; Global Trachoma Mapping Project; sanitation; trachoma; trichiasis; water supply

Introduction

For the elimination of trachoma as a public health problem, the World Health Organization (WHO) recommends implementation of the SAFE strategy (Surgery for trachomatous trichiasis (TT); Antibiotics to clear ocular *Chlamydia trachomatis* infection; Facial cleanliness and Environmental improvement to reduce *C. trachomatis* transmission).[1,2] The district-level elimination targets set by WHO are a prevalence of trachomatous inflammation—follicular (TF) of <5% in children aged 1–9 years, and a prevalence of TT unknown to the health system of <0.2% in persons aged ≥15 years.[3] Experimental[4,5] and operational[6,7] data suggest that the SAFE strategy works.

Countries are now scaling up or are already fully implementing SAFE at scale,[8,9] in an effort to achieve elimination by the year 2020. The decision to continue or discontinue elements of the SAFE strategy depends on data from impact surveys, which are carried out after specified periods of programme implementation.[10–12]

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*See Appendix
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In Nigeria, State governments partner with non-governmental organisations to deploy trachoma elimination activities at the district (local government area, LGA) level. As elsewhere, the duration of intervention varies between LGAs, depending on prevalence estimates of TF and TT. In Kebbi, Sokoto and Zamfara States of north-western Nigeria, trachoma programmes were gradually rolled out from 2003. Baseline surveys were undertaken. Local systems and capacities were developed to deliver community-based trichiasis surgery, with operations performed by trained ophthalmic nurses. Tetracycline eye ointment and azithromycin were distributed, facial cleanliness was promoted, and interventions launched to improve access to water and sanitation.

To assess the collective impact of these interventions in reducing the prevalence of disease towards elimination targets, we carried out impact surveys in the LGAs of Kebbi, Sokoto and Zamfara States. The systems and processes of the Global Trachoma Mapping Project[13] (GTMP) were used. This paper reports the results of those surveys, comparing the prevalence estimates obtained with those generated at baseline.

Methods

Setting

Baseline population-based prevalence surveys for trachoma were conducted in 2004 in six LGAs of Kebbi,[14] six LGAs of Sokoto [unpublished data], and six LGAs of Zamfara[15] (Table 1). In 2006, six further baseline surveys were conducted in Sokoto State [unpublished data]. In 2011 and 2012, baseline surveys were conducted in 25 LGAs of Sokoto and Kebbi.[16] In total, baseline surveys were conducted in 49 LGAs of Kebbi, Sokoto and Zamfara during the period 2004–2012. Based on LGA-level prevalence estimates of TF in children aged 1–9 years, 20 LGAs required 3 years of azithromycin mass drug administration (MDA, TF prevalence 10–29.9%) and 7 other LGAs required 5 years of azithromycin MDA (TF prevalence ≥30.0%), together with appropriate F & E interventions. The remaining 22 LGAs had TF prevalence estimates <10% and (according to then-current WHO guidance[12]) did not qualify for district-wide antibiotic MDA. Based on the prevalence of trichiasis in persons aged ≥15 years, 40 LGAs surveyed required community-based trichiasis surgery to reach the trichiasis elimination threshold. The decision was made to implement various aspects of the SAFE strategy in 49 LGAs found to have trachoma of public health significance (27 LGAs with TF prevalence ≥10% and 40 LGAs with trichiasis prevalence ≥0.2%, of which 22 LGAs required public-health-level trichiasis interventions [S], 9 LGAs required A, F and E, and 18 LGAs required S, A, F and E). Health ministries in the three states and relevant LGA offices partnered with the non-governmental organisation Sightsavers to intervene against trachoma.

Interventions commenced in 2003 with provision of trichiasis surgery in six LGAs (including Arewa, Argungu and Augie) of Kebbi, five LGAs (including Goronyo, Illela, Isa and Rabah) of Sokoto and four LGAs (including Birnin Magaji, Shinkafi and Zurmi) of Zamfara. By the end of 2016, in the 15 LGAs under review here, a total of 19,860 trichiasis surgeries had been carried out (Table 1).

MDA of antibiotics commenced in 2004, using oral azithromycin (Zithromax®, Pfizer, New York, NY, USA) and/or 1% tetracycline eye ointment, each of which was purchased on the open market. Funding

Table 1. Results of 15 selected baseline trachoma prevalence surveys conducted from 2004 to 2006, and consequent public health-level actions, Kebbi, Sokoto and Zamfara States, Nigeria[14,15,unpublished data].

State	Local government area	Year of baseline survey	Trichiasis prevalence (≥15 years old, %)[a]	Action (S)	TF prevalence (1–9 years old, %)[a]	Action (A, F, E)
Kebbi	Arewa	2004	1.0	2390	13.6	3 years MDA, BCC
	Argungu	2004	1.8	2415	16.3	3 years MDA, BCC
	Augie	2004	0.9	1675	21.3	3 years MDA, BCC
Sokoto	Binji	2006	2.1	413	29	3 years MDA, BCC
	Gada	2004	3.1	1632	29.1	3 years MDA, BCC
	Goronyo	2004	5.9	1290	26.8	3 years MDA, BCC
	Gwadabawa	2006	4.0	927	49	5 years MDA, BCC
	Illela	2004	3.1	1309	29.7	3 years MDA, BCC
	Isa	2004	2.9	2163	13.5	3 years MDA, BCC
	Kware	2006	5.6	666	43	5 years MDA, BCC
	Rabah	2004	2.8	1339	21.4	3 years MDA, BCC
	Tangaza	2004	2.7	1431	21.4	3 years MDA, BCC
Zamfara	Birnin Magaji	2004	1.4	696	32.1	5 years MDA, BCC
	Shinkafi	2004	1.2	803	17.9	3 years MDA, BCC
	Zurmi	2004	1.1	711	22.7	3 years MDA, BCC

[a]Unadjusted.
A = antibiotics; BCC = behaviour change communication; F = facial cleanliness; E = environmental improvement; MDA = mass drug administration; S = surgery; TF = trachomatous inflammation—follicular; TT = trachomatous trichiasis.

limitations meant that quantities of antibiotics available prior to 2010 were very limited, and as a consequence, MDA was somewhat patchy and irregular. Donated azithromycin (Zithromax®, Pfizer, supplied through the International Trachoma Initiative[9]) became available in 2010 in Arewa (Kebbi), Gwadabawa (Sokoto) and Birnin Magaji (Zamfara) and was expanded in 2011 to include two further LGAs in Kebbi and 14 further LGAs in Sokoto (Figure 1).

The facial cleanliness and environmental improvement aspects of the SAFE strategy were principally implemented through health education and community sensitisation. Front-line heath workers (government employees) provided basic health education alongside other primary health care duties at community health centres on a daily basis. Community drug distributors displayed and discussed posters about transmission, prevention and treatment of trachoma during community meetings and MDA events, with the aim of encouraging safer hygiene practices and facial cleanliness. Trachoma-endemic communities were also provided with sanitation hardware (e.g., wheelbarrows, shovels) to be used during monthly general sanitation exercises for ensuring that faeces was disposed of in ways that kept it away from human contact. Community members were encouraged to build toilets. Trained ophthalmic nurses also carried out community mobilisation and health education about trachoma during MDA and trichiasis surgery

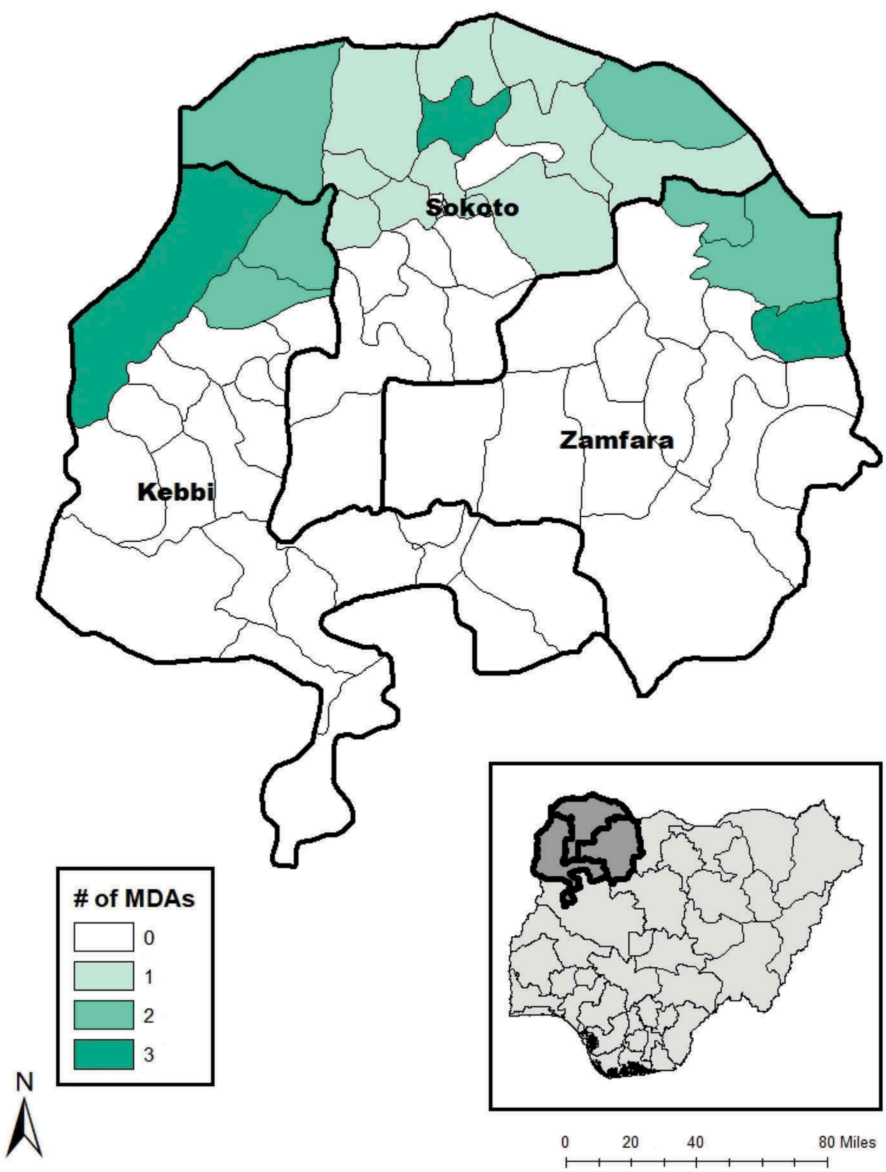

Figure 1. Number of rounds of antibiotic mass drug administration (MDA) for trachoma, Kebbi, Sokoto and Zamfara States, Nigeria, 2010–2013.

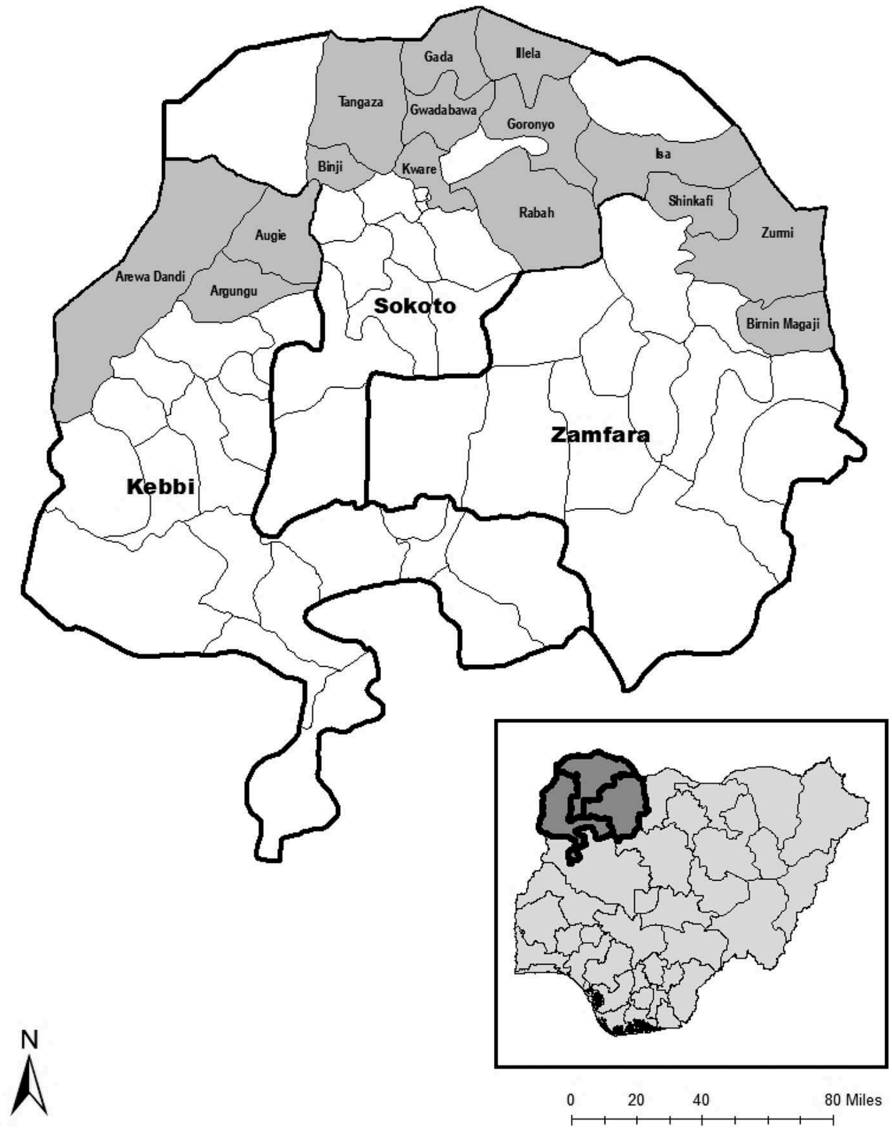

Figure 2. Local government areas for trachoma impact surveys, Kebbi, Sokoto and Zamfara States, Nigeria, 2014–2016.

campaign activities, and encouraged, through inspection, the use of sanitation facilities.

Impact survey rationale and design

Beginning in 2014, in each of the 15 LGAs (Figure 2), we conducted cross-sectional population-based prevalence surveys of persons aged ≥1 year, selected using multi-stage cluster random sampling. These LGAs had not necessarily completed the WHO-recommended numbers of MDA rounds indicated by their baseline TF prevalence,[12] but given the chequered history of intervention and the long time period elapsed since the previous round of surveys, re-focussing the programme by undertaking fresh estimates was felt to be a good idea.

We determined the required sample size for each LGA based on the requirements to estimate a TF prevalence around the elimination threshold, using the single-population proportion-for-precision formula: $n = 1.2 \times (\text{design effect}) \times p(1 - p)/(2 \times d/((1.96 \times 2)^2))$. We used the following assumptions[11,17]: expected TF prevalence in 1–9-year-olds (p) = 4%, required absolute precision (d) = 2%, risk of α error = 5% and design effect = 2.65. The calculated minimal sample size was 978 children.

In each LGA (with the exception of Arewa), we selected 25 clusters (villages) from a list of all villages in the LGA, using a probability-proportional-to-village-size methodology.[12] We then segmented each selected village (using pre-existing administrative units of approximately equal size) and selected one of the units at random, by drawing lots. From the selected administrative unit, 25 households were selected using the random walk method.[18–23] Based on there being a mean of two children aged 1–9 years per household, this was expected to allow recruitment from a resident population of 1250 1–9-year-olds in each LGA, which would allow for partial non-response. In Arewa, we subdivided the LGA into four subunits and selected 25 clusters from each, in order to investigate how much additional information sub-district-level surveys would provide in this environment at the impact survey stage; thus a total of 100 clusters were selected in Arewa. All residents aged ≥1 year, living in selected households, were invited to participate.

Pre-survey field team training, certification and data collection techniques followed standard GTMP protocols.[17] We used version 3 of the GTMP training system.[24]

Ethics

Protocols were approved by the Ethics Committees of the Ministries of Health of Kebbi and Sokoto States, the National Health Research Ethics Committee of Nigeria (NHREC/01/01/2007) and the London School of Hygiene & Tropical Medicine (6319 and 8355), while Zamfara State Ministry of Health gave permission for the survey in the absence of a State Ethics Committee. After field teams explained the examination protocol to each adult in a language they understood, verbal consent for enrolment and examination was obtained. (Most survey participants could neither read nor write.) Heads of households gave consent for the participation of minors, while adults gave consent for their own participation. Consent was documented in an Open Data Kit-based Android smartphone application (LINKS).[25] Individuals with active trachoma were given two tubes of 1% tetracycline eye ointment and instructed on its use; persons with trichiasis were referred for lid surgery at the nearest facility at which certified trichiasis surgeons could be accessed. Examiners cleaned their hands with an alcohol-based skin cleaning agent after examination of each participant.

Data collection and definitions

We used the WHO simplified grading scheme to grade trachoma.[26] We recorded the presence or absence of TF, trachomatous inflammation—intense, and trichiasis, on the basis of the assessments of GTMP-certified trachoma graders, one of whom examined each subject using ×2.5 magnifying loupes. In any eye with trichiasis, the grader noted the presence or otherwise of trachomatous conjunctival scarring.[27] For the purposes of this paper, we defined TT as the presence of trichiasis plus trachomatous conjunctival scarring (or the grader finding the upper eyelid impossible to evert) in the same eye. GPS coordinates for each household were recorded, and data on household-level access to water and sanitation were collected through interviews and inspection (where relevant) of household sanitation facilities. Sanitation facilities were categorised as improved or unimproved, as per the WHO/UNICEF Joint Monitoring Program (JMP) for Water Supply and Sanitation definitions used for monitoring progress towards the Millennium Development Goals.[28] Water sources referred to those used for washing purposes, and not specifically for drinking. Types of water sources were categorised as improved and unimproved as per the JMP definitions.[28] A household was defined as a compound head together with all individuals normally resident in the compound and eating from the same pot.

Data analysis

Data cleaning was undertaken by an objective (non-programme-linked) data manager (RW). Data analysis was performed using R (R Foundation for Statistical Computing, Vienna, Austria) and Structured Query Language. We controlled for age and gender of those examined, and the total number of people examined per cluster, using algorithms applied across all constituent projects of the GTMP.[18–23,29–49] For TF, the proportion of children aged 1–9 years who had that sign in each cluster was adjusted for age in 1-year age bands. For trichiasis and TT, the proportion of adults aged ≥15 years who had that sign in each cluster was adjusted for age and gender in 5-year age bands. Arithmetic means of the adjusted cluster-level proportions gave the LGA prevalence for each sign. Confidence intervals were generated by bootstrapping, with replacement, the adjusted cluster-level proportions, over 10,000 iterations.

Results

Surveys were conducted between 2014 and 2016. The number of households enrolled per LGA ranged from 623 (Kware and Tangaza) to 2488 (Arewa). The number of children aged 1–9 years examined exceeded the sample size estimate in every LGA except Kware, where 921 children (94% of the target) were examined. At least as many persons aged ≥15 years as children aged 1–9 years were included in most LGAs – a reflection of local demographics rather than refusal to participate, which was rare (Table 2).

Prevalence of trachoma

Prevalence estimates for TT in ≥15-year-olds and TF in 1–9-year-olds years old are shown in Table 3. Following a 2015 impact survey (using the same methodologies described above) in which the TF prevalence in 1–9-year-olds years old was estimated to be 5.4%, Birnin Magaji was given one further round of azithromycin MDA, in 2016. An impact survey was conducted 8 months later; the TT and TF prevalence estimates reported in Table 3 (and the data provided in Tables 2 and 5) are those generated in the second impact survey, which followed a total of four rounds of azithromycin MDA.

Marked reductions compared to baseline estimates, in both the TT and TF indices, were noted in all 15 LGAs. In the various sub-districts in Arewa, the prevalence of TF in 1–9-year-olds ranged from 2.2% to 5.7%, while the prevalence of TT in persons ≥15-year-olds ranged from 0.5% to 1.1% (Table 4).

If the trichiasis prevalence at baseline is compared to the all-trichiasis prevalence at impact survey (ignoring the presence or absence of trachomatous conjunctival scarring), prevalence reductions from baseline to impact are still noted (Table 5).

Access to water and sanitation

Across LGAs, access to a water source within 1 km of households ranged from 49% to 96%, while access to an improved water source ranged from 2% (Tangaza) to 79% (Birnin Magaji). Across all LGAs surveyed, access to improved sanitation facilities was generally low, with Birnin Magaji (59%) having the highest levels of access (Table 6).

Discussion

In the LGAs for which we report trachoma impact survey data here, there has been implementation of some or all aspects of the SAFE strategy to varying extents. Eight of the 15 LGAs (Arewa, Argungu, Gwadabawa, Kware, Rabah, Birnin Magaji, Shinkafi and Zurmi) have now attained the elimination target for TF (<5% prevalence in 1–9-year-olds) and so enter the 2-year surveillance phase.[50] Implementation of azithromycin MDA, even though irregular, combined with education on the need for personal and environmental hygiene, likely contributed to declines in TF prevalence. Reduced TF prevalence is associated with a reduction in the reservoir of ocular *C. trachomatis*, so this is expected to be accompanied by decreased community transmission intensity[51] and, ultimately, a fall in the incidence of TT.[52]

We are, however, unable to confidently credit apparent falls in TF prevalence (Table 3) to implementation of the A, F and E components of the SAFE strategy. We cannot even say with certainty that prevalence estimates at impact survey were significantly lower than at baseline: scrutiny of the baseline survey methodologies and data could not be undertaken because the original datasets (and for some, even survey reports) could not be located, despite intensive search. Baseline surveys conducted in these LGAs used methodologies that almost certainly diverged in important ways from the standards that were set up some years later by the GTMP, including the fact that the graders were not internationally standardised. Furthermore, the present study was not a randomised trial, but a series of post-intervention surveys, and intervention delivery was intermittent, incomplete and hard to quantify for each of the A, F and E

Table 2. Enumeration and examination characteristics of sampled individuals in 15 local government areas, impact surveys for trachoma, Kebbi, Sokoto and Zamfara States, Nigeria, 2014–2016.

			Persons enumerated			Persons examined, *n* (%)		Persons absent		Persons refusing examination	
State	Local government area	Households surveyed	Total	1-9-year-olds	≥15-year-olds	1-9-year-olds	≥15-year-olds	1-9-year-olds	≥15-year-olds	1-9-year-olds	≥15-year-olds
Kebbi	Argungu	765	4620	1754	2304	1651 (94)	1880 (82)	52	362	51	62
	Augie	745	4388	1892	2057	1853 (98)	1861 (90)	22	179	17	16
	Arewa	2488	13,606	5642	6733	5283 (94)	5672 (84)	190	895	169	166
Sokoto	Gada	625	3385	1462	1589	1375 (94)	1294 (81)	39	146	47	148
	Gwadabawa	726	3538	1458	1790	1370 (94)	1272 (71)	44	397	44	121
	Kware	623	2698	956	1511	921 (96)	1388 (92)	7	110	28	13
	Binji	625	3147	1275	1543	1246 (98)	1359 (88)	11	90	18	94
	Goronyo	624	3694	1655	1622	1537 (93)	1239 (76)	72	175	46	208
	Illela	624	3189	1300	1578	1255 (97)	1340 (85)	19	136	26	102
	Isa	624	3598	1449	1690	1374 (95)	1314 (78)	43	213	32	162
	Rabah	626	3368	1374	1598	1288 (94)	1205 (75)	50	184	36	208
	Tangaza	623	3210	1300	1539	1241 (95)	1318 (86)	20	126	39	95
Zamfara	Birnin Magaji[a]	624	3701	1547	1814	1400 (90)	1537 (85)	88	233	59	44
	Shinkafi	897	4285	1799	2120	1772 (98)	1828 (86)	12	221	15	71
	Zurmi	895	5092	1927	2646	1792 (93)	2259 (85)	74	377	61	10

[a]Second impact survey (2016).

Table 3. Prevalence of trachomatous inflammation—follicular (TF) and trichiasis or trachomatous trichiasis (TT) at baseline and impact surveys, 15 local government areas of Kebbi, Sokoto and Zamfara States, Nigeria.

			Baseline survey data						Impact survey data		
State	Local government area	Population	Year	Trichiasis[a] prevalence in ≥15-year-olds, % [95% confidence interval]	Estimated TT backlog	TF prevalence in 1-9-year-olds, % [95% confidence interval]	Number of people operated for TT	Rounds of MDA	Year	TT prevalence in ≥15-year-olds, % [95% confidence interval]	TF prevalence in 1-9-year-olds (%) [95% confidence interval]
Kebbi	Argungu	200,248	2004	1.8 [0.5–3.1]	2018	16.3 [12.6–20.0]	2415	3	2014	0.05 [0.00–0.14]	2.8 [1.7–4.3]
	Augie	116,368	2004	0.9 [0–1.8]	586	21.3 [17.1–25.5]	1675	3	2014	0.26 [0.07–0.48]	6.7 [4.1–10.0]
	Arewa	198,728	2004	1.0 [0.1–1.9]	1113	13.6 [10.2–17.0]	2390	3	2014	0.77 [0.51–1.10]	4.3 [3.3–5.4]
Sokoto	Gada	249,051	2004	3.1 [1.6–4.6]	4324	29.1 [24.7–33.5]	1632	3	2016	0.1 [0.0–0.3]	9.7 [6.5–13.5]
	Gwadabawa	231,569	2006	4.0 [2.5–6.3]	5187	49 [42.9–55.1]	927	5	2014	0.03 [0.00–0.08]	4.2 [2.2–7.1]
	Kware	134,084	2006	5.6 [3.2–8.0]	4205	43 [36.9–49.1]	666	1	2014	0.3 [0.1–0.4]	2.2 [0.7–2.9]
	Binji	104,274	2006	2.1 [0.6–3.6]	1226	29 [23.4–3.6]	413	3	2016	0.4 [0.0–0.9]	5.9 [4.1–7.9]
	Goronyo	182,118	2004	5.9 [3.8–8.0]	6017	26.8 [22.5–31.1]	1290	3	2016	0.03 [0.0–0.1]	7 [4.8–9.1]
	Illela	150,133	2004	3.1 [1.6–4.6]	2606	29.7 [25.4–34.0]	1309	3	2016	0.04 [0.0–0.09]	10.3 [7.2–14.3]
	Isa	150,268	2004	2.9 [1.5–4.3]	2440	13.5 [10.2–16.8]	2163	3	2016	0.04 [0.0–0.12]	5.4 [3.7–7.7]
	Rabah	149,152	2004	2.8 [1.4–4.2]	2339	21.4 [17.5–25.3]	1339	3	2016	0	3.8 [1.5–5.7]
	Tangaza	114,770	2004	2.7 [1.3–4.1]	1735	21.4 [17.5–25.4]	1431	3	2016	0.1 [0.0–0.28]	6.5 [4.3–9.3]
Zamfara	Birnin Magaji[b]	184,083	2004	1.4 [0.4–2.4]	1443	32.1 [27.6–36.6]	696	4	2016	0.22 [0.07–0.43]	1.7 [1.1–2.3]
	Shinkafi	135,964	2004	1.2 [0.25–2.15]	914	17.9 [14.1–21.6]	803	3	2015	0.01 [0.00–0.04]	1.4 [0.5–2.9]
	Zurmi	293,977	2004	1.1 [0.2–1.9]	1811	22.7 [18.7–26.7]	711	3	2015	0.18 [0.03–0.38]	1.2 [0.6–2.1]

[a]Baseline surveys were conducted by other investigators; for many of these surveys, fieldwork and analysis protocols could not be located. Baseline survey data have been provided as reported, and only as a comparator for our impact survey data. We assume, based on then-current practice that the presence of TS was not required for "trachomatous trichiasis" to be diagnosed at baseline, even though the survey reports refer to prevalence estimates of "trachomatous trichiasis".

[b]Second impact survey (2016).

Table 4. Prevalence of trachomatous inflammation—follicular (TF) and trachomatous trichiasis (TT), impact surveys, four sub-districts of Arewa local government area, Kebbi State, Nigeria, 2014.

		1-9-year-olds					≥15-year-olds				
Sub-district	Number of households sampled	Residents enumerated	Residents examined	Absent	Refused	TF prevalence[a] (95% CI)	Residents enumerated	Residents examined	Absent	Refused	TT prevalence[b] (95% CI)
1	595	1406	1271	48	87	5.1 (2.6–8.2)	1645	1438	183	22	1.1 (0.6–1.6)
2	599	1266	1202	27	37	4.1 (2.2–5.9)	1564	1326	191	46	1.0 (0.5–1.5)
3	648	1450	1365	68	16	2.2 (1.2–3.4)	1686	1408	262	16	0.6 (0.1–1.4)
4	646	1520	1445	47	28	5.7 (3.6–8.4)	1838	1500	259	79	0.5 (0.1–1.1)

[a]Adjusted for age in 1-year age bands.
[b]Adjusted for gender and age in 5-year age bands.
CI = confidence interval.

Table 5. Number of individuals with trichiasis, number of individuals with trichiasis + trachomatous conjunctival scarring (a combination referred to here as trachomatous trichiasis, TT: see text) and prevalence of each of these things, impact surveys, 15 local government areas (LGAs) of Kebbi, Sokoto and Zamfara States, Nigeria, 2014–2016.

State	LGA	Number of ≥15-year-olds with trichiasis	Trichiasis prevalence in ≥15-year-olds, % (95% confidence interval)	Number of ≥15-year-olds with TT	TT prevalence in ≥15-year-olds, % (95% confidence interval)
Kebbi	Argungu	13	0.53 (0.11–1.23)	3	0.05 (0.00–0.14)
	Augie	17	0.49 (0.19–0.86)	9	0.26 (0.07–0.48)
	Arewa	17	0.77 (0.52–1.09)	9	0.77 (0.51–1.10)
Sokoto	Gada	8	0.99 (0.35–1.79)	3	0.1 (0.0–0.3)
	Gwadabawa	16	0.82 (0,45–1.28)	10	0.03 (0.00–0.08)
	Kware	8	0.26 (0.11–0.42)	8	0.3 (0.1–0.4)
	Binji	22	1.83 (0.87–3.22)	8	0.4 (0.0–0.9)
	Goronyo	13	0.70 (0.16–1.64)	1	0.03 (0.0–0.1)
	Illela	16	0.68 (0.27–1.23)	2	0.04 (0.0–0.09)
	Isa	9	0.36 (0.11–0.75)	2	0.04 (0.0–0.12)
	Rabah	4	0.20 (0.03–0.48)	0	0
	Tangaza	8	0.22 (0.05–0.48)	4	0.1 (0.0–0.28)
Zamfara	Birnin Magaji	10	0.30 (013–0.51)	7	0.22(0.07–0.43)
	Shinkafi	4	0.09 (0.01–0.19)	1	0.01 (0.00–0.04)
	Zurmi	9	0.22 (0.06–0.42)	6	0.18 (0.03–0.38)

components. Though our survey methodology is considered best-in-class,[53] we acknowledge residual weaknesses, including the use of random walk to select households in Nigeria; reliance on self-report of access to water and use of sanitation; exclusive focus in questions about sanitation use on where household adults defecate (ignoring sites of disposal of children's faeces); suboptimal recruitment (Table 2); and relatively low sample sizes of adults.

Notwithstanding these limitations, our data reveal a need to improve access to water and sanitation in these LGAs. From the perspective of sustaining progress against active trachoma, if water and sanitation[54] and behaviour change efforts[55] do in fact help to reduce *C. trachomatis* transmission, as many believe,[56,57] there is a particular imperative to undertake these activities in the LGAs that have entered the surveillance phase on the pathway towards elimination. In these populations,

Table 6. Household access to water and improved sanitation facilities, 15 local government areas of Kebbi, Sokoto and Zamfara States, Nigeria, 2014–2016.

State	Local government area	Access to a water source for washing within 1 km of the household, %	Access to an improved water source, %	Access to an improved sanitation facility, %
Kebbi	Argungu	96	72	42
	Augie	88	33	12
	Arewa	82	53	10
Sokoto	Gada	54	33	17
	Gwadabawa	62	17	16
	Kware	71	28	24
	Binji	90	7	11
	Goronyo	74	30	29
	Illela	81	8	20
	Isa	85	44	34
	Rabah	65	21	28
	Tangaza	89	2	22
Zamfara	Birnin Magajia	89	79	59
	Shinkafi	67	58	25
	Zurmi	49	53	19

[a]Second impact survey (2016).

antibiotics will no longer be used to suppress the prevalence of infection, and keeping transmission intensity low presumably depends on how successful F and E have been. While >80% of households we sampled in Arewa and Birnin Magaji had access to washing water within 1 km of the residence, the other four LGAs in which TF was <5% fell short of this mark. Of particular concern in all LGAs is the very low access to improved sanitation facilities, which may presage high muscid fly densities and a greater chance of transmission of residual infection.[58–61] In rural areas of Nigeria as a whole, in the interval between 2000 and 2015, access to improved sanitation reportedly decreased from 35% to 27% – a trend that, if continuing, requires urgent correction – while access to improved drinking water sources increased from 36% to 62%.[62]

Although Arewa as a whole achieved the TF elimination prevalence target, two of its sub-districts had TF prevalences above that mark, estimated in fully fledged independent surveys with more-than-adequate sample sizes (Table 4). TF prevalences, however, were not significantly different between the sub-districts. This observation, though limited in scope, probably supports the recent revision[50] to WHO guidance on impact surveys, in which previous recommendations[63] to frame impact surveys at sub-district level were changed in favour of districts being the standard evaluation unit at baseline, impact and surveillance phases of the programme. We will, however, keep a close watch for recrudescence of disease in the communities of Arewa.

Six surveyed LGAs (Augie, Gada, Binji, Goronyo, Isa and Tangaza) require one round of azithromycin MDA before impact surveys are repeated. During this period, education on personal and environmental hygiene must be ongoing. However, for education to be accepted and implemented by communities, access to water and sanitation needs to be improved: all these LGAs had poor household access to improved sanitation, and two of them (Gada and Goronyo) also had <80% household access to washing water within 1 km of the household. One LGA (Illela) had a TF prevalence indicating a need for three further rounds of azithromycin MDA together with F and E.

The estimated TT prevalence was lower at impact survey than at baseline survey in all LGAs. In Arewa, the TT prevalence in sub-district 1 in 2014 (1.1, 95% CI 0.6–1.6) was, at face value, higher than the whole-LGA trichiasis prevalence in 2004 (1.0, 95% CI 0.1–1.9), despite more than double the estimated 2004 backlog of Arewa trichiasis patients having been managed in the intervening period (Tables 1 and 3). This result should be more realistically interpreted in the light of the imprecision of each estimate, but can also be taken as a cautionary note against comparing prevalence estimates generated at different administrative levels at different times. Looking solely at LGA-level data, there is also a lesson here about the continuing incidence of TT even as TF prevalence falls, and the pitfalls inherent in using surgical output data to predict the success or otherwise of meeting the TT elimination threshold prevalence.[27]

Ten LGAs recorded TT prevalences of <0.2% in ≥15-year-olds, the elimination threshold. In these LGAs, there may be a reduced need for community-based TT surgery, but structures to identify and treat individuals who develop TT should be maintained.[3] Robust follow-up mechanisms should also be continued, in order to detect post-surgical recurrence in those previously operated, and to ensure patients who elected for epilation over surgery but eventually want more formal intervention are able to access it. In LGAs with TT prevalence estimates ≥0.2%, progress (shown by reductions in trichiasis prevalence, Tables 3 and 5) should also be celebrated, with an eye to encouraging local teams to redouble their efforts towards achieving elimination targets. Health ministries will review the number, distribution, and motivation of surgeons, and the extent to which they are adequately equipped with the materials necessary to do their jobs.

Much progress has been made towards the elimination of trachoma in Kebbi, Sokoto and Zamfara States. While some LGAs still require antibiotic MDA, greater emphasis needs to be placed on collaboration with agencies involved in water and sanitation to improve access to these services. In addition, community-based trichiasis surgery needs to be reinforced in four LGAs to finish the task of elimination of trachoma as a public health problem.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Funding

This study was principally funded by the Global Trachoma Mapping Project (GTMP) grant from the United Kingdom's Department for International Development (ARIES: 203145) to Sightsavers, which led a consortium of non-governmental organisations and academic institutions to support health ministries to complete trachoma prevalence surveys. The GTMP was also funded by the United States Agency for International Development (USAID), through the ENVISION project implemented by RTI International under cooperative agreement number AID-OAA-A-11-00048, and the END in Asia project implemented by FHI360 under cooperative agreement number OAA-A-10-

00051. A committee established in March 2012 to examine issues surrounding completion of global trachoma mapping was initially funded by a grant from Pfizer to the International Trachoma Initiative. AWS was a Wellcome Trust Intermediate Clinical Fellow (098521) at the London School of Hygiene & Tropical Medicine, and is now, like SB and BAG, a staff member of the World Health Organization. The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated. None of the funders had any role in project design, in project implementation or analysis or interpretation of data, in the decisions on where, how or when to publish in the peer reviewed press, or in preparation of the manuscript.

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