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Progress of Trachoma Mapping in Mainland Tanzania: Results of Baseline Surveys from 2012 to 2014

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ABSTRACT

Purpose: Following surveys in 2004–2006 in 50 high-risk districts of mainland Tanzania, trachoma was still suspected to be widespread elsewhere. We report on baseline surveys undertaken from 2012 to 2014.

Methods: A total of 31 districts were surveyed. In 2012 and 2013, 12 at-risk districts were selected based on proximity to known trachoma endemic districts, while in 2014, trachoma rapid assessments were undertaken, and 19 of 55 districts prioritized for baseline surveys. A multi-stage cluster random sampling methodology was applied whereby 20 villages (clusters) and 36 households per cluster were surveyed. Eligible participants, children aged 1–9 years and people aged 15 years and older, were examined for trachoma using the World Health Organization simplified grading system.

Results: A total of 23,171 households were surveyed and 104,959 participants (92.3% of those enumerated) examined for trachoma signs. A total of 44,511 children aged 1–9 years and 65,255 people aged 15 years and older were examined for trachomatous inflammation–follicular (TF) and trichiasis, respectively. Prevalence of TF varied by district, ranging from 0.0% (95% confidence interval, CI 0.0–0.1%) in Mbinga to 11.8% (95% CI 6.8–16.5%) in Chunya. Trichiasis prevalence was lowest in Urambo (0.03%, 95% CI 0.00–0.24%) and highest in Kibaha (1.08%, 95% CI 0.74–1.43%).

Conclusion: Only three districts qualified for mass drug administration with azithromycin. Trichiasis is still a public health problem in many districts, thus community-based trichiasis surgery should be considered to prevent blindness due to trachoma. These findings will facilitate achievement of trachoma elimination objectives.

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Baseline survey; GTMP; SAFE strategy; Tanzania; trachoma; trichiasis

Background

Trachoma, a neglected tropical disease, is the most common infectious cause of blindness, responsible for visual impairment in about 2.2 million people, of whom 1.2 million are irreversibly blind.[1] The World Health Organization (WHO) Alliance for the Global Elimination of Blinding Trachoma by 2020 (GET2020) is an initiative endorsed by the World Health Assembly in 1998 with the goal of eliminating trachoma through the SAFE strategy.[2,3] The SAFE strategy comprises: (1) Surgery for trichiasis to correct in-turned eyelashes, stopping pain and minimizing progression of corneal damage;[4] (2) Antibiotics to clear conjunctival *Chlamydia trachomatis* infection using annual single-dose oral azithromycin;[5] (3) Facial cleanliness through sustained behavior change;[6] and (4) Environmental improvement to increase access to water and sanitation.[7] Prior to SAFE implementation, baseline surveys of trachoma prevalence are needed to guide programs about where to implement interventions.[8]

In mainland Tanzania, trachoma has been documented as a serious public health problem in large parts of the country. While there are no nationally representative data

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on blindness, a survey in 1990 in Central Tanzania estimated that 26% of blindness was due to trachoma.[9] Surveys of trachoma undertaken in 2004–2006 in 50 districts showed that 43 districts had trachomatous inflammation–follicular (TF) prevalences of 10% and above, and were thus eligible for implementation of the A, F and E components of the SAFE strategy.[10] By 2012, large parts of the country were still suspected to be endemic for trachoma; therefore, further baseline surveys were required to plan for implementation of the SAFE strategy with the target of achieving GET2020 objectives. We report results of baseline prevalence surveys undertaken in 31 districts of mainland Tanzania in 2012–2014.

Materials and methods

Study setting

Surveys were undertaken in 9, 3, and 19 districts in 2012, 2013, and 2014, respectively (Figure 1). In 2012 and 2013, the survey districts were selected because they were adjacent to districts known to be trachoma endemic from the 2004–2006 surveys,[10] and had low water and sanitation coverage (based on routine data collection). However, since none of the districts surveyed in 2012 or 2013 were found to be endemic for trachoma, trachoma rapid assessments (TRA)[11] were undertaken in 55 un-surveyed rural districts to prioritize those in which population-based surveys were warranted. A total of 19 districts were selected for surveys in 2014 on the basis of ≥30 trichiasis surgeries performed over the previous 5 years, ≥15% proportion of active trachoma (TF and/or trachomatous inflammation-intense) in examined children aged 1–9 years, and/or ≥5% proportion of trichiasis in examined people aged 15 years and older, based on TRA results.

Sample size estimation

To estimate the district prevalence of TF among children aged 1–9 years, the sample size was calculated assuming an expected prevalence of 20% with an absolute precision of ± 5%, 95% confidence level, a design effect of 4 and 10% non-response rate. A minimum sample size of 1082 children aged 1–9 years was required in each district. Assuming that 30% of the population was aged between 1 and 9 years, and an average household size of 4.8 persons,[12] it was

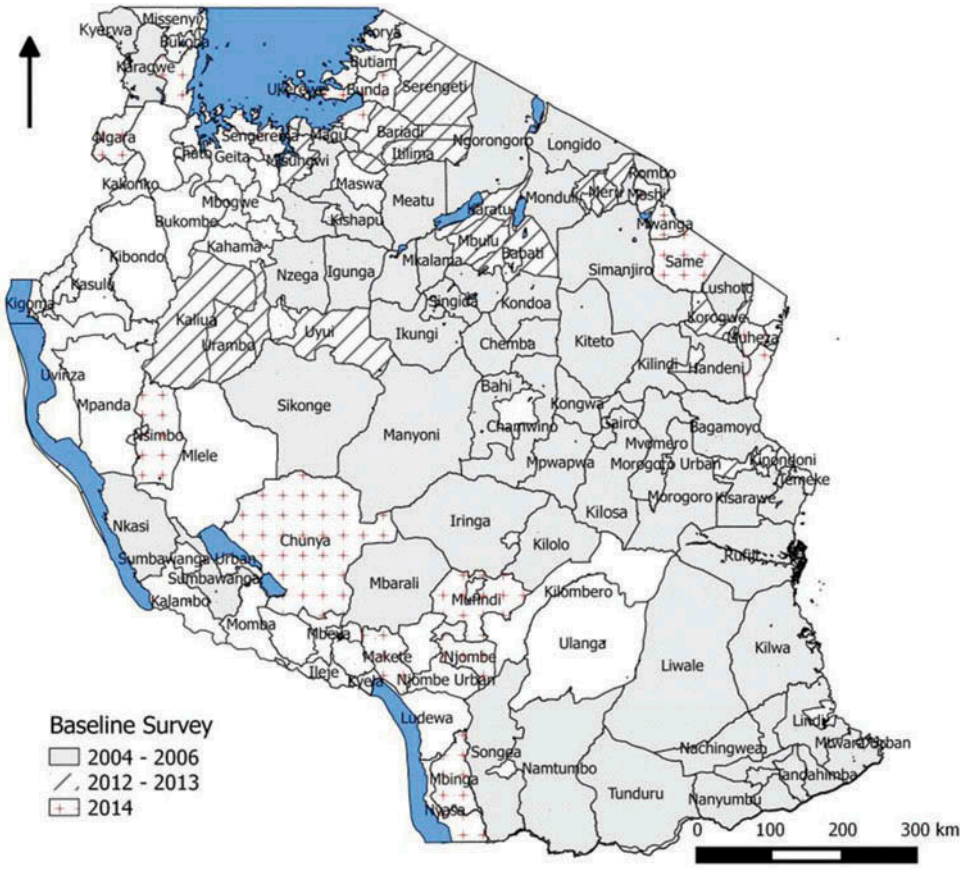

Figure 1. Map of Tanzania showing districts previously surveyed for trachoma in 2004–2006 and locations of districts surveyed in 2012–2014.

necessary to sample a total of 721 households. The number of clusters per district was set at 20, therefore a total of 36 households were to be sampled per cluster, in order to reach the required sample size.

The sample size for trichiasis was calculated assuming an expected prevalence of 2%, with an absolute precision of 1%, 95% confidence level, 5% level of significance and 10% non-response rate. Based on these parameters, a total of 1657 adults aged 15 years and older in each district were required to be sampled. With 50% of the population estimated to be aged 15 years and older and an average household size of 4.8 persons,[12] it was necessary to sample 663 households per district in order to examine the required number of adults for trichiasis. This resulted in 33 households per cluster. Therefore, sampling the larger sample of 721 households ensured that the sample size for both TF and trichiasis were achieved. For the Global Trachoma Mapping Project (GTMP)-supported surveys conducted in 2014, these sample size calculations were accepted as providing outcomes equivalent to the templates used elsewhere for the GTMP.[13]

Sample selection

Selection of clusters

In mainland Tanzania, districts are sub-divided into divisions, wards and villages. Villages have populations ranging from 2000 to 5000 people;[14] they are sub-divided into hamlets (*kitongoji*), each with an average size of 100 households. A multi-stage cluster random sampling design was used. In the first stage, 20 clusters (villages) were randomly selected per district. The complete list of villages in each district was obtained from the National Bureau of Statistics. Village selection was stratified by ward to ensure adequate representation of the full geographical range of district residents. The number of villages selected per ward was proportional to the ward population, with at least one village selected from each ward. Villages were systematically selected in each ward. In each selected village, two hamlets were randomly selected.

Selection of households

A household was defined as persons living together and sharing meals. In the second sampling stage, in each of the two randomly selected hamlets, systematic random sampling was used to select 18 households making a total of 36 households per village. Village leaders were requested to prepare the list of households for each selected hamlet. The total number of households in a hamlet was divided by the required number of households per hamlet to obtain the sampling interval for systematic sampling. Thereafter, a table of random numbers was used to randomly select the starting household and subsequent households systematically identified by adding the sampling interval.

Selection of participants

In the third stage, within the selected households, all eligible household participants (children aged 1–9 years and people aged 15 years and older) were examined for trachoma signs.

Household interviews

Household interviews on water sanitation and hygiene (WASH) indicators were undertaken by trained interviewers. Heads of households were interviewed on types of water sources and distance to water source, while types of sanitation facilities used by the household were verified through observation. WASH questions differed slightly between the survey waves with the 2014 surveys using the standard GTMP questionnaire.[13]

Trachoma grading

Graders participating in the surveys had obtained kappa ≥0.7 for inter-grader agreement for TF compared to a qualified senior grader, as per the GTMP standards.[15] Eyelids and tarsal conjunctivae were examined using a 2.5× magnifying loupe and torch, looking for signs of active trachoma and its complications.

Data management and analysis

In 2012, data were collected using paper-based questionnaires and processed using the TELEFORM System (http://www.cardiff.com/products/teleform/) that enabled scanning of completed questionnaires into a database. In 2013 and 2014, data were collected electronically using Android tablets and smartphones and the LINKS system (https://gtmp.linkssystem.org/tanzania) developed for the GTMP, and processed as described elsewhere.[13,15] In 2012, data analysis was undertaken using Stata 12 (Stata Corporation, College Park, Texas, USA). Age- and sex-specific weights were calculated based on the 2012 population census and applied to all survey participants. Point prevalence estimates and confidence intervals (CIs) accounted for clustering of trachoma, standardization by age and sex, and the survey design.[16] Associations of trachoma signs and WASH indicators were explored using Spearman's rank test.

Ethical consideration

The surveys were undertaken as part of routine programmatic implementation of the SAFE strategy, therefore ethical clearance was not required a priori. Permission to conduct all surveys was obtained from the Ministry of Health and Social Welfare. Approval for the GTMP-supported surveys in 2014 was obtained from the ethics committee of the London School of Hygiene & Tropical Medicine (reference 6319). Written consent forms (in Swahili) were signed by heads of households selected to participate in the survey. Personal identifiers were removed from the datasets before analyses were undertaken. Permission to publish these data was granted by the Director General, National Institute for Medical Research, Tanzania.

Results

Survey population characteristics

Table 1 summarizes the characteristics of the population examined by district. A total of 104,959 participants (92.3% of those enumerated) in 23,171 households from 620 clusters in 31 districts were examined. The proportion of male participants was 50.0% among children 1–9 years and 44.8% among people aged 15 years and older. The mean age was 5.2 (standard deviation, SD, 2.6) years among children aged 1–9 years and 37.0 (SD 18.4) years among people aged 15 years and older.

Prevalence of trachoma signs

The prevalence of trachoma signs is shown in Table 2 and Figure 2. A total of 43,568 children aged 1–9 years and 61,373 people aged 15 years and older were examined for TF and trichiasis, respectively. Prevalence of TF varied by district, ranging from 0.0% (95% CI 0.0–0.1%) in Mbinga, to 11.8% (95% CI 6.8–16.5%) in Chunya. Among people aged 15 years and older, prevalence of trichiasis was lowest in Urambo (0.09%, 95% CI 0.00–0.24%) and highest in Kibaha (1.08%, 95% CI 0.74–1.43%).

Prevalence of access to water sanitation and hygiene

Table 3 summarizes key WASH indicators by district. The overall proportion of households that reported

Table 1. Characteristics of the survey population, population-based trachoma surveys, Tanzania, 2012–2014.

				Children aged 1–9 years		People aged 15 years and older	
Region	District	Year of survey	Households sampled, *n*	Examined, *n*	Proportion male, %	Examined, *n*	Proportion male, %
Arusha	Arumeru District Council	2012	754	1292	50.2	1964	48.7
Arusha	Karatu District Council	2012	749	1499	49.8	2051	49.3
Iringa	Mufindi District Council	2014	778	1772	52.1	2048	45.0
Kagera	Muleba District Council	2014	730	1669	49.6	2057	45.6
Kagera	Ngara District Council	2014	726	1663	48.5	1981	43.7
Katavi	Nsimbo District Council	2014	724	1731	49.8	2178	46.1
Kilimanjaro	Moshi District Council	2014	743	1379	49.8	2112	41.4
Kilimanjaro	Mwanga District Council	2014	724	1226	48.4	2105	42.5
Kilimanjaro	Same District Council	2014	733	1201	51.5	2128	42.9
Kilimanjaro	Siha District Council	2013	857	1181	48.6	2198	45.0
Manyara	Babati District Council	2012	753	1285	49.7	2178	48.0
Manyara	Mbulu District Council	2012	775	1396	50.6	1821	46.5
Mara	Bunda District Council	2014	724	1513	50.1	2203	43.2
Mara	Serengeti District Council	2012	823	1191	50.9	2269	45.9
Mbeya	Chunya District Council	2014	735	1200	47.0	2164	43.5
Mtwara	Mtwara Municipal Council	2014	726	1263	48.3	2263	36.8
Mwanza	Misungwi District Council	2013	726	1282	50.6	2170	44.0
Mwanza	Sengerema District Council	2014	722	1389	48.3	2294	45.7
Njombe	Makete District Council	2014	813	1261	51.0	1965	43.5
Njombe	Njombe District Council	2014	756	1501	50.0	1948	45.7
Njombe	Wanging'ombe District Council	2014	777	1229	49.0	1990	45.6
Pwani	Kibaha District Council	2013	769	1561	50.9	2096	41.4
Ruvuma	Mbinga District Council	2014	730	1353	50.0	2115	46.9
Ruvuma	Nyasa District Council	2014	729	1324	48.7	2030	42.0
Simiyu	Bariadi District Council	2012	710	1338	49.1	2207	47.0
Simiyu	Busega District Council	2014	724	1729	50.2	2253	43.5
Tabora	Urambo District Council	2012	738	1743	51.2	2179	51.1
Tabora	Uyui District Council	2012	742	1152	51.8	2268	52.9
Tanga	Korogwe District Council	2012	733	1439	52.3	1952	46.7
Tanga	Muheza District Council	2014	725	1622	49.0	2048	40.0
Tanga	Pangani District Council	2014	723	1202	53.5	2020	37.8
Overall			23,171	43,586	50.0	65,255	44.8

Table 2. Prevalence of trachomatous inflammation–follicular (TF) among children aged 1–9 years and trichiasis among people aged 15 years and older, Tanzania, 2012–2014.

Region	District	TF, % (95% CI)	Trichiasis, % (95% CI)
Arusha	Arumeru District Council	1.9 (0.7–3.8)	0.31 (0.06–0.67)
Arusha	Karatu District Council	2.8 (1.5–4.6)	0.27 (0.00–0.65)
Iringa	Mufindi District Council	0.3 (0.1–0.6)	0.35 (0.14–0.63)
Kagera	Muleba District Council	3.0 (1.1–5.4)	0.35 (0.08–0.83)
Kagera	Ngara District Council	8.3 (4.5–12.9)	0.10 (0.00–0.27)
Katavi	Nsimbo District Council	3.9 (1.8–6.2)	0.34 (0.13–0.59)
Kilimanjaro	Moshi District Council	0.1 (0.0–0.4)	0.10 (0.00–0.27)
Kilimanjaro	Mwanga District Council	1.0 (0.1–2.4)	0.12 (0.00–0.21)
Kilimanjaro	Same District Council	1.0 (0.1–2.1)	0.05 (0.00–0.12)
Kilimanjaro	Siha District Council	3.2 (1.7–5.2)	0.20 (0.79–1.56)
Manyara	Babati District Council	0.3 (0.1–0.6)	0.55 (0.13–1.18)
Manyara	Mbulu District Council	2.8 (1.1–4.5)	0.80 (0.12–1.70)
Mara	Bunda District Council	4.1 (1.7–6.5)	0.22 (0.06–0.45)
Mara	Serengeti District Council	0.1 (0.0–0.2)	0.13 (0.05–0.39)
Mbeya	Chunya District Council	11.8 (6.8–16.5)	0.67 (0.37–0.99)
Mtwara	Mtwara Municipal Council	0.4 (0.1–0.9)	0.82 (0.38–1.25)
Mwanza	Misungwi District Council	5.5 (3.7–7.8)	0.12 (0.00–0.08)
Mwanza	Sengerema District Council	4.3 (2.8–6.3)	0.18 (0.02–0.36)
Njombe	Makete District Council	1.2 (0.5–2.2)	0.52 (0.25–0.79)
Njombe	Njombe District Council	0.3 (0.0–0.8)	0.28 (0.03–0.65)
Njombe	Wanging'ombe District Council	1.0 (0.3–1.7)	0.50 (0.21–0.85)
Pwani	Kibaha District Council	3.9 (1.0–6.8)	1.08 (0.74–1.43)
Ruvuma	Mbinga District Council	0.0 (0.0–0.1)	0.15 (0.03–0.24)
Ruvuma	Nyasa District Council	0.3 (0.1–0.6)	0.19 (0.02–0.35)
Simiyu	Bariadi District Council	1.8 (1.1–2.8)	0.14 (0.00–0.39)
Simiyu	Busega District Council	3.1 (1.9–4.8)	0.23 (0.07–0.36)
Tabora	Urambo District Council	0.4 (0.1–1.0)	0.03 (0.00–0.24)
Tabora	Uyui District Council	0.1 (0.0–0.3)	0.08 (0.00–0.19)
Tanga	Korogwe District Council	1.2 (0.3–1.9)	1.06 (0.00–2.12)
Tanga	Muheza District Council	0.1 (0.0–0.2)	0.28 (0.05–0.64)
Tanga	Pangani District Council	1.1 (0.5–1.9)	0.21 (0.05–0.44)

CI, confidence interval.

using an improved drinking water source was 46.9% (range by district, 9.7% in Muleba to 94.4% in Siha). Across the survey districts, 63.0% (range by district, 30.6% in Ngara to 93.2% in Siha) of households reported that their drinking water source was in the household's yard or within 1 km. Overall, 83.0% (range by district, 53.3% in Serengeti to 99.1% in Moshi District Council) had access to sanitation facilities. District-level TF prevalence was associated with the proportion of households with a drinking water source in the yard or within 1 km (spearman rho = −0.5; p = 0.004), however, there was no association of TF prevalence with the proportion of households with an improved drinking water source (p = 0.7) or the proportion of households with sanitation facilities (p = 0.07). Trichiasis prevalence by district was not associated with any of the WASH indicators; the proportion of households with an improved drinking water source (p = 0.3), proportion of households with a drinking water source in the yard or within 1 km (p = 0.1), or proportion of households with sanitation facilities (p = 0.5) were not significantly associated with trichiasis prevalence.

Discussion

With five years remaining before the GET2020 deadline, timely baseline surveys of trachoma in suspected endemic districts are important for planning SAFE interventions. Our data revealed that in 29 of 31 districts surveyed, the prevalence of TF was below 5% and therefore mass drug administration with azithromycin is not warranted in these districts. In Chunya, TF prevalence was above 10%, while in Ngara and Misungwi, TF prevalence was between 5% and 9.9%; therefore these two districts require implementation of mass drug administration, and community-based implementation of the F and E components of the SAFE intervention, before impact surveys are undertaken.[17] In Korogwe and Kibaha, prevalence of trichiasis was above the 1.0% threshold at which community-based trichiasis surgery services become a public health priority, while a further 19 districts had trichiasis prevalences in adults at or above the 0.2% elimination threshold (1 case per 1000 total population). The surveys found that, while access to WASH varied markedly by district, overall, nearly half of all households reported using an improved drinking water source, 6/10 households reported using a drinking water source in the yard or within 1 km distance, and more than 4/5 households had a sanitation facility. Increased distance to water source was associated with increasing prevalence of TF.

The 2012 and 2013 survey districts were selected because they were suspected to be trachoma endemic, due to proximity to known endemic districts surveyed nearly a decade previously. This selection criterion turned out to be uninformative in predicting districts that required SAFE implementation. In 2014, trachoma rapid assessments were undertaken to prioritize districts for further surveys, however, only 3/19 selected districts had trachoma as a serious public health problem. Nonetheless, these survey findings are important, facilitating planning of SAFE interventions where needed, and de-prioritizing attention to trachoma where they are not.

The survey estimated key WASH indicators including proportion of households with an improved drinking water source, proportion of households with a drinking water source in the yard

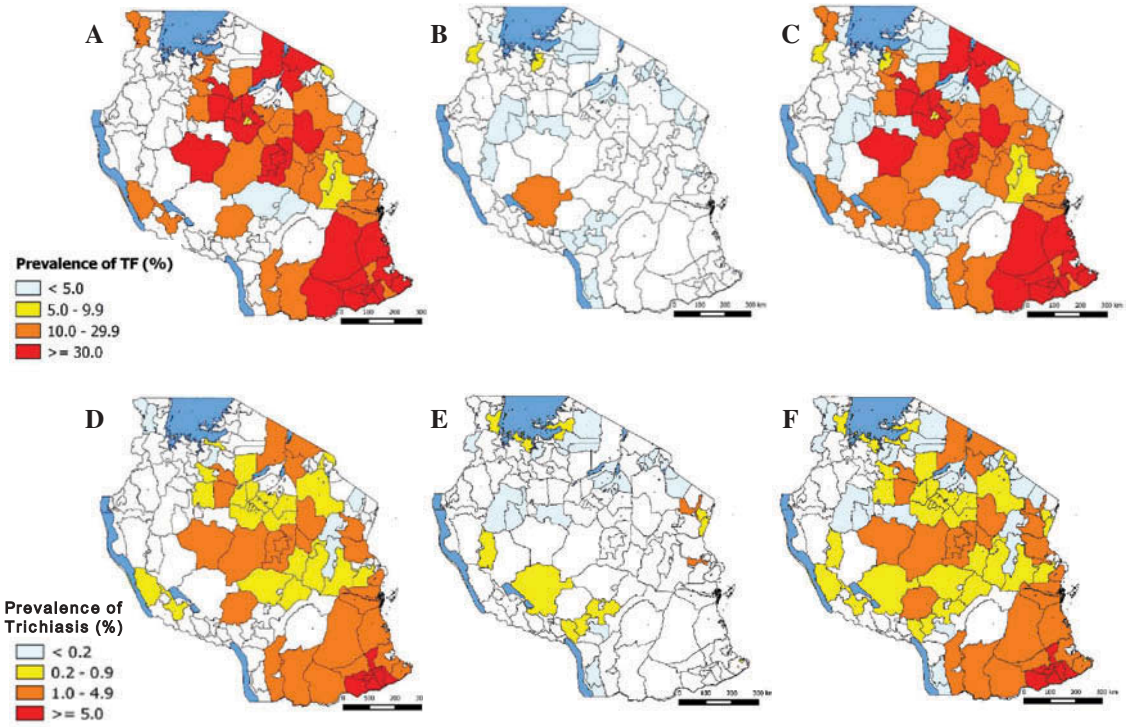

Figure 2. Prevalence of trachomatous inflammation–follicular (TF) in children aged 1–9 years and trichiasis in people aged 15 years and older, Tanzania, 2012–2014. (A) TF prevalence 2004–2006 surveys; (B) TF prevalence 2012–2014 surveys; (C) TF prevalence 2004–2014 surveys; (D) Trichiasis prevalence 2004–2006 surveys; (E) Trichiasis prevalence 2012–2014 surveys; (F) Trichiasis prevalence 2004–2014 surveys.

or within 1 km, and proportion of households with sanitation facilities. The findings on WASH were consistent with those reported in the most recent (2010) demographic and health survey for Tanzania, which reported that of surveyed households, 56.2% used an improved source of drinking water, 54.6% had a drinking water source in the yard or within 1 km distance and 86.3% had a toilet/latrine facility.[18]

Our surveys used methods recommended by the WHO for sampling of populations and examination for trachoma. The overall proportion of eligible participants absent from surveyed households was 7.7%. The majority of those absent at the time of the survey team's visit were adult men. This may have potentially biased the prevalence estimates for trichiasis. Nonetheless, adjustment of trichiasis prevalence estimates for age and sex enabled calculation of more precise prevalence estimates. Recent evidence from Ethiopia suggests that trichiasis is frequently attributable to metaplastic or misdirected eyelashes,[19] often from etiologies other than trachoma. We did not examine eyes with trichiasis for trachomatous scarring, so we have reported prevalence of trichiasis. Sub-division of districts after surveys were conducted remains a potential limitation when generalizing findings from "mother" districts to respective "child" districts. Following the surveys, a number of districts have been sub-divided as follows; Arumeru district split into Arusha District Council and Meru District Council, Urambo district split into Urambo and Kaliua, and Bariadi split into Bariadi and Itilima. To overcome this challenge, the neglected tropical diseases program in Tanzania has adopted an approach whereby the prevalence from a "mother" district is applied to "child" districts, but for all subsequent surveys, the "child" districts are to be surveyed as independent domains.

The findings from these surveys are important and will facilitate progress of mainland Tanzania towards GET2020 targets. Our data suggest that only two of the districts surveyed require mass drug administration with azithromycin and implementation of the F and E components of the SAFE strategy. Nonetheless, trichiasis is still a public health problem in many districts, indicating urgent consideration of the best way to deliver surgery for trichiasis to the populations of these districts.

Declaration of interest

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

Table 3. Summary of key water and sanitation hygiene indicators by district, population-based trachoma surveys, Tanzania, 2012–2014.

		Proportion of households, %		
Region	District	Using improved drinking water source	Drinking water source in yard/within 1 km	With sanitation facilities
Arusha	Arumeru District Council	66.3	58.5	89.0
Arusha	Karatu District Council	65.6	57.4	81.4
Iringa	Mufindi District Council	39.7	57.5	94.0
Kagera	Muleba District Council	9.7	32.7	76.7
Kagera	Ngara District Council	48.5	30.6	74.0
Katavi	Nsimbo District Council	29.7	45.4	76.7
Kilimanjaro	Moshi District Council	76.9	83.0	99.1
Kilimanjaro	Mwanga District Council	47.4	68.0	97.9
Kilimanjaro	Same District Council	47.7	67.4	94.4
Kilimanjaro	Siha District Council	94.4	93.2	90.4
Manyara	Babati District Council	54.4	65.9	87.9
Manyara	Mbulu District Council	31.1	54.7	71.9
Mara	Bunda District Council	10.1	31.5	67.5
Mara	Serengeti District Council	36.8	64.9	53.5
Mbeya	Chunya District Council	15.9	55.0	76.9
Mtwara	Mtwara Municipal Council	92.0	93.1	98.2
Mwanza	Misungwi District Council	82.8	61.0	65.7
Mwanza	Sengerema District Council	17.7	33.9	82.7
Njombe	Makete District Council	60.5	79.7	97.0
Njombe	Njombe District Council	23.4	59.9	97.0
Njombe	Wanging'ombe District Council	51.7	54.3	97.0
Pwani	Kibaha District Council	64.0	55.1	82.4
Ruvuma	Mbinga District Council	62.6	89.3	94.9
Ruvuma	Nyasa District Council	53.8	85.9	95.7
Simiyu	Bariadi District Council	68.7	64.9	59.3
Simiyu	Busega District Council	31.9	31.4	81.1
Tabora	Urambo District Council	14.9	66.7	70.6
Tabora	Uyui District Council	20.6	62.0	62.4
Tanga	Korogwe District Council	46.1	76.7	83.1
Tanga	Muheza District Council	40.7	51.0	96.7
Tanga	Pangani District Council	40.5	51.7	77.6
Overall		46.9	61.0	83.0

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