The Gambia trachomatous trichiasis surveys: Results from five evaluation units confirm attainment of trachoma elimination thresholds

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Conflict of interest

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Abstract

Introduction

Trichiasis is present when in-turned eyelashes touch the eyeball. It may result in permanent vision loss. Trachomatous trichiasis (TT) is caused by multiple rounds of inflammation associated with conjunctival *Chlamydia trachomatis* infection. Surveys have been designed to estimate the prevalence of TT in evaluation units (EUs) of trachoma-endemic countries in order to help develop appropriate programme-level plans. In this study, TT-only surveys were conducted in five EUs of The Gambia to determine whether further intensive programmatic action was required.

Methods

Two-stage cluster sampling was used to select 27 villages per EU and ~25 households per village. Graders assessed the TT status of individuals aged ≥15 years in each selected household, including the presence or absence of conjunctival scarring in those with TT.

Results

From February to March 2019, 11,595 people aged ≥15 years were examined. A total of 34 cases of TT were identified. All five EUs had an age- and gender-adjusted prevalence of TT unknown to the health system <0.2%. Three of five EUs had a prevalence of 0.0%.

Conclusion

Using these and other previously collected data, in 2021, The Gambia was validated as having achieved national elimination of trachoma as a public health problem. Trachoma is still present in the population, but as its prevalence is low, it is unlikely that today's youth will experience the exposure to *C. trachomatis* required to precipitate TT. The Gambia demonstrates that with political will and consistent application of human and financial resources, trachoma can be eliminated as a public health problem.

Introduction

Trichiasis is present when in-turned eyelashes from the upper or lower eyelid touch the eyeball. Potential complications include corneal trauma, corneal opacification and permanent vision loss.[1,2] Trachomatous trichiasis (TT) is trichiasis caused by repeated exposure to *Chlamydia trachomatis*,[3] an intracellular bacterium that infects the conjunctivae; in susceptible individuals, this precipitates scarring[4] and subsequent structural changes. Trachoma is estimated to be responsible for visual impairment in 1.9 million people,[5] and is the leading infectious cause of blindness worldwide.[6]

In 1996, the World Health Organization (WHO) launched the WHO Alliance for the Global Elimination of Trachoma by 2020 (GET2020).[7] The Alliance's recommended approach to trachoma elimination involves the implementation of the SAFE strategy: Surgery for trichiasis, Antibiotics to clear infection, and Facial cleanliness and Environmental improvement to reduce transmission,[8,9] alongside standardised monitoring and epidemiological assessment in endemic populations. Monitoring includes a number of different phases of surveys: baseline mapping of prevalence to determine whether implementation of elimination activities is needed; impact surveys post-treatment to ascertain if elimination prevalence thresholds have been met; and surveillance surveys to determine if these thresholds have been sustained.[10] These surveys typically generate data on the prevalence of both trachomatous inflammation—follicular (TF;[11] the key clinical sign indicating ocular *C. trachomatis* infection) and TT in children and adults, respectively. In 2017, in response to requests from its Member States, WHO introduced a new type of survey specifically for estimating the prevalence of TT in people aged ≥15 years, for use in particular epidemiological contexts.[12] One of the situations in which TT-only surveys are recommended is where the estimated prevalence of TF in children is <5% but the prevalence of TT in people aged ≥15 years may be ≥0.2% and there is a need to re-estimate the prevalence of TT after implementing TT case finding and management.[13]

The Gambia has been a focal point for trachoma research for over 60 years.[14] In 1986, following a national survey that determined that trachoma was the second leading cause of blindness in the country, the National Eye Health Programme (then referred to as the National Eye Care Programme) was formed.[15] A network of community ophthalmic nurses was trained to screen communities for trachoma and to conduct TT surgery. Public health initiatives with a focus on preventative eye care and facial cleanliness were rolled out to work with school children and rural communities, while urban centres benefitted from a targeted programme designed to meet the eye health needs of marginalised populations.

In 1996, a second national survey of blindness was conducted which found the prevalence of active trachoma (TF and/or trachomatous inflammation—intense, TI) in children aged 0–9 years to be approximately 6% in western regions but <2% in the eastern Upper River region and Banjul City.[16] A decade later, population-based surveys conducted in two regions (Lower River Region and North Bank Region) in advance of an antibiotic mass drug administration (MDA) campaign for trachoma found ≥10% TF prevalence in the same age group.[17] Based on these data, 11 rural districts with predicted TF prevalence between10 – 29.9% were targeted for three rounds of MDA, following WHO guidelines.[18] MDA began in 2007 and finished in 2010.[19] In another 12 districts in which the prevalence of TF in children was projected to be between 5 and 9.9%, a screen-and-treat strategy was adopted. Under this scheme, community-based screening of all children aged 1–9 years was first carried out. Where the prevalence of TF in 1–9-year-olds was ≥10%, the community was offered three rounds of MDA. If

TF prevalence was <10%, individuals with active trachoma and the other members of their household were treated with antibiotics.[20]

Following the completion of three MDA rounds in endemic rural communities in The Gambia, using WHO trachoma surveillance guidance that was in place at the time,[21] cross-sectional surveys were conducted in nine surveillance zones (Figure 1) in 2011, 2012 and 2013, to determine the prevalence of TF and TT. Each zone had a similar size, with populations of 60,000–90,000 people, excluding urban settlements.[22] In 2011, all nine zones had TF prevalence in children <5%, but only four of nine had TT prevalence in ≥15-year-olds <0.2% (zones F-I). In 2013, all nine zones again had a TF prevalence <5%, but zones A, B, C, E and F had a TT prevalence ≥0.2%.

Between 2013 and 2019, no further surveys of trachoma were conducted in these five zones, despite on-going TT surgical service provision. There was therefore a need for TT-only surveys to determine if the TT elimination threshold had been reached in these populations.

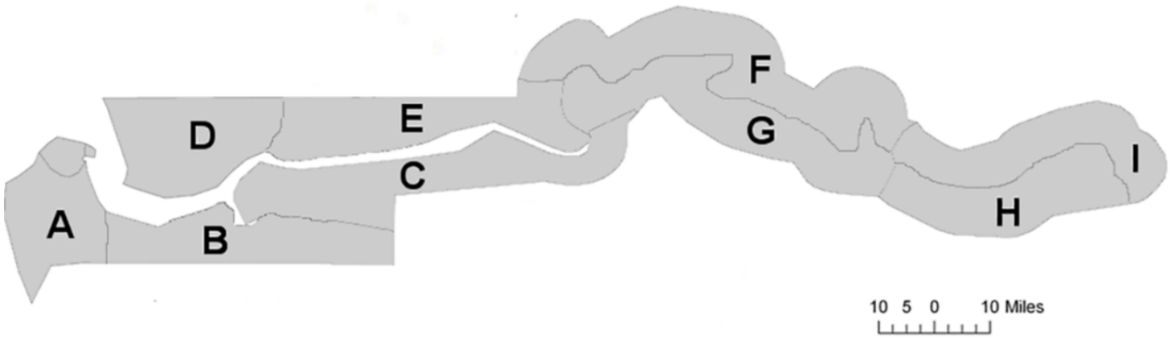

Figure 1. Administrative zones used to survey The Gambia for trachoma, 2011-2013. From Burr et al.[22] used with permission. The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the authors, or the institutions with which they are affiliated, concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Methods

Study ethics and consent

In conformity with national research requirements, the survey protocol, questionnaire, and consent forms were reviewed and approved by the Joint Gambia Government/MRC Ethics Committee (SCC1660) and approval for Tropical Data support for the surveys was provided by the London School of Hygiene & Tropical Medicine ethics committee (reference: 16105). The aim of the project and the examination protocols were explained to each participant in the local language prior to requesting consent. Individuals' consent for examination was recorded in the Tropical Data Android application, used for data collection.

Study design and participant selection

The evaluation unit (EU) for trachoma surveys is the district, which (for trachoma elimination purposes) WHO defines as "the normal administrative unit for health care management, consisting of a population unit between 100,000–250,000 persons".[23] In The Gambia, EUs correspond with the zones marked in Figure 1. Urban populations were removed from the sampling frame.[18] The two zones with populations below 100,000 (C and E) were treated as separate EUs, since they had previously been surveyed as independent zones.[22]

The sample size was calculated to estimate, with 95% confidence, an expected TT prevalence of 0.2% with absolute precision of 0.2% and a design effect of 1.47, yielding 2818 as the target number of adults aged ≥15 years to be examined.[12] This number was inflated by 1.2 to account for the expected non-response rate, giving a total of 3382. On average, there are estimated to be five ≥15-year-olds resident per household in The Gambia;[24] since a team can comfortably enumerate and examine the residents of 25 households in a day, 27 first-stage clusters (villages) were included per EU.

The survey was a two-stage cluster sampled survey, using probability proportional to size sampling to select the 27 villages. Twenty-five households in each of those villages were selected using random sampling from a household list. Household members aged ≥15 years were targeted for examination.

Grader training and clinical examinations

To ensure quality and consistency, the training materials used in the survey conformed with those developed by the Global Trachoma Mapping Project and Tropical Data.[25–27] Eight experienced TT surgeons were invited to participate in the standard 2.5-day Tropical Data training course for TT-only surveys,[27] where they were taught how to perform trichiasis examinations and record the findings. Graders underwent an Objective Structured Clinical Examination (OSCE) in grading trichiasis and recording skills, with a passing grade requiring no more than two grades of "below expectation". The six surgeons with the highest OSCE grades were recruited to conduct the survey. Training and fieldwork included the use of binocular 2.5× magnifying loupes and a torch for assessing the trichiasis status and presence of trachomatous scarring (TS) in the upper and lower eyelids, separately. Individuals with upper and/or lower eyelid trichiasis were asked if they had been offered management (surgery or epilation) for the trichiasis by a healthcare worker, and they were also examined to determine the presence or absence of conjunctival scarring.

Graders were equipped with tetracycline eye ointment to treat patients with active trachoma, and referral forms for patients requiring TT surgery. Each team was composed of a grader (who also recorded the survey findings in the Tropical Data app), a village guide and a driver. Data collection started on 19th February 2019 and the final EU fieldwork was completed on 13th March 2019.

Data collection and management

All data were captured electronically, using a purpose-built Tropical Data ODK-based Android phone application. The name, age in years and gender were recorded for each resident of the household aged ≥15 years and the trichiasis findings (and TS and health management questions, where appropriate) were recorded for examined individuals. Association analyses between TT and age and gender were not performed for these data as the number of TT cases per EU was too small to provide meaningful results.

Definitions

We defined TT as at least one eyelash from the upper or lower eyelid touching the eyeball, or evidence of recent epilation.[11] There is a more recent, modified, TT definition which only counts in-

turned eyelashes from the upper eyelid as TT[2] due to changes recommended by the 4th Global Scientific Meeting (GSM4) on Trachoma in late 2018.[28] These surveys were performed prior to the widespread implementation of this modification, and so the previous, broader definition of TT (including both upper and lower eyelid trichiasis) was used. It should be noted that pre-GSM4 unmanaged TT is not equivalent to post-GSM4 unmanaged TT, as pre-GSM4 surveys did not include the management questions split into upper and lower eyelid.

We defined TT "unknown to the health system" as TT for which the individual self-reported that no management (surgery and/or epilation) had been offered, and excluded recurrences, refusals and those already referred:.[29] an important refinement because prevalence of TT unknown to the health system is the metric used by WHO to frame elimination of trachoma as a public health problem.[30]

We defined a household as a group of people living together and eating from the same pot.

Results

Study Population

In the five EUs combined, 12,550 people aged ≥15 years were enumerated, and a total of 11,595 were examined (92.4% response rate). Absence at the time of survey was the main reason for enumerated individuals not being examined (Table 1). Examinees had a mean age of 37 years, and 60% of individuals examined were women.

Clinical findings

A total of 34 cases of TT were identified. All five EUs had an age- and gender-adjusted TT prevalence unknown to the health system less than the WHO elimination prevalence threshold of 0.2% (Figure 2). Half of TT cases also had TS. Three of five EUs had a prevalence of 0%, as all cases of TT identified had been offered management in some form (Table 2). In all but one EU, the majority of TT cases were found in women (figure 3), and were manifest in the upper eyelid.

Discussion

The key finding of this series of TT-only surveys was that all five EUs had an age- and gender-adjusted TT prevalence unknown to the health system below the WHO elimination threshold of 0.2%. In 2021, based partly on these data, The Gambia was validated by WHO as having eliminated trachoma as a public health problem.[6,31] As previously described, The Gambia has invested a considerable effort into reducing the prevalence of active trachoma and treating TT, including multiple rounds of MDA in areas with high TF prevalence from 2010 onwards, and intensified TT case finding from 2014–2017, with particular emphasis on the five zones subsequently involved in the 2019 TT-only surveys.[22] The last survey in 2013 showed below-threshold TF and TT prevalence estimates in the other four zones, and therefore re-survey was not indicated for these areas. It is of interest to note that the western Upper River region (URR) of The Gambia (zones H and I) has consistently had low TF and TT prevalence[22] since surveys began, suggesting a naturally occurring low *C. trachomatis* prevalence. A study investigating the presence of *C. trachomatis* antibodies in people living in the lower river region (LRR) in the east and URR in the west corroborates this finding, as the results showed significantly lower overall seroprevalence in the URR.[32]

It is evident from the results summarised here and the comparison with TT estimates from prior surveys that the strategies used were successful in reducing the burden of trachoma in The Gambia (Figure 2). Of the few cases of TT that were identified in these surveys, the vast majority (91%) were known to the health system, having previously been offered or undergone some sort of

management. While there were too few cases of TT to determine if there was a significant association between age, gender and TT, Figure 3 shows females had more cases of TT than males in all age groups where TT was present, with females aged over 70 having the largest proportion of recorded TT cases. Previous studies have shown that females are more at risk of trichiasis[33], most likely due to cultural gender-roles rather than biological factors.[34]

The Gambia was the second sub-Saharan country after Ghana to achieve elimination status for trachoma, and the eleventh country overall.[6] The WHO-recommended SAFE strategy was key, with TT case finding and management shown to be important in reducing TT prevalence below the elimination threshold.[35–38] The reduction in the prevalence of active trachoma achieved through multiple rounds of antibiotic treatment and improved hygiene and sanitation is likely to reduce the burden of TT in future generations.[8,39–41] While data on water, sanitation and hygiene (WASH) variables are not collected in TT-only surveys, other data have shown a sustained and continued improvement in WASH indicators in sub-saharan Africa, in particular access to clean water,[42] providing confidence that the sustained elimination of TT is an achievable and realistic goal.

One of the limitations of the work described here is that the number of people examined per EU was well under the calculated sample size of 2818 outlined in our methods section. As the number of enumerated people was also under the recommended sample size, it is likely that the census data used to estimate the number of people aged ≥15 years per household were inaccurate, and more households needed to be surveyed, or that people absent from the household at the time of the survey teams' visits were not reported to field teams. This issue was not apparent until after the surveys were completed, and it was not possible to adjust the survey plan and return to the relevant locations due to timing and funding limitations. This uncertainty in examination coverage is a limitation that is common to trachoma surveys everywhere,[43] and by presumed extension, to most cross-sectional surveys.

Another common issue when surveying low frequency events such as cases of TT, is that when the numbers are much lower than projected in the sample size calculation as seen in this study, the survey is limited in its ability to detect rare events. However, the consistency of the finding of very low prevalence across the five EUs and relatively tight empirical confidence intervals around each estimate provide reassurance that the true TT prevalence was below the <0.2% threshold for each population. In addition to this, because two EUs had population sizes below the recommended 100,000 lower limit, as the number of clusters and households surveyed remained constant, our data provide even greater granularity than would have been generated by framing EUs with larger populations, as a larger proportion of individuals within each of our EUs was surveyed. This adds to the confidence in the accuracy of the TT prevalence estimates.

The Gambia has made impressive gains to achieve elimination status, but trachoma is still present in the population. Due to the infectious nature of *C. trachomatis*, active trachoma is likely to continue to occur in individuals for at least some time.[44] However, as the local transmission intensity is low, it is unlikely that the level of exposure to *C. trachomatis* required to precipitate trichiasis in later life[3] will occur in the current generation of children. The Gambia's Ministry of Health has implemented numerous public health measures to reduce the burden of both active trachoma and TT, and the maintenance of these measures should ensure that trachoma continues to be controlled in the country. This work confirms that with political will, collaboration and partnerships, and consistent effort and funding, trachoma can be eliminated as a public health problem.

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Table 1. Survey demographics for the five evaluation units (EUs) surveyed using the trachomatous trichiasis-only survey methodology, The Gambia, 2019.

Region	Zone (EU code)	Districts	Population size*	Number of clusters	Number of households	Number of people aged ≥15 years enumerated	Number of people aged ≥15 years absent	Number of people aged ≥15 years who refused	Number of people aged ≥15 years examined	Number of people aged ≥15 years examined who were female (%)
Brikama	A (50076)	Kombo South Kombo North Kombo Central	224,221	27	677	2508	204	9	2295	1431 (62)
	B (50077)	Kombo East Foni Kansala Foni Jarrol Foni Brefet Foni Bondali Foni Bintang-Karanai	128,339	27	672	2316	137	9	2168	1232 (57)
Mansakonko	C (50078)	Kiang West Kiang East Kiang Central Jarra West Jarra East Jarra Central	71,903	27	674	2447	175	3	2269	1350 (59)
Kerewan	E (50079)	Sabach Sanjal Lower Badibu Illiasa Central Badibu	97,096	27	675	2562	199	4	2359	1447 (61)
Kuntaur	F (50080)	Upper Saloum Sami Nianija Niani Lower Saloum	100,920	27	671	2717	207	6	2504	1502 (60)

*Population data were estimated using the 2013 census counts[24] as baseline, and extrapolating based on predicted population growth rates for each region.

Table 2. Results of the trachomatous trichiasis (TT)-only surveys performed in five evaluation units (EUs), The Gambia, 2019. The most recent prior estimates of TT and trachomatous inflammation—follicular (TF) prevalence, generated in 2013[22], are also shown.

Region	Zone/EU	District	Survey results 2013*		Survey results 2019**					
			TT%	TF%	Number of people aged ≥15 years with TT	Number of women aged ≥15 years with TT	Number of people aged ≥15 years with TT (upper eyelid only)	Number of people aged ≥15 years with TT known to the health system	Age- and gender-adjusted prevalence of TT with TS unknown to the health system in those aged ≥15 years, % (95% CI)	Age- and gender-adjusted prevalence of TT unknown to the health system in those aged ≥15 years, % (95% CI)
Brikama	A	Kombo South Kombo North Kombo Central	0.3	1.2	1	0	1	1	0.00 (-)	0.00 (-)
	B	Kombo East Foni Kansala Foni Jarrol Foni Brefet Foni Bondali Foni Bintang - Karanai	0.6	1.9	5	5	5	3	0.00 (-)	0.02 (0.00-0.05)
Mansakonko	C	Kiang West Kiang East Kiang Central Jarra West Jarra East Jarra Central	1.0	1.8	13	11	13	13	0.00 (-)	0.00 (-)
Kerewan	E	Sabach Sanjal Lower Badibu Illiasa Central Badibu	0.3	0.2	6	4	6	6	0.00 (-)	0.00 (-)
Kuntaur	F	Upper Saloum Sami Nianija Niani Lower Saloum	0.4	0.6	9	8	8	8	0.02 (0.00-0.04)	0.02 (0.00-0.04)

*calculations for the 2013 estimates were simple proportions without adjustment for age or gender.

** TT was defined as at least one eyelash from the upper or lower eyelid touching the eyeball or evidence of recent epilation, unless stated otherwise.

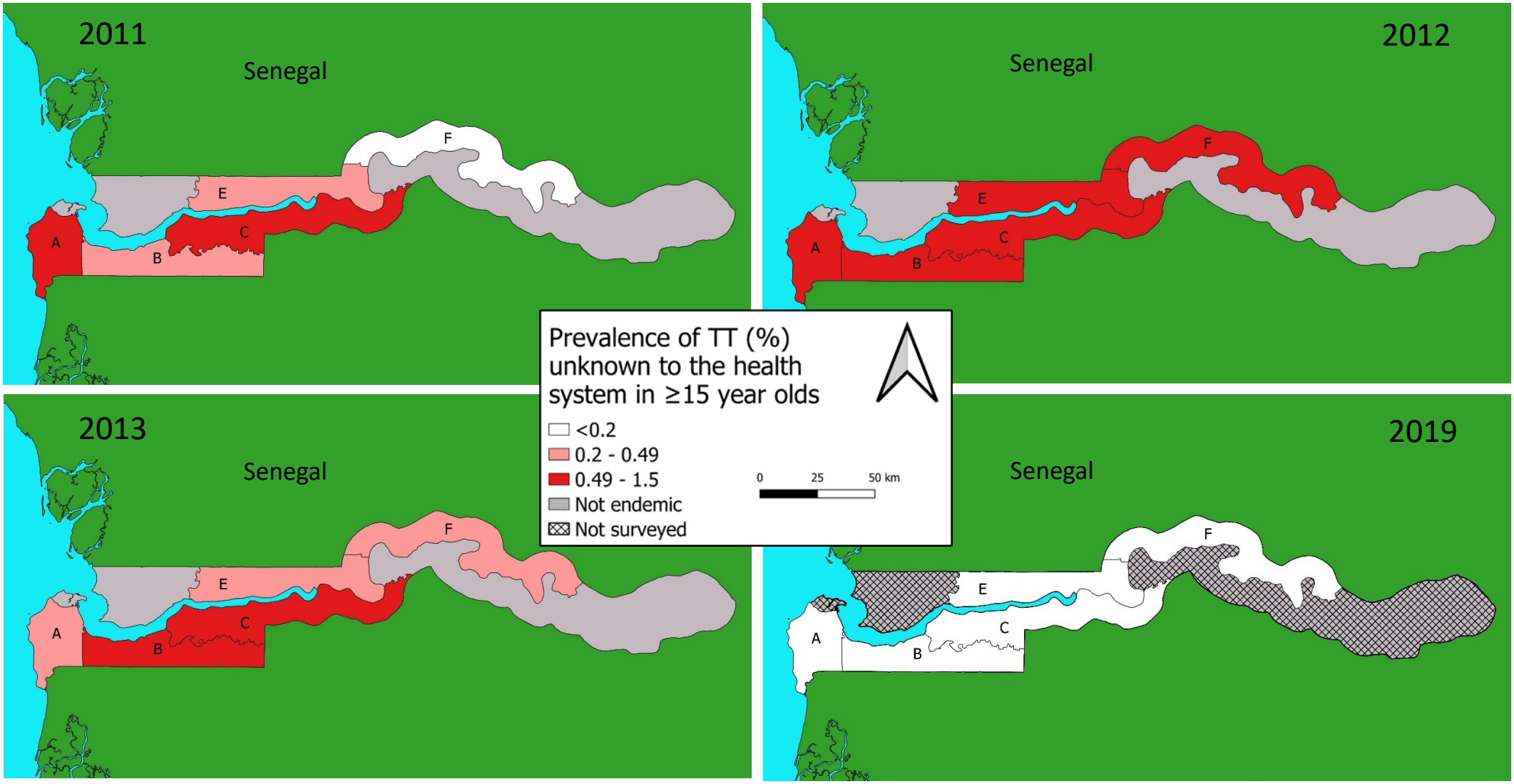
2011
Senegal
A
B
C
E
F
2012
Senegal
A
B
C
E
F
Prevalence of TT (%) unknown to the health system in ≥15 year olds
<0.2
0.2 - 0.49
0.49 - 1.5
Not endemic
Not surveyed
0
25
50 km
2013
Senegal
A
B
C
E
F
2019
Senegal
A
B
C
E
F

Figure 2. Trachomatous trichiasis (TT) prevalence map showing the change over time from the 2011-2013 surveys[22] to the data generated using the TT-only survey methodology in 2019 in five evaluation units, The Gambia. The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the authors, or the institutions with which they are affiliated, concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

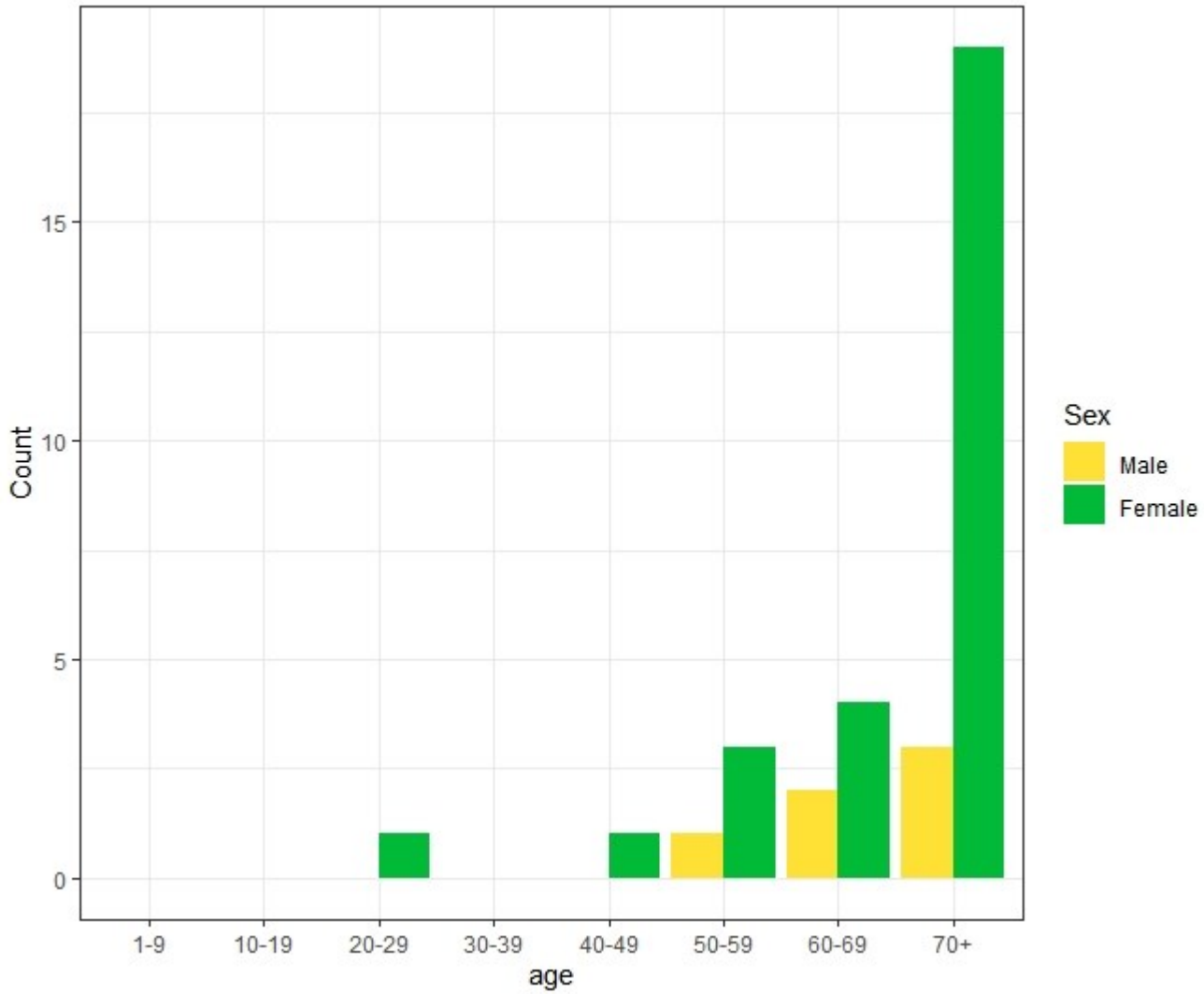

Figure 3. Barplot showing the number of trachomatous trichiasis cases by age group and sex in The Gambia, 2019.