How much trachomatous trichiasis is there? A guide to calculating district-level estimates

Estimating the number of people with trachomatous trichiasis allows managers to plan surgical services and obtain the resources needed to eliminate this painful condition.

In some people living in trachoma-endemic areas, repeated conjunctival *Chlamydia trachomatis* infection eventually leads to trachomatous trichiasis (TT), in which one or more eyelashes are misdirected so that they rub on the eyeball.1,2 Untreated, this can scar the cornea and result in permanent blindness. Estimating the likely number of people with TT helps programme managers to plan surgical services and secure resources.3,4 Recent work to complete high-quality baseline mapping of suspected trachoma-endemic populations worldwide5,6 and to standardise the systems and methodologies of trachoma impact surveys, pre-validation surveillance surveys, and TT-only surveys7–10 has facilitated production of more accurate estimates of the number of people with TT.11,12

This paper, intended for programme managers and their supporters, explains the concepts involved in estimating TT prevalence and discusses programmatic applications of that information. We hope it will help these stakeholders to use their TT data with greater confidence.

1. What does prevalence mean?

The prevalence of a disease is the percentage of people in a defined population who are affected by that disease at a particular time. In this definition, it is important to clearly identify the defined population. The prevalence of TT can be estimated for a single community,13 a single administrative division of a country,14 or a whole country.15 At each of these levels, prevalence could be estimated in (for example) people of all ages,16 people aged ≥15 years,17 women aged ≥15 years,18 or some other subset of the population, such as indigenous inhabitants,19 so it is important to be clear on the group being studied.

2. At what administrative level are TT prevalence estimates usually generated?

For trachoma elimination purposes, the World Health Organization (WHO) defines districts as “the normal administrative unit for health care management,” which “for purposes of clarification, consists of a population unit between 100,000 and 250,000 persons”.20 Although surveys at baseline may be conducted at larger-than-district-level in order to start the programme,20–23 it is currently recommended that impact, pre-validation surveillance and TT-only surveys are done at district level. In the real world, the term district has different meanings in different contexts. Because of this, and because the administrative level surveyed may change from one round of surveys to the next, we will subsequently refer here instead to evaluation units (EUs), a generic term for the population unit surveyed, regardless of size – even though we used ‘district-level’ (for readability) in the title of this article.

Regardless of the administrative level at which EUs are framed, data should be interpreted and applied at that same level; in other words, local data should inform local action.

3. What data are used to generate TT prevalence estimates?

To estimate TT prevalence, population-based surveys are recommended.24 Standard trachoma baseline, impact, pre-validation surveillance and TT-only surveys are all population-based surveys. These all employ sampling, in which a small proportion of EU residents...
are selected for examination, using a random or quasi-random sampling technique, with data on individuals examined considered to be representative of the EU population overall.

In trachoma surveys, the sampling strategy used is often two-stage cluster sampling. The first stage involves selecting 20–30 communities (first-stage clusters) from the set of all communities in the EU. The second stage, undertaken within each selected community, involves selecting a fixed number of households (second-stage clusters, often grouped within a single compact segment) from the set of all households in the community. (In compact segment sampling, a sketch map is drawn of the sampled first-stage cluster, and the area then divided into sub-clusters or segments containing approximately equal numbers of households. One segment is selected by random draw.) All qualifying individuals living in selected households are asked to participate (in compact segment sampling, all residents of all households in the compact segment are asked to participate), and both eyes of consenting individuals are examined by certified trachoma graders.

A person with trichiasis is defined as someone in whom, in at least one eye, one or more eyelashes touch the eyeball or there is evidence of recent removal of in-turned eyelashes. Although determining whether eyelashes that have been removed were in-turned is difficult, this may be very important: in Fiji, for example, many adults practice eyelash epilation in the absence of trichiasis.

4. How are survey data processed to generate a TT prevalence estimate?

Before any calculations are performed, data are screened for possible errors, such as missing data from some included communities, inclusion of data from communities lying outside the EU, or missing data from particular demographic subsets. Best practice calls for data to be cleaned and analysed by an objective data manager who works in collaboration with, but at arm’s length from, the health ministry, employing standardised methods. Outputs are checked and approved by the responsible health ministry. Then if, for example, 2,000 people aged ≥15 years living in the EU were examined, and 10 of them had TT, the raw TT prevalence in ≥15-year-olds would be 0.5%. (In this example, the calculation is: Prevalence = 10/2,000 × 100 = 0.5%. The number 10 here is referred to as the numerator, and 2,000 is the denominator.)

Such an estimate may not represent the true EU-level prevalence in ≥15-year-olds, for two reasons. First, it is rare that everyone resident in selected households is examined: women and older adults are both more likely to be examined in house-to-house surveys, and more likely to have trichiasis, than men and younger adults, respectively. Second, the number of ≥15-year-olds examined in a set number of households (say, n households) in each community varies. Communities in which a greater number of ≥15-year-olds are examined should not contribute more weight to the EU-level prevalence.

To compensate, partially, for the first problem (unbalanced recruitment of different age and gender groups), standard trachoma survey analyses adjust the first-stage cluster data by gender and age in five-year age bands. This can be conceptualised as filling in missing data from individuals who were resident in selected households but not examined, using the assumption that their risk of trichiasis was similar to that of residents of similar age and gender who were examined. To compensate for the second problem (varying numbers of individuals examined per cluster), the age- and gender-adjusted first-stage cluster-level TT percentages are averaged to generate the EU-level TT prevalence. This gives equal weight to each of the first-stage clusters, as if the same number of ≥15-year-olds had been examined in each one.

5. How accurate are TT prevalence estimates generated from cluster-sampled surveys?

Estimates generated through sampling are subject to two types of error: bias and chance. Bias is present if the people included in the sample are systematically different to the EU population as a whole: under-representation of adults with jobs that result in absence on the day of the survey, for example. Gender- and age-adjustment, as described above, attempts to partially correct for this problem, but cannot fully compensate for it. (Biases cannot be quantified, and no amount of statistical manipulation should be considered to completely remove their effect.)

Chance affects prevalence estimates through sampling variation: if a different sample of 2000 ≥15-year-olds living in the EU had been examined, a different prevalence estimate might have been generated. The chance-induced uncertainty of an estimate produced through sampling can be quantified: it is expressed as a confidence interval. A 95% confidence interval suggests that, based on the observed data, if surveys using the same methodology were repeated multiple times in the EU, in 95% of instances the prevalence estimate would fall between the confidence interval’s lower and upper bounds. Other factors being equal, larger sample sizes will produce narrower confidence intervals.

6. Can data from house-to-house case searches be used to generate a TT prevalence estimate instead?

In some programmes, TT case-finding is undertaken through house-to-house searches. If a very high proportion of households in a very high proportion of the EU’s communities are visited, with examination undertaken by appropriately trained examiners, such an exercise could provide a better estimate of TT prevalence than a cluster-sampled survey. (Thinking statistically: by trying to examine everyone, chance is removed, though it is possible that bias is not.)

7. What are known and unknown cases of TT, and why is the distinction important?

The trichiasis prevalence threshold for “elimination of trachoma as a public health problem” is a prevalence of TT unknown to the health system in ≥15-year-olds of <0.2%. Known cases are people with trichiasis in eyes that have already had surgery for trichiasis,
for which surgery has been refused, or for which a surgical date has been agreed. (An aide-memoire for this is: “recurrences, refusals and those already referred”). In standard trachoma surveys, when an eye is diagnosed as having trichiasis, the subject is asked if a health worker has ever recommended surgery or epilation for that eye. This allows accurate determination of the numerator for estimating the prevalence of TT unknown to the health system, as included in Tropical Data’s expanded trichiasis report (http://tropicaldata.knowledgeowl.com/help/demo-project—expanded-trichiasis-report).

8. What is postoperative TT, and why is this important?

Even when surgeons are highly skilled, by 12 months after surgery, at least 8–10% of patients again have TT. Some of this postoperative TT may be due to under-correction and some to further progression of the underlying scarring processes; the term postoperative TT avoids the need to blame or absolve the surgeon, by simply noting that TT is present after an operation has been performed. Postoperative TT is probably not optimally managed by repeating the same procedure that was used to treat primary TT, and should be managed by the most experienced trichiasis surgeon or eye specialist available. All programmes should have a plan for managing postoperative TT, so the expanded trichiasis report includes specific information to assist.

It’s important to note that standard trachoma surveys do not provide information on how often TT surgery is successful, because individuals who have been successfully managed will not be recorded as being any different to those who have never had TT.

9. Why does the expanded trichiasis report also provide data on trichiasis + TS (trichiasis plus trachomatous scarring)?

Not all trichiasis is caused by trachoma. The global trachoma programme is currently trying to better understand how to distinguish trachomatous from non-trachomatous trichiasis. As part of this effort, when an eye is diagnosed as having trichiasis, standard trachoma survey systems prompt the examiner to assess the conjunctiva of that eye for the presence or absence of trachomatous scarring (TS); when the eyelid cannot be everted, the eye is presumed to have TS. Generation of these data was recommended by the 2nd Global Scientific Meeting on TT.

10. How does the TT prevalence estimate relate to the number of people who need surgery?

TT prevalence is useful at EU level for determining whether the TT prevalence criterion for elimination as a public health problem has been reached; if it has not, public health-level TT surgery services, including active case finding, are recommended. For service planning, the number of prevalent cases should be determined by multiplying the TT prevalence in ≥15-year-olds by the number of resident ≥15-year-olds in the EU. It is important to remember that the number of prevalent cases is just an estimate. Programmes should aim to cover the entire EU with case finding and TT management; this may identify considerably more or considerably fewer people with TT than indicated by the estimate.

11. How is the presence of TT in both eyes accounted for?

In an individual with TT, one or both eyes may need management. When planning surgical services, a requirement to operate on two eyes rather than one increases (in varying proportions) requirements for selected consumables and operating theatre time. The expanded trichiasis report uses data on the proportion of survey subjects who had bilateral disease to provide an estimate of the number of eyes, as well as the number of people, with TT.

12. Should my estimate of the number of prevalent cases take into account the number of people managed for TT since the most recent prevalence survey?

No: not unless those people were managed within a few weeks of the survey and no further time has passed. As months and years elapse after a survey, new (incident) cases of TT develop; determining that the TT prevalence is below the TT prevalence threshold for elimination of trachoma as a public health problem almost always requires a formal prevalence estimate. It’s also critical to remember that after the TT prevalence criterion for elimination has been achieved, the need to provide surgical services does not disappear: programmes should expect incident cases to continue to occur for many years. This is the rationale for the inclusion of “written evidence that the health system is able to identify and manage incident TT cases, using defined strategies, with evidence of appropriate financial resources to implement those strategies” as a criterion for trachoma elimination.

13. Why aren’t we talking about the TT backlog or the ultimate intervention goal?

Each of these terms has been used in different ways by different stakeholders, such that their usefulness as labels has been completely eroded. We do not recommend that these terms be used.

14. Can we eliminate TT by 2020?

Yes. Unlike active trachoma – where the dynamics of C. trachomatis transmission and increased treatment of C. trachomatis are fundamental to programme impact, and accelerated intervention, such as biannual antibiotic mass drug administration, has not shown to make a programmatically significant difference – the rate of decline in TT prevalence is determined by the resources invested. More systematic TT case-finding – plus good access to trained, certified, resourced, and appropriately motivated surgeons and surgical teams – will lead to faster reductions in the numbers of prevalent cases. That is not to say that speed of service delivery is the only important consideration: quality is also paramount.

Vision loss from TT is avoidable. Together, we must do everything we can to consign it to history.
References

1. Taylor HR, Burton MJ, Haddad D, West S, Wright H. Trachoma. Lancet 2014; 384(9960): 2142-52.
2. Gambhir M, Basanez MG, Burton MJ, et al. The development of an age-structured model for trachoma transmission dynamics, pathogenesis and control. PLoS Negl Trop Dis 2009; 3(6): e462.
3. Courtiery P, Rotondo LA, MaxArthur C, et al. Strengthening the links between mapping, planning and global engagement for disease elimination: lessons learnt from trachoma. Br J Ophthalmol 2018; 102(10): 1324-7.
4. Smith JL, Haddad D, Polack S, et al. Mapping the global distribution of trachoma: why an updated atlas is needed. PLoS Negl Trop Dis 2011; 5(6): e973.
5. Solomon AW, Pavlack A, Courtiery P, et al. The Global Trachoma Mapping Project: methodology of a 34-country population-based study. Ophthalmic Epidemiol 2015; 22(3): 214-25.
6. Solomon AW, Willis R, Pavlack A, et al. Quality Assurance and Quality Control in the Global Trachoma Mapping Project. Am J Trop Med Hyg 2018; 99(4): 858-63.
7. Hooper PJ, Millar T, Rotondo LA, Solomon AW. Tropical Data: a new service for generating high quality epidemiological data. Community Eye Health 2016; 29(49): 38.
8. Kaia K, Chisambl A, Chainayina D, et al. One round of azithromycin MDA adequate to interrupt transmission in districts with prevalence of trachomatous inflammation-follicular of 5.0-9.9%. Evidence from Malawi. PLoS Negl Trop Dis 2018; 12(6): e0006543.
9. World Health Organization. Design parameters for population-based trachoma prevalence surveys (WHO/HTM/NTD/PCT/2018.07). Geneva: World Health Organization; 2018.
10. World Health Organization Strategic and Technical Advisory Group on Neglected Tropical Diseases. Design and validation of a trachomatous trichiasis-only survey (WHO/HTM/NTD/PCT/2017.08). Geneva: World Health Organization; 2018.
11. Fluéziger RM, Courtiery P, Abdala M, et al. The global burden of trichiasis in 2016. bioRxiv 2018; 348995.
12. World Health Organization. WHO Alliance for the Global Elimination of Trachoma by 2020: progress report on elimination of trachoma, 2017. Wkly Epidemiol Rec 2018; 93(26): 371-80.
13. Boll PJ, Faal H, Johnson GJ, et al. Reduction of trachoma in a sub-Saharan village in absence of a disease control programme. Lancet 1997; 349(9064): 1511-2.
14. Sokona O, Macleod C, Jack K, et al. Mapping Trachoma in the Solomon Islands: Results of Three Baseline Population-Based Prevalence Surveys Conducted with the Global Trachoma Mapping Project. Ophthalmic Epidemiol 2015; 23(Sup 1): 15-21.
15. Schëmm JF, Sacko D, Banou A, et al. [Cartography of trachoma in Mali: results of a national survey]. Bull World Health Organ 1998; 76(6): 599-606.
16. Southsahombath K, Sisalemsak S, Channan P, et al. National Trachoma Assessment in the Lao People’s Democratic Republic in 2013-2014. Ophthalmic Epidemiol 2016; 23(Sup 1): 8-14.
17. Bero B, Macleod C, Alemuayu W, et al. Prevalence of and Risk Factors for Trachoma in Oromia Regional State of Ethiopia: Results of 79 Population-Based Prevalence Surveys Conducted with the Global Trachoma Mapping Project. Ophthalmic Epidemiol 2016; 23(Sup 1): 392-405.
18. Mpyet C, Lass BD, Yahaya HB, Solomon AW. Prevalence of and risk factors for trachoma in Kano state, Nigeria. PLoS One 2012; 7(7): e40421.
19. Dirani M, Basanez MG, van Wijngaarden P, Taylor HR. Prevalence of trachomatous trichiasis in Mozambique: results of 96 population-based prevalence surveys. Ophthalmic Epidemiol 2017; 23(Sup 1): 201-10.
20. Turner AG, Magnani RJ, Shuaib M. A not quite as quick but much cleaner alternative to the Expanded Programme on Immunization (EPI) Cluster Survey design. Int J Epidemiol 1996; 25(1): 198-203.
21. Macleod C, Tyler C, Butcher R, et al. Eyelash Epilation in the Absence of Trachoma: Results of a Population-Based Prevalence Survey in the Western Division of Fiji. PLoS Negl Trop Dis 2017; 11(1): e0005277.
22. Engels D. The Global Trachoma Mapping Project: A Catalyst for Progress Against Neglected Tropical Diseases. Ophthalmic Epidemiol 2016; 23(Sup 1): 1-2.
23. Adera TH, Macleod C, Endriyas M, et al. Prevalence of and Risk Factors for Trachoma in Southern Nations, Nationalities, and Peoples’ Region, Ethiopia: Results of 40 Population-Based Prevalence Surveys Carried Out with the Global Trachoma Mapping Project. Ophthalmic Epidemiol 2016; 23(Sup 1): 84-93.
24. Solomon AW, Zondervan M, Kuper H, Buchan JC, Mabey DCM, Foster A. Trachoma control: a guide for programme managers. Geneva: World Health Organization; 2006.
25. Milligan P, Njie A, Bennett S. Comparison of two cluster sampling methods for health surveys in developing countries. Int J Epidemiol 2004; 33(3): 469-76.
26. Abdala M, Singhano C, Willis R, et al. The epidemiology of trachoma in Mozambique: results of 96 population-based prevalence surveys. Ophthalmic Epidemiol 2017; 23(Sup 1): 201-10.
27. Turner AG, Magnani RJ, Shuaib M. A not quite as quick but much cleaner alternative to the Expanded Programme on Immunization (EPI) Cluster Survey design. Int J Epidemiol 1996; 25(1): 198-203.
28. Macleod C, Tyler C, Butcher R, et al. Eyelash Epilation in the Absence of Trachoma: Results of a Population-Based Prevalence Survey in the Western Division of Fiji. PLoS Negl Trop Dis 2017; 11(1): e0005277.
29. Engels D. The Global Trachoma Mapping Project: A Catalyst for Progress Against Neglected Tropical Diseases. Ophthalmic Epidemiol 2016; 23(Sup 1): 1-2.
30. Ministry of Health. Dossier documenting elimination of trachoma as a public health problem: Ghana (available at: http://espen.afro.who.int/system/files/content/resources/GhanaTrachomaDossier_EN.pdf, accessed 09 July 2018). Accra: Government of Ghana; 2018.
31. World Health Organization. Validation of elimination of trachoma as a public health problem (WHO/HTM/NTD/2016.8). Geneva: World Health Organization; 2016.
32. Courtiery P, MacArthur C, Macleod C, et al. Tropical data: training for trachoma prevalence surveys (version 1). Available at: http://http://tropicaldata.knowledgeowl.com/help/training-system-for-trachoma-prevalence-surveys, accessed 30/08/2017]. London: International Coalition for Trachoma Control; 2016.
33. Hiep NX, Ngondi JM, Anh VT, et al. Trachoma in Viet Nam: results of 11 surveillance surveys conducted with the Global Trachoma Mapping Project. Ophthalmic Epidemiol 2018; 25(Sup 1): 93-102.
34. Habtamu E, Wondie T, Aweke S, et al. Posterior versus bilamellar tarsal rotation surgery for trachomatous trichiasis in Ethiopia: a randomised controlled trial. Lancet Glob Health 2016; 4; e175-84.
35. West S, Alemayehu W, Munoz B, Gower EW. Azithromycin prevents recurrence of severe trichiasis following trichiasis surgery: STAR trial. Ophthalmic Epidemiol 2007; 14(5): 273-7.
36. World Health Organization Alliance for the Global Elimination of Trachoma by 2020. Second Global Scientific Meeting on Trachomatous Trichiasis. Cape Town, 4-6 November 2015 (WHO/HTM/NTD/2016.5). Geneva: World Health Organization; 2016.
37. Solomon AW. Optimising the management of trachomatous trichiasis. Lancet Glob Health 2016; 4(3): e140-1.
38. World Health Organization Strategic and Technical Advisory Group on Neglected Tropical Diseases. Technical consultation on trachoma surveillance. September 11−12, 2014, Task Force for Global Health, Decatur, USA (WHO/HTM/NTD/2015.02). Geneva: World Health Organization; 2015.
39. Møgensen J, Jeppe J, Novack A, et al. Serology reflects a decline in the prevalence of trachoma in two regions of The Gambia. Sci Rep 2017; 7(1): 15040.
40. Blake IM, Burton MJ, Bailey RL, et al. Estimating household and community transmission of ocular Chlamydia trachomatis. PLoS Negl Trop Dis 2009; 3(6): e481.
41. Gebre T, Ayale B, Zerihun M, et al. Comparison of annual versus twice-yearly mass azithromycin treatment for hyperendemic trachoma in Ethiopia: a cluster-randomised trial. Lancet 2012; 379(9811): 143-51.
42. Gower EW, Kello AB, Kollmann KM. Training trichiasis surgeons: ensuring quality. Community Eye Health 2014; 27(87): 58.
43. Mpyet C, Kello AB, Solomon AW. Global Elimination of Trachoma by 2020: A Work in Progress. Ophthalmic Epidemiol 2015; 22(3): 148-50.