WHO's mandate is to provide technical leadership and coordination to the international efforts aiming to eliminate trachoma as a public health problem. The recommended elimination strategy, known as "SAFE", was adopted by WHO in 1996, and is a combination of interventions implemented as an integrated approach. SAFE is an acronym for:

- **S**urgery for *trachomatous trichiasis*
- **A**ntibiotics to clear ocular *C. trachomatis* infection
- **F**acial cleanliness to reduce transmission of ocular *C. trachomatis*
- **E**nvironmental improvement, particularly improved access to water and sanitation.

The summaries on this page are related to **Surgery for *trachomatous trichiasis***

Titles included in this document:

1. Epilation for Minor Trachomatous Trichiasis: Four-Year Results of a Randomised Controlled Trial
2. Pathogenesis of Progressive Scarring Trachoma in Ethiopia and Tanzania and its Implications for Disease Control: Two Cohort Studies
3. A Community-based Eye Care Intervention in Southern Egypt: Impact on Trachomatous Trichiasis Surgical Coverage
4. Posterior versus bilamellar tarsal rotation surgery for trachomatous trichiasis in Ethiopia: a randomised controlled trial
5. Identifying Patient Perceived Barriers to Trichiasis Surgery in Kongwa District, Tanzania
6. Predictors of Trachomatous Trichiasis Surgery Outcome
7. *Pre-Operative Trichiatic Eyelash Pattern Predicts Post-Operative Trachomatous Trichiasis.*
8. Optimising age adjustment of trichiasis prevalence estimates using data from 162 standardised surveys from seven regions of Ethiopia

1. **Epilation for Minor Trachomatous Trichiasis: Four-Year Results of a Randomised Controlled Trial**

Esmael Habtamu, Saul N. Rajak, Zerihun Tadesse, Tariku Wondie, Mulat Zerihun, Birhan Guadie, Teshome Gebre, Amir Bedri Kello, Kelly Callahan, David C. W. Mabey, Peng T. Khaw, Clare E. Gilbert, Helen A. Weiss, Paul M. Emerson, Matthew J. Burton
PLoS Negl Trop Dis 9 (3): e0003558
http://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0003558

Trachoma causes visual impairment through the effect of in-turned eyelashes (trichiasis) on the surface of the eye. The risk of sight loss is directly correlated with disease severity, becoming more frequent with increasing severity of trichiasis. The clinical phenotype ranges from a single aberrant eyelash touching the eye (without entropion) to the whole eyelid having rolled in. Trichiasis can be grouped based on the number of eyelashes touching the eye, into minor TT (1-5 lashes touching the eye) and major TT (>5 lashes touching the eye). Eyelid surgery is performed to correct the entropion that causes the trichiasis, in the expectation that this reduces the risk of sight loss. However, up to half of the individuals with trachomatous trichiasis may not have significant entropion. Therefore, there is scientific debate about how patients with non-entropic trichiasis should best be managed, particularly those with only a few lashes touching the eye. Many individuals with trichiasis, particularly those with mild disease, decline surgery, even when this is provided free and close to home, raising a need for non-surgical, community-based management strategies for those declining surgery. Epilation, intermittent plucking of lashes touching the eye, is a common traditional practice in many trachoma endemic societies, with up to 70% of people with trichiasis using this treatment strategy. However, its long-term effectiveness in preventing visual impairment is unknown.

In view of the problems in delivering the necessary volume of surgery, the high rate of refusals in some areas and concerns about the quality of outcomes, we conducted a randomized controlled trial of epilation versus eyelid surgery (the main treatment option) in Ethiopia. 1300 individuals with minor trichiasis were recruited and randomly assigned to trichiasis surgery or repeated epilation using high quality epilation forceps by a trained person with good near vision. We have previously reported results to two years[1] and have now re-assessed these individuals at four years.

At two years, all epilation arm participants were offered free surgery; two-thirds chose to continue epilating. At four years, 1151 (88.5%) were re-examined: 572 (88%) and 579 (89%) from epilation and surgery arms, respectively. 21.1% of the surgery arm participants had recurrent trichiasis. We found low rates of surgery uptake (33%) among people with mild disease, even with free community-based surgery. Among those who declined surgery and continued epilating, more than half (54.1%) fully controlled their trichiasis, 43.3% had minor trichiasis and only 2.6% had progressed to major trichiasis (>5 lashes). Among those who continued epilation: 92% had never tried to obtain trichiasis surgery, 85% reported that they were happy epilating and 92% had retained at least one pair of epilation forceps among the provided two. More importantly, there was no difference between the epilation and surgery groups in terms of change in vision (p=0.89) and corneal opacity (p=0.38) between baseline and four years.

There is a need for clear guidelines on how programmes should manage patients with a few non-entropic lashes who refuse surgery. Trichiasis in general and particularly major trichiasis warrants surgical treatment. However, the results of this study and the reality of low surgical uptake in many regions, suggest that epilation is a reasonable second-line alternative to surgery for minor trichiasis for individuals who either decline surgery or do not have immediate access to surgical treatment.

[1] Surgery Versus Epilation for the Treatment of Minor Trichiasis in Ethiopia: A Randomised Controlled Noninferiority Trial.
Saul N. Rajak, Esmael Habtamu, Helen A. Weiss, Amir Bedri Kello, Teshome Gebre, Asrat Genet, Robin L. Bailey, David C. W. Mabey, Peng T. Khaw, Clare E. Gilbert, Paul M. Emerson, Matthew J. Burton
PLoS Med 8(12): e1001136
http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001136

2. Pathogenesis of Progressive Scarring Trachoma in Ethiopia and Tanzania and its Implications for Disease Control: Two Cohort Studies

Matthew J. Burton, Saul N. Rajak, Victor H. Hu, Athumani Ramadhani, Esmael Habtamu, Patrick Massae, Zerihun Tadesse, Kelly Callahan, Paul M. Emerson, Peng T. Khaw, David Jeffries, David C. W. Mabey, Robin L. Bailey, Helen A. Weiss, and Martin J. HollandPLoS Negl Trop Dis 9 (5): e0003763

http://www.plosntds.org/article/Metrics/info:doi/10.1371/journal.pntd.0003763

Blinding trachoma is the end result of a long-term progressive scarring process that is initiated by recurrent infection by the bacterium *Chlamydia trachomatis*, starting in childhood. Scar tissue develops on the inner surface of the upper eyelids (conjunctiva). However, the rates, drivers and pathophysiological determinants are poorly understood. It is important to have an understanding of disease progression in order to be able to design control measures and to plan for the possible number of new cases of people with scarring complications that might develop in the future. This study was conducted in Ethiopia and Tanzania to investigate rates of progressive scarring and its relationship to conjunctival infection, inflammation and the expression of immunological and scarring factors that may be involved in the disease process.

We recruited two cohorts, one each in Ethiopia and Tanzania, of individuals with established trachomatous conjunctival scarring. They were assessed six-monthly for two years (five occasions), with clinical examinations and conjunctival swab sample collection. We compared high-resolution photographs taken of the upper tarsal conjunctiva at baseline with those taken at two years, to determine whether there was evidence of progression in the scarring. In the analysis we compare people with progressive scarring to individuals without scarring progression. The conjunctival swab samples were tested for *C. trachomatis* by PCR. In addition, we measured the expression of several genes that might be important in progressive scarring. These included a number of factors that are linked to inflammation or scarring (*S100A7, IL1B, IL13, IL17A, CXCL5, CTGF, SPARCL1, CEACAM5, MMP7, MMP9* and *CD83)*.

We compared paired photographs for 585 Ethiopian and 577 Tanzanian participants. Progressive scarring was found in 135/585 (23.1%) Ethiopians and 173/577 (30.0%) Tanzanians. There was a strong relationship between progressive scarring and increasing number of inflammatory episodes (Ethiopia: OR 5.93, 95%CI 3.31–10.6, p<0.0001. Tanzania: OR 5.76, 95%CI 2.60–12.7, p<0.0001). No episodes of *C. trachomatis* infection were detected in the Ethiopian cohort with only 5 episodes in the Tanzanian cohort during the two-year period. Clinical inflammation, but not scarring progression, was associated with increased expression of *S100A7*, *IL1B*, *IL17A*, *CXCL5*, *CTGF*, *CEACAM5, MMP7*, *CD83* and reduced *SPARCL1.*

In conclusion, scarring progressed in about a quarter of people over two years. The progression was closely associated with episodes of conjunctival inflammation but not to the detection of *C. trachomatis* infection. This raises uncertainty about the primary drivers of late-stage trachoma, once scarring changes have developed. Chronic conjunctival inflammation appears to be important and is associated with enriched expression of pro-inflammatory factors and altered expression of

extracellular matrix regulators (which are important in development of scar tissue). Host determinants of scarring progression appear more complex and subtle than the features of inflammation. Overall this study suggests a potential role for anti-inflammatory interventions to interrupt scarring progression and the need for trichiasis disease surveillance and surgery long after chlamydial infection has been controlled at community level.

3. A Community-based Eye Care Intervention in Southern Egypt: Impact on Trachomatous Trichiasis Surgical Coverage

Ahmed Mousa, Paul Courtright, Arminee Kazanjian, Ken Bassett

Middle East African Journal of Ophthalmology, Volume 22, Issue 4, October - December 2015 pp: 478-483.

In Egypt, population-based trachoma surveys in the past 15 years in 3 governorates provided evidence on the persistence of trachoma as a public health problem. In those governorates (Menofiya, Fayoum, and Menia), the prevalence of trachomatous trichiasis (TT) ranged between 6.2% and 7.7% in adults aged 40 years or older, with females 1.7 times more likely to have TT compared to males. Under-utilization of surgical services and poor quality of services were noted in all settings.

In the current study, the aim was to measure the impact of a community-based education and empowerment model on the uptake of trichiasis surgery. Four trachoma-endemic villages were selected in Samalout District, Menia Governorate. All 4 underwent a baseline survey of trachomatous trichiasis in adults aged 40 years and above. Two villages were randomly selected for intervention and the remaining two were non-intervention villages. The intervention model consisted of 3 main components: [1] community health education through information sessions and door-to-door health education, [2] detection and [3] supportive referral (assistance to attend surgery at the nearby local hospital). Due to the poor quality of TT surgical services at the hospital serving all 4 villages retraining of staff and provision of instruments and consumables were undertaken. The intervention was evaluated through comparison of findings from the baseline survey and a similar post-intervention survey. All patients with trichiasis answered a questionnaire regarding surgical utilization and barriers and a sample were interviewed to understand perspectives about the disease and the available services.

In the baseline survey, the prevalence of TT was 9.4-10.1% in villages and TT surgical coverage was 22.7% (38.9% males, 16.7% females). Following the intervention, the TT surgical coverage increased from 20.1% to 68% in intervention villages (81.5% males, 60% females; $p<0.01$) but no real change was recognized (a slight decrease from 26.1% to 14.7%) in the nonintervention villages.

Particular lessons learned from this study included:

- Although improvements to the quality and delivery of surgical service are essential, alone, they are unlikely to lead to any significant improvements in utilization of TT services.
- This is one of very few studies using TT case finders to both identify and counsel patients to increase use of TT surgeries; our findings suggest that TT case finders can be effective, if they are adequately trained and supported.
- In this setting, and possibly others, men are more likely to use the services first; reasons for delayed uptake by women need to be further explored and addressed.
- Although distances to the local hospital are relatively short (less than 10 km) the support provided by the trained community agent enabled patients to use the service more effectively; community agents served as ombudsmen helping to negotiate the desired service.

4. **Posterior versus bilamellar tarsal rotation surgery for trachomatous trichiasis in Ethiopia: a randomised controlled trial**

Esmael Habtamu, Tariku Wondie, Sintayehu Aweke, Zerihun Tadesse, Mulat Zerihun, Zebideru Zewudie, Amir Bedri Kello, Chrissy h. Roberts, Paul M. Emerson, Robin L. Bailey, David C. W. Mabey, Saul N. Rajak, Kelly Callahan, Helen A. Weiss, and Matthew J. Burton

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Free to download from: http://www.thelancet.com/pdfs/journals/langlo/PIIS2214-109X%2815%2900299-5.pdf

There is an unprecedented effort to scale up global trichiasis surgery output and improve outcomes, to clear the huge trichiasis backlog. However, recurrent trichiasis is frequent, presenting a substantial limitation in preventing sight loss from trachoma. Among several factors that are determinants of recurrent trichiasis is the type of operation. Two procedures are recommended by WHO and are both in common routine practice: bilamellar tarsal rotation (BLTR) and posterior lamellar tarsal rotation (PLTR, also known as the Trabut procedure). However, the relative effectiveness of these two procedures has not previously been adequately studied. Identifying the surgical intervention with the lowest recurrence rate has been a WHO research priority for some time. We conducted a randomized controlled single masked clinical trial to identify which of these two operations has the best outcomes in a programmatic setting in Amhara Region, Ethiopia.

We recruited 1000 participants with trachomatous trichiasis. They were randomly assigned (1:1) to either BLTR (501) or PLTR (499) surgery. The randomisation was stratified by surgeon. Surgery was done in a community setting following WHO guidelines. Participants were examined at before surgery, and at 6 and 12 months after surgery by assessors masked to allocation. The primary outcome was the cumulative proportion of individuals who developed recurrent trichiasis by 12 months. The intervention effect was estimated by logistic regression, controlled for surgeon as a fixed effect in the model.

At 12 months, 98% of the study participants were examined. We found cumulative recurrent trichiasis by 12 months was more frequent in the BLTR group (110/496 [22%]) than in the PLTR group (63/496 [13%]); adjusted odds ratio [OR] 1·96 [95% CI 1·40–2·75]; p=0·0001), with a risk difference of 9·50% (95% CI 4·79–14·16).

For secondary outcomes, BLTR was associated with more bleeding (OR=2·76; 95%CI 1·27–6·00), post-operative infection (OR=4·44; 95%CI 2·11–9·33), postoperative pain (OR=1·46; 95%CI 1·24–1·89) and under-correction. There was no difference in clinically significant eyelid contour abnormality (ECA), however BLTR had fewer clinically non-significant ECA (RRR=0·50; 95%CI 0·34–0·73). BLTR was associated with fewer post-operative granulomas (OR=0·41; 95%CI 0·20–0·83).

In conclusion, PLTR procedure was superior to the BLTR in terms of lower trichiasis recurrence and fewer intraoperative and immediate postoperative complications. PLTR could be the preferred

procedure for the programmatic management of trachomatous trichiasis. We suggest new surgical trainees in both established and new programmes should be trained in the PLTR procedure.

Commentary from Dr Anthony Solomon, WHO, in the same issue of the Lancet Global Health

Free to download from: http://www.thelancet.com/pdfs/journals/langlo/PIIS2214-109X%2816%2900004-8.pdf

5. **Identifying Patient Perceived Barriers to Trichiasis Surgery in Kongwa District, Tanzania**

Bickley, RJ, Mkocha H, Munoz B, and West SK of Dana Center at Johns Hopkins School of Medicine and Kongwa Trachoma Project in Tanzania

Trachomatous trichiasis (TT), inturned eyelashes from repeated infection with *Chlamydia trachomatis*, is the leading infectious cause of blindness in the world. Trichiasis surgery will correct entropion caused by trachoma, but one of the problems is that TT patients do not take up surgery. In order to improve uptake, we need to understand the barriers that patients identify to having surgery, and to understand factors that may have helped others to have surgery.

Following a study on TT screening in Kongwa District, Tanzania a TT surgical camp was convened to offer free surgery and transport to the camp for all persons identified with TT [1]. Surgery was also offered at the District Hospital. Two years after the camp, we interviewed those who did and those who did not have surgery using careful questions that asked opinions about barriers and what could be done to improve services.

The group who did not have surgery was similar to those who did have surgery in that they knew the benefits of surgery (reduce eye pain, see better). Knowledge of the benefits of surgery was not an issue in this study.
Both groups also reported that fear of surgery was the biggest barrier (89% and 79%). However, the ones who did not have surgery reported that this was a "general" reason that people did not have surgery but were less likely to report to the interviewers that they were personally afraid. Another difference is that the ones who did have surgery reported that fear of surgery was a barrier but that they were also afraid of losing vision without surgery. We believe that fear of losing eyesight enabled them to overcome their fear of the surgery itself. Increasing uptake will require presenting simple facts to the TT cases about the surgery itself to reduce the fear(which they may not state directly to program staff). These facts include outlining surgery logistics, surgical outcomes in the short term and long term, and stressing the risk of vision loss without surgery. A simple tool to provide basic education on what to expect will likely be of help.
Compared to acceptors, non-acceptors were more likely to report the following:

1. They had no one to accompany them to surgery (75.3%)
2. They could manage TT on their own (69.9%)
3. The surgery camp was too far (53.4%)

Distance to surgery, cost of surgery (if there is a cost) and lack of someone to accompany the cases are barriers that have also been reported in many other studies and programs may have to address these issues to improve uptake.

Very few persons reported that the surgeons did not do a good job, or that they worried about the way they would look after the surgery, so these were not barriers in Kongwa district.

The most frequent suggestion reported by both groups to improve the surgery program was to increase the education about the surgery itself so people can make informed decisions.
Our findings are similar to other reports from Ethiopia, Nigeria, The Gambia, India, and other districts in Tanzania, suggesting the usefulness of applying our findings to other settings.

6. Predictors of Trachomatous Trichiasis Surgery Outcome

Ophthalmology. 2017 Apr 21. pii: S0161-6420(17)30262-2. doi: 10.1016/j.ophtha.2017.03.016.
Esmael Habtamu,1,2 Tariku Wondie2, Sintayehu Aweke2, Zerihun Tadesse,2 Mulat Zerihun, Bizuayehu Gashaw, Guadie S. Wondimagegn4 , Hiwot D. Mengistie5, Saul N. Rajak,1 Kelly Callahan, Helen A. Weiss, and Matthew J. Burton1
1 London School of Hygiene & Tropical Medicine, London, UK; 2 The Carter Center, Addis Ababa, Ethiopia; 3 Amhara Regional Health Bureau, Bahirdar, Ethiopia; 4 Bahirdar University, Bahirdar, Ethiopia; 5 Felegehiwot Referral Hospital, Bahirdar, Ethiopia; 6 The Carter Center, Atlanta, USA

Unfavorable outcomes following Trachomatous Trichiasis (TT) surgery have the potential to undermine the global trachoma elimination effort. A secondary analysis from a randomised, controlled, single masked clinical trial was conducted to investigate predictors of postoperative TT (PTT), Eyelid Contour Abnormalities (ECA) and Granuloma in the two most common TT surgery procedures: Posterior Lamellar Tarsal Rotation (PLTR) and Bilamellar Tarsal Rotation (BLTR).

Participants were one thousand patients with TT, with lashes touching the eye or evidence of epilation, in association with tarsal conjunctival scarring. These were randomly allocated and received either BLTR (n=501) or PLTR (n=499) surgery. Disease severity at baseline; and surgical incisions, sutures and corrections were graded during and immediately after surgery. Participants were examined at 6- and 12-months by assessors masked to allocation. Main outcome measures were PTT, ECA and granuloma.

Data were available for 992 (99.2%) trial participants (496 in each arm). There was strong evidence that performing more peripheral dissection with scissors in PLTR (OR=0.70; 95% CI=0.54–0.91; p=0.008) and BLTR (OR=0.83; 95% CI=0.72–0.96; p=0.01) independently protected against PTT. Baseline major trichiasis and mixed location lashes; and immediate postoperative central under-correction independently predicted PTT in both surgical procedures. Peripheral lashes in PLTR (OR=5.91; 95% CI=1.48–23.5; p=0.01) and external central incision height ≥4mm in BLTR (OR=2.89; 95% CI=1.55–5.41; p=0.001) were independently associated with PTT. Suture interval asymmetry of >2mm (OR=3.18; 95% CI=1.31–7.70; p=0.01) in PLTR; and baseline conjunctival scarring in BLTR (OR=1.72; 95% CI=1.06–2.81; p=0.03) were independently associated with ECA. Older age was independently associated with ECA in both PLTR (p-value for trend<0.0001) and BLTR (p-value for trend=0.03). There was substantial inter-surgeon variability in ECA rates for both PLTR (range, 19.0%–36.2%) and BLTR (range, 6.1%–28.7%) procedures. In PLTR surgery, irregular posterior lamellar incision at the centre of the eyelid (OR=6.72; 95% CI=1.55–29.04; p=0.01) and ECA (OR=3.08; 95% CI=1.37–6.94; p=0.007) resulted in granuloma formation.

Overall, the results suggest that poor postoperative outcomes in TT surgery were mainly associated with modifiable operative factors which are relatively straightforward to address during surgical training and surgical practice. Consideration should be given to including these things in WHO's

checklist of procedures for certification of trichiasis surgeons. Systems for frequent, regular supportive supervision of surgeons and outcomes monitoring through active follow-up of patients should be strengthened. Surgeons consistently delivering suboptimal outcomes should be identified and given additional practical training.

7. **Pre-Operative Trichiatic Eyelash Pattern Predicts Post-Operative Trachomatous Trichiasis.**

PLoS Negl Trop Dis. 2019 Oct 07; 13(10) e0007637 | DOI: 10.1371/journal.pntd.0007637

Gower EW, Munoz B, Rajak S, Habtamu E, West SK, Merbs SL, Harding JC, Alemayehu W, Callahan EK, Emerson PM, Gebre T, Burton MJ

Trichiasis surgery is one of the four pillars of the World Health Organization trachoma elimination strategy. Although many endemic countries are scaling up their surgical programs to meet demand, high rates of post-operative trichiasis (PTT) remain an impediment to trachoma elimination. PTT, defined as one or more eyelashes touching the globe or evidence of epilation following surgery, results either from surgical failure due to inadequate correction of the eyelid or from recurrent trichiasis due to disease progression. Although previous studies have identified an association between PTT and surgical skills, none have looked at whether pre-operative trichiatic eyelash location may predict PTT. This information could be used to evaluate and improve surgical quality.

We performed a secondary analysis of data from four large randomized clinical trials conducted in Tanzania and Ethiopia. The trials used different surgical procedures (i.e. bilamellar tarsal rotation and posterior lamellar tarsal rotation). We included all 6,747 study eyes that received surgery. We conducted analyses at the trial level to compare rates of PTT based on trichiatic eyelash location. We used logistic regression adjusting for age, correlation between two eyes of an individual, baseline number of trichiatic eyelashes, clinical trial treatment (e.g., surgical procedure, oral and ointment antibiotic) assignment and surgical instrumentation.

The most common pre-operative trichiatic eyelash location was central, followed by temporal, and then nasal. We combined nasal and temporal into “peripheral” due to similar results in these groups. Two-year PTT rates ranged from 10–40% across trials. Eyelids with trichiatic eyelashes in >1 location pre-operatively were the most likely to develop PTT. Among the eyelids with either peripheral-only or central-only trichiatic eyelashes pre-operatively and no epilation, PTT was more common in eyelids with peripheral than central trichiasis pre-operatively. We observed a statistically significant association between pre-operative peripheral eyelashes and increased PTT risk for two trials after adjusting for baseline number of trichiatic eyelashes and age. The most likely explanation for this finding is that peripheral eyelashes are at greater risk of insufficient rotation during surgery because the incision may not extend all the way through the nasal and temporal aspects of the eyelid due to surgeons' concern about potential for bleeding. Furthermore, the incision will be shorter than the eyelid width if hemostats are positioned too close together or an eyelid clamp that is too small is used.

Across procedures and surgeon skill levels, the majority of eyelids with PTT had less severe disease at follow up than they did pre-operatively. This suggests that while the surgery was not completely successful in all cases, it often improved the eyelid status and reduced the trichiatic eyelash burden. This finding is important, as programs look to evaluate the benefits of conducting surgery and are asked questions regarding its cost-benefit. Given that in most instances, PTT returns to the same location as the trichiasis that was present before surgery, surgeons must be particularly attentive to this area and confirm that the region with trichiasis is slightly over-rotated at the completion of surgery.

In conclusion, this analysis demonstrated that across trichiasis surgery procedures, surgeon skill levels, and trichiasis severity levels, peripheral trichiatic eyelashes are the most likely to result in PTT. Utilizing data from four trials with varying surgeon skill levels and surgical procedures allows for a robust analysis of these factors. This finding emphasizes the importance of trichiasis surgery training programs focusing on ensuring adequate incision length and appropriate correction of peripheral eyelashes.

8. Optimising age adjustment of trichiasis prevalence estimates using data from 162 standardised surveys from seven regions of Ethiopia

Ophthalmic Epidemiol 2019 Jun;26(3):161-168. doi: 10.1080/09286586.2018.1555262.

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Key message:
The study findings suggest that data analysts assisting programme managers to make trichiasis surgery estimates for planning purposes should adjust sample proportions by gender and by age in 5 year age-bands up to the age of 69, and by gender and age in 20 year age-bands thereafter in order to maximise the accuracy of these estimates. This will be incorporated in standard analyses run by Tropical Data.

Training trichiasis surgeons is costly, with the numbers required informed by the estimated number of eyes requiring surgery in a given area. This relies on accurate population-level estimates of the trichiasis prevalence. Surveys carried out in the daytime are prone to find older individuals and females at home; because both female gender and increasing age are strongly associated with trichiasis, sample proportions tend to be higher than the true prevalence of trichiasis. Therefore, proportions should be adjusted to reflect the overall age and gender breakdown of the population. The best method of dividing the population into agebands is unclear.

In this analysis we assessed the accuracy of different methods of subdividing the sample population by age and gender in order to identify the approach that would produce the most accurate population-level trichiasis estimates. Gender was included and dichotomised (feminine/female, masculine/male) *a priori*, with credible methods of aggregating age into "bins" considered as bandwidths in multiples of 5 years, because census populations most commonly present age at a minimum resolution of 5 years. In addition, in developing countries, the population typically decreases sharply above the age of average life expectancy. This means that at ages above this point, the bin proportion estimates lack precision because bins have very few individuals with which to make an estimate of the true proportion of trichiasis. With this in mind, we considered models which divided the sampled population by varying combinations of gender, bin size, and transition point from fine to coarse resolution (small to large bin sizes), with transitions considered at 40, 60, 65, and 70 years of age.

The models were evaluated by internal cross-validation using data from 162 standardised population-based trachoma prevalence surveys carried out in Ethiopia from 2012 to 2015 as part of the Global Trachoma Mapping Project (GTMP). The dataset was first partitioned into training (95%) and test (5%) datasets. In this way, each model was applied to 95% of the data and tested on the remaining 5%. For each model, age- and gender-specific proportions were calculated and assigned as probabilities to individuals in the test dataset based on their respective age and gender. The results were then scored based on the ability to predict whether the individual in the test dataset did or did not have trichiasis.

In the datasets, there was a total of 4529 (1.9%) cases of trichiasis amongst 241,139 individuals aged ≥15 years from a total of 4210 clusters and 122,090 households visited. Seventeen models were considered as credible strategies for adjustment. Overall, the method that split by gender and by 5-year bands from age 15 to 69 years, with coarser binning in 20-year age-bands above this age, provided the best predictive accuracy. Compared to the neutral-bias estimate, the estimate for the trichiasis backlog was higher in those with a negative-bias in self-reported age (tending to be older than reported). The estimate for the trichiasis backlog was lower in those with a positive bias in self-reported age (tending to be younger than reported). However, without specific cultural knowledge, it is not clear how this can be applied programmatically, other than to remind programme managers that accurate age reporting and recording is crucial and that where positive or negative age-reporting bias is thought to be present, trichiasis estimates can be affected.

This modelling suggests that data analysts assisting programme managers to make trichiasis surgery estimates for planning purposes should adjust sample proportions by gender and by age in 5 year age-bands up to the age of 69, and by gender and age in 20 year age-bands thereafter in order to maximise the accuracy of these estimates. This will be incorporated in standard analyses run by Tropical Data.