International Health 2023; **15**, **Suppl.2**: ii58–ii67
https://doi.org/10.1093/inthealth/ihad067

ORIGINAL ARTICLE

Gender differences in the surgical management of trachomatous trichiasis: an exploratory analysis of global trachoma survey data, 2015–2019

Kristin M. Sullivan[a,*,†], Emma M. Harding-Esch[b], Wilfrid E. Batcho[c], Amadou A. Bio Issifou[d], Maria de Fátima Costa Lopes[e], Celia Landmann Szwarcwald[f], Daniela Vaz Ferreira Gomez[g], Clarisse Bougouma[h], Nassa Christophe[i], Martin Kabore[j], Victor Bucumi[k], Assumpta L. Bella[l], Emilienne Epee[m], Georges Yaya[n], Julian Trujillo-Trujillo[o], Michael Dejene[p], Fikre Seife Gebretsadik[q], Genet Gebru[q], Fikreab Kebede[q], Tsedeke Mathewos[q], Eunice Texiera de Silva Cassama[r], Salimato Sanha[s], Ernest Barasa[t], Hadley Matendechero Sultani[u], Titus Watitu[t], Rabebe Tekeraoi[v], Khumbo M. Kalua[w], Michael P. Masika[x], Lamine Traoré[y], Abdallahi O. Minnih[z], Mariamo Abdala[aa], Marília E. Massangaie[aa], Ye Win[ab], Sue-Chen Apadinuwe[ac], Sailesh Kumar Mishra[ad], Shekhar Sharma[ae], Abdou Amza[af], Boubacar Kadri[af], Beido Nassirou[af], Caleb D. Mpyet[ag], Nicholas Olobio[ah], Arif Hussain[ai], Asad Aslam Khan[aj], Garap Jambi[ak], Robert Ko[al], Amir B. Kello[am], Mouctar D. Badiane[an], Boubacar Sarr[ao], Abdi Dalmar[ap], Balgesa E. Elshafie[aq], George E. Kabona[ar], Oscar Kaitaba[ar], Upendo Mwingira[ar], Alistidia Simon[ar], Sarjo Kanyi[as], Marcel S. Awoussi[at], Kwamy Togbey[au], Gilbert Baayenda[av], Mugume Francis[av], Edridah M. Tukahebwa[aw], Ana Bakhtiari[ax], Alexander P. Keil[a], Joanna Maselko[a], Daniel Westreich[a], Mackline Garae[ay], Fasiah Taleo[ay], Tawfik Q. Al-Khateeb[az], Consity Mwale[ba], Anthony W. Solomon[bb] and Emily W. Gower[a]

[a]Department of Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA; [b]Clinical Research Department, London School of Hygiene & Tropical Medicine, London, UK; [c]Programme National De Lutte Contre Les Maladies Transmissibles, Ministère De La Santé, Cotonou, Benin; [d]Département D'ophthalmologie, Université De Parakou, Borgou, Benin; [e]Secretaria de Vigilância em Saúde e Ambiente, Ministério da Saúde, Brazil; [f]Institute of Scientific and Technological Communication and Information in Health, Oswaldo Cruz Foundation, Rio de Janeiro, Brazil; [g]Ministério da Saúde, Brazil; [h]Direction de la Protection de la Santé de la Population, Ministère de la Santé, Burkina Faso; [i]Attaché de Santé en Épidémiologie, Programme National de Lutte Contre Les MTN, Burkina Faso; [j]L'unité d'élimination du trachome, PNMTN, Ouagadougou, Burkina Faso; [k]Département En Charge des Maladies Tropicales, Négligées Ministère De La Santé Publique Et De La Lutte Contre Le Sida, Bujumbura, Burundi; [l]Programme National de Lutte Contre La Cecite, Ministère de la Santé Publique, Yaoundé, Cameroun; [m]Department Of Ophthalmology, University of Yaoundé Yaounde Centre/Ministère de la Santé Publique, Yaoundé, Cameroun; [n]Ministère de la Santé Publique, Bangui, Central African Republic; [o]Subdirectorate of Communicable Diseases, Ministry of Health and Social Protection, Bogotá, Colombia; [p]Sightsavers, Addis Ababa, Ethiopia; [q]Neglected Tropical Disease Prevention and Control Program, Ministry of Health, Addis Ababa, Ethiopia; [r]Region Sanitaria Bolama-Bijagós, Bubaque, Guinea Bissau; [s]Programa Nacional De Sau´de De Visão, Minsap, Bissau, Guinea-Bissau; [t]Ministry of Health, Nairobi, Kenya; [u]State Department for Public Health and Professional Standards, Ministry of Health, Nairobi, Kenya; [v]Tungaru Central Hospital, MHMS Tarawa, Kiribati; [w]Blantyre Institute for Community Outreach, Blantyre, Malawi; [x]Department of Clinical and Medical Rehabilitation Services, Ministry of Health, Lilongwe, Malawi; [y]National Eye Health Program, Ministry of Health and Social Development, Mali; [z]Département Des Maladies Transmissibles, Ministère De La Santé Nouakchott, Nouakchott, Mauritania; [aa]Direção Nacional de Saúde Pública, Ministerio Da Saude, Maputo, Mozambique; [ab]Department of Public Health, Ministry of Health and Sports, Nay Pyi Taw, Myanmar; [ac]Department of Health, Denigomodu District Nauru, Nauru; [ad]National Society for Comprehensive Eye Care, Nepal Netra Jyoti Sangh, Kathmandu, Nepal; [ae]Ministry of Health, Kathmandu, Nepal; [af]Programme National De Santé Oculaire, Ministère De La Santé Publique, Niamey, Niger; [ag]Department of Ophthalmology, University of Jos, Jos, Plateau, Nigeria; [ah]Neglected Tropical Diseases Division, Department of Public Health, Federal Ministry of Health, Abuja, Nigeria; [ai]Community Ophthalmology, College of Ophthalmology & Allied Vision Sciences (COAVS), Mayo Hospital Lahore, Lahore, Pakistan; [aj]College of Ophthalmology and Allied Vision Sciences, Mayo Hospital, Lahore, Pakistan; [ak]Prevention of Blindness Committee, PNG Eye Care, Boroko, Papua New Guinea; [al]National Department of Health, Waigani, Papua New Guinea; [am]AF/UCU UHC/Communicable and Noncommunicable Diseases Unit, ESPEN, World Health Organization, Brazzaville, Republic of Congo; [an]Programme National de Promotion de La Santé Oculaire, Ministère de la Santé et de L'Action Sociale, Dakar, Senegal; [ao]Ministère de la Santé et de l'Action Sociale, Senegal; [ap]Ministry of Health, Mogadishu, Somalia; [aq]National Program for Prevention of Blindness, Federal Ministry of Health, Khartoum, Sudan; [ar]Neglected Tropical Diseases Control Program, Ministry of Health, Dodoma, Tanzania; [as]National Eye Health Programme, Ministry of Health and Social Welfare, Banjul, The Gambia; [at]Ministère de la Santé et de L'Hygiène Publique, Lomé, Togo; [au]Programme National des Maladies Tropicales Negligées, Ministry of Health, Public Hygiene and Universal Access to Care, Lomé, Togo;

[av]Neglected Tropical Diseases Control, Ministry of Health, Kampala, Uganda; [aw]Vector-Borne and Neglected Tropical Diseases, Ministry of Health, Kampala, Uganda; [ax]International Trachoma Initiative, Task Force for Global Health, Decatur, Georgia, USA; [ay]Department of Neglected Tropical Diseases, Vanuatu Ministry of Health, Port Vila, Vanuatu; [az]Department Of Ophthalmology, Sana'a University, Sana'a, Yemen; [ba]Kitwe Teaching Eye Hospital, Ministry of Health, Kitwe, Zambia; [bb]Global Neglected Tropical Diseases Programme, World Health Organization, Geneva, Switzerland

*Corresponding author: Tel: +14045921402; E-mail: ksullivan@unc.edu

†Present address: The Task Force for Global Health, Inc. Children Without Worms (CWW), 325 Swanton Way, Decatur, GA 30030. Tel: (404) 592-1402; E-mail: ksullivan@taskforce.org

Received 14 April 2023; revised 28 June 2023; editorial decision 24 July 2023; accepted 26 July 2023

Background: Trachomatous trichiasis (TT) is a painful, potentially blinding eye condition that can be managed through epilation or surgery. Women are affected by TT approximately twice as often as men and are believed to face gendered barriers to receiving surgical care to prevent vision loss.

Methods: We used data from 817 cross-sectional surveys conducted during 2015–2019 in 20 African countries to estimate the prevalence difference (PD) between female and male eyes for four outcomes potentially indicating gender-related differences in TT management: (1) received surgery and developed postoperative TT (PTT), (2) never offered surgery, (3) offered surgery but declined it, and (4) offered epilation but never offered surgery.

Results: The prevalence was modestly elevated among female eyes compared with male eyes for having PTT (PD:1.8 [95% confidence limits (CL): 0.6, 3.0]) and having declined surgery for the eye (PD: 6.2 [95% CL: 1.8, 10.7]). The proportion offered epilation was similar by gender (PD:0.5 [95% CL: −0.4, 1.3]), while never having been offered surgery was somewhat more prevalent among male eyes (PD: −2.1 [95% CL: −3.5, −0.7]).

Conclusions: Our results suggest potential gender differences in TT management. More research is needed to determine the causes and implications of the observed differences.

Keywords: *Chlamydia trachomatis*, elimination, gender, surgery, trachoma, trichiasis.

Introduction

Inflammatory trachoma (associated with ocular infection with the *Chlamydia trachomatis* bacterium) is most commonly seen among rural and suburban preschool-aged children who have insufficient access to water and sanitation. Trachoma is the leading infectious cause of blindness globally, and it disproportionately affects the world's most impoverished people. Approximately 125 million people live in trachoma-endemic districts of 44 countries, and approximately 2 million have visual impairment or blindness due to trachoma.[1,2]

While a single infection is typically benign, vision impairment occurs when the accumulating effects of recurrent infections cause the eyelid to turn inward such that eyelashes abrade the eyeball, a painful condition known as trachomatous trichiasis (TT). Compared with men, women are estimated to have approximately twice the prevalence of TT, and in some areas, as high as four times.[3,4] While the roots of this gender disparity remain unclear, the prevailing belief is that the high disease burden among women is driven at least in part by gender-associated sociocultural and socioeconomic factors that shape the division of labor among women in trachoma-endemic areas.[5] Experts suggest that a critical driver of the gender disparity may be frequent infections due to chronic exposure to *C. trachomatis* among primary caregivers of young children.[5]

While some TT-affected individuals may choose epilation management (a temporary solution), surgical correction of TT early in the disease may prevent progression to blindness and is recommended for TT-affected individuals when ≥1 eyelash touches the cornea.[6] Unfortunately, some gender-specific factors predisposing women to inflammatory trachoma may also be barriers to receiving timely surgical management for TT. Such factors include the inability to forgo responsibility for necessary domestic tasks (caring for children, cooking, fetching water) in order to travel to, have, and recover from surgery.[7] Women may also have limited decision-making capacity within the household, lack social support and be unable to travel unescorted.[7] Thus, they may decline surgery or delay care until the disease becomes more severe,[8] potentially increasing their risk for worse visual impairment and poor surgical outcomes, such as postoperative TT (PTT).[9]

Gender differences in TT surgical uptake may partially explain the increased TT prevalence reported among women, yet limited studies have explored this issue. Recent global TT surgery estimates from WHO are encouraging and suggest gender-equitable receipt of surgery, with 69% of all TT surgeries performed in 2021 provided to women.[1] However, the results of studies that have explored gender-specific surgical uptake are mixed.[10–12] More research is needed to ensure that trachoma elimination programs reach women equitably.

To explore potential gender differences in TT surgical uptake, we analyzed data collected from standardized, cross-sectional surveys from 30 countries, although our results focus on 20 African countries. The objective of this exploratory secondary analysis was to estimate the prevalence difference between female and male eyes in four outcomes that could suggest differential approaches to management. Specifically, these outcomes were (1) had surgery and developed PTT, (2) never offered surgery, (3) previously offered surgery but the individual declined it, and (4) offered epilation but never offered surgery.

Materials and Methods

Primary data source

Data for this study were collected from surveys supported by the Global Trachoma Mapping Project (GTMP)[13] and Tropical Data (TD; https://www.tropicaldata.org/). Full details of the GTMP/TD methodology have been published elsewhere.[13–15] Key elements are provided below.

Survey design

The GTMP/TD-supported surveys are cross-sectional and use two-stage cluster sampling to estimate the prevalence of trachomatous inflammation—follicular among children aged 1–9 y and TT among adults aged ≥15 y ($TT_{\geq 15}$). Surveys are conducted at the evaluation unit (EU) level, where an EU is generally equivalent to a district and defined by WHO as 'the normal administrative unit for health care management consisting of a population unit between 100 000–250 000 individuals'.[16] EUs are surveyed at baseline (where trachoma is suspected of being endemic) or after a defined intervention period dictated by the EU's prevalence estimate from the most recent survey.[14] Within each EU, in general, the primary sampling unit is the cluster (i.e. the local equivalent of a village), and the secondary sampling unit is the household. Within randomly selected households, all individuals aged ≥1 y are invited to participate; however, only those aged ≥15 y are included for TT-related estimates.[15] Samples are drawn under equal probability sampling to the extent achievable.[14]

Survey conduct

Trained, certified graders conduct clinical eye examinations of eligible, consenting household members. They examine individuals' eyes and grade each for the presence or absence of TT based on the WHO simplified trachoma grading system.[17] Individuals with TT are referred for TT surgery when appropriate.

TT management questions

For trachoma elimination purposes, WHO defines the TT target as a prevalence 'unknown to the health system' of <0.2% in adults aged ≥15 y,[18,19] where 'unknown to the health system' excludes identified TT cases who have PTT, who have refused surgery and who have a surgical date set but have not yet received an operation. At the time of survey fieldwork, TT-affected individuals are asked a question regarding the TT surgical management of their affected eye(s) to classify it as 'known' or 'unknown' to the health system (Box 1). This question was asked during some 2015–2016 GTMP surveys and all TD surveys. The surgical management question provides information on whether a health worker had ever offered the individual eye surgery. In addition to the surgical management question, individuals with TT are also asked if they have ever been offered epilation by a health worker.

Box 1. Trachomatous trichiasis management questions

Have you ever been offered surgery by a health worker to correct the trichiasis (in-turned eyelashes) in this eye?

(a) Yes, a health worker informed me and offered me surgery, and I had surgery.
(b) Yes, a health worker informed me and offered me surgery and I accepted the offer, but I have not yet had surgery.
(c) Yes, a health worker informed me and offered me surgery, but I declined it.
(d) No health worker informed me and offered me surgery.
(e) Don't know.

Have you ever been offered epilation by a health worker to correct the trichiasis (in-turned eyelashes) in this eye?

- Yes.
- No.
- Don't know.

Present study

Setting

We invited all 42 countries that had conducted surveys with support from GTMP/TD through to 2019 to share data. All survey types (baseline, impact, surveillance, TT-only) conducted from 2015 to 2019 were included (see Supplementary Text for additional information on survey types). In EUs where more than one survey had been conducted, we considered for inclusion only data from the most recent survey. While all eligible countries were invited to participate, due to small numbers of eligible eyes outside of WHO's African region, the prevalence differences presented in the main text are for that region only.

Individuals

Individuals in this study were TT-affected adults aged ≥15 y, the age group corresponding to the WHO TT elimination indicator. At the eye level, this study included only the TT-affected eyes of these individuals.

Table 1. Trachomatous trichiasis management outcomes examined

Outcome (numerator)	Implication of outcome	Measured among (denominator)*†
Received surgery for the eye and developed PTT	Eye in need of further management	All TT-affected eyes
Never offered surgery for the eye	Eye in need of initial surgery or has received non-surgical management of TT	Surgery-naïve TT-affected eyes
Offered surgery, but the individual declined it for the eye	Eye diagnosed with TT at previous eye care encounter but not yet had surgery (delayed care) and unlikely to receive surgery in the absence of addressing concerns/barriers	Surgery-naïve TT-affected eyes previously offered surgery
Offered epilation but never offered surgery for the eye	Eye previously diagnosed with TT but not offered surgery at the time of diagnosis	Eyes never offered surgery

Abbreviations: PTT, postoperative trachomatous trichiasis; TT, trachomatous trichiasis.
*Line style and color shown following text correspond to the compartments outlined in Figure 1.
†See Supplementary Text for additional details on outcome calculations.

Inclusion criteria

At the EU level, surveys must have started in 2015 or later, identified at least one TT case among both men and women, and asked the surgical management question to TT-affected individuals.

TT status

Two slightly different definitions were used for classifying TT during the survey period. Prior to the 2018 4th Global Scientific Meeting (GSM4) on Trachoma,[20] surveys considered TT present when at least one eyelash was touching the eyeball or if there was evidence of recent eyelash removal (epilation) without indicating the upper or lower eyelid. Post-GSM4 surveys restricted the TT definition to the upper eyelid only. Among eligible surveys for this analysis, 96% were conducted using the pre-GSM4 definition and 4% using the post-GSM4 definition.

Variables

The surveyor records gender as either male or female based on their observation. Given the prevailing belief that social factors, rather than biological ones, predispose a woman to TT and create potential barriers for care, we felt that this response reasonably represents 'gender', describing the 'norms, roles and relationships of and between women and men'.[21] Age is asked of all survey respondents. The outcomes (Table 1) were derived primarily from the TT surgical management question responses. However, because some individuals may be offered non-surgical management options, we included responses from the epilation management question for the fourth outcome. For this outcome, we looked exclusively among eyes that had never been offered surgery but had been offered epilation, as this combination indicates that the individual's eye had been diagnosed with TT previously but was not offered surgery at the time of diagnosis.

Conceptual framework

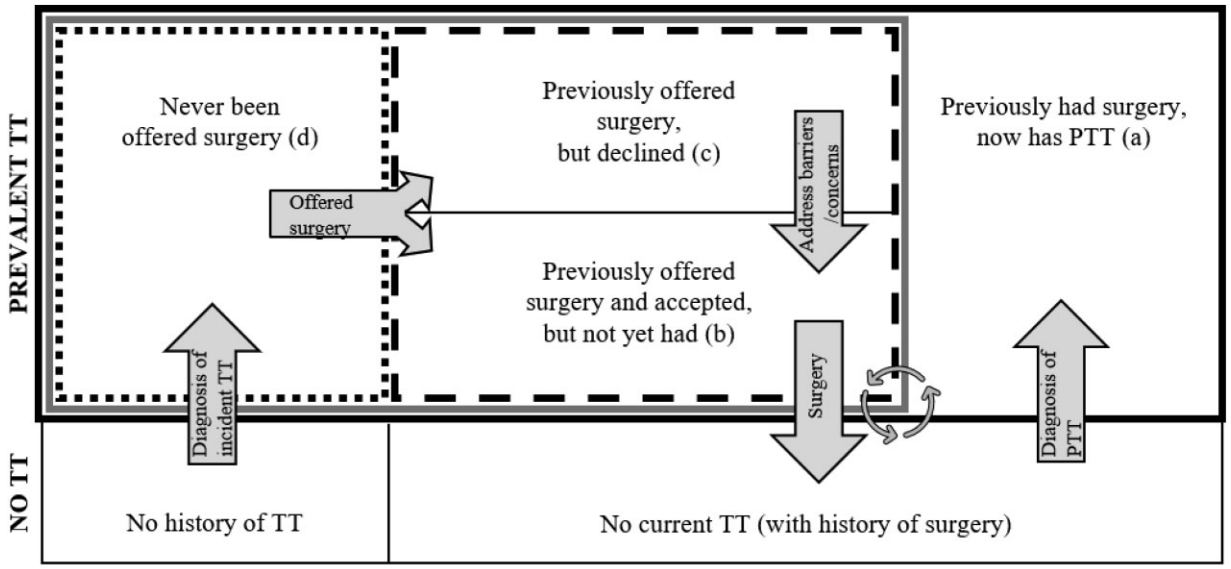
Figure 1 conceptualizes where gender differences may arise as they relate to our TT management outcomes. At the time of the GTMP/TD cross-sectional survey, individuals' eyes will be in one of the compartments shown in the figure. Eyes without TT may either have no history of TT or may have had successful surgery that resolved their TT; our data cannot distinguish between these two groups.

Among those with prevalent TT, an eye can appear in one of four compartments indicative of the surgical status of the eye (the letters, a-d, correspond to the response to the surgical management question provided in Box 1). Compartment 'd' (never been offered surgery) includes eyes newly diagnosed by GTMP/TD surveyors or eyes previously diagnosed (either through a previous GTMP/TD survey or other eye care services) but not offered surgery. Eyes in compartments 'b' (not yet had surgery) and 'c' (declined surgery) had been diagnosed and previously offered surgery by a health worker but had not received surgery in the time between diagnosis and the current examination. Finally, eyes in compartment 'a' (PTT) previously had surgery to correct TT but developed PTT. To reach this compartment, eyes exited the TT-prevalent population for some time and returned when PTT occurred.

The probabilities that dictate the transition of eyes through these compartments may differ by gender. If so, the compartment in which a surveyed eye appears will be a function of the gender-specific probability of incident TT, being diagnosed with TT, being offered (and accepting) surgery, having surgery, having incident PTT and being diagnosed with PTT. If the relative sizes of these compartments are unequal among men and women, this may inform the need for further investigations into any observed gender differences.

Statistical methods

All analyses were stratified by WHO region. To determine the prevalence difference between women's eyes and men's eyes



Abbreviations: TT, trachomatous trichiasis; PTT, postoperative trachomatous trichiasis.
**Box size does not represent relative distribution; letters in the prevalent TT cases population represent corresponding responses to the surgical management question used in this study (see Box 1).*

Figure 1. Conceptual framework describing categorization of study eyes regarding surgical management of trachomatous trichiasis*.

(reference category), we calculated the gender-specific proportion of each outcome measure described in Table 1. This analysis was conducted at the eye level, so each eligible individual contributed one or two observations. To account for correlated outcomes within an individual, we used linear risk generalized estimating equation models to estimate 95% confidence limits for prevalence differences. We specified repeated measures at the individual level and assumed independence of observations within an individual (independent correlation matrix). We assumed that residual correlation beyond the individual (such as village- or EU-levels) would not substantially impact standard error estimation.

Non-response weights. Men are more commonly absent from the household at the time of GTMP/TD surveys and thus have a higher probability of not being examined. To account for this, we created non-response weights based on gender and 5-y age categories derived from the distribution of recorded household members within each EU (whether present for examination or not). Because a sensitivity analysis indicated that these weights did not meaningfully change the results, we present the non-weighted results in this work (see Supplementary Figure S2 for weighted results). We used SAS version 9.4 (Cary, NC, USA) for data management and analyses.

Results

Selection of study eyes

Of the 42 countries invited to participate, 32 shared data for this study and contributed 1682 potentially eligible EUs. Among these EUs, data from 825 EUs were excluded because they did not meet the inclusion criteria (Table 2). Two countries (Somalia, Vanuatu) did not report any TT-affected eyes in contributed, eligible surveys. After eligibility criteria were met, the analysis dataset contained 28 979 TT-affected eyes of 19 965 individuals.

Eligible study eyes

Eligible surveys were from 857 EUs of 30 countries (Tables 3 and 4). Of the 15 405 women included in the study, 46.2% had bilateral TT, while 41.7% of the 4560 men had bilateral TT. For each male eye included, roughly 3.5 female eyes were included (6461 male eyes, 22 518 female eyes).

As expected, given the global TT burden, the four non-African WHO regions contributed only 2.5% of eligible eyes. Estimates in these regions were imprecise, but may be necessary for understanding gender differences in TT management. We focus the remainder of this text on the African region but present results from the four other regions in Supplementary Figures S1 and S2. While eligible eyes from 20 African countries are included, Ethiopia alone contributed >50% of eligible eyes.

Responses to the TT management questions by gender

The response distribution to the TT management questions from the African region is presented in Table 4. More than 70% of female and male TT-affected eyes had never been offered surgery; roughly 12% of all eyes were offered epilation (irrespective of their surgical management status).

Table 2. Selection of eligible eyes by exclusion criteria for all WHO regions

	Exclusions				Remaining after exclusion			
Exclusion criteria (applied sequentially)	Countries	EUs	Individuals	Eyes	Countries	EUs	Individuals	Eyes
Start: data from most recent surveys in EU	N/A	N/A	N/A	N/A	32	1682	3 082 039	6 164 078
Exclude EUs in which survey began prior to 2015*	0	432	724 724	1 449 448	32	1250	2 357 315	4 714 630
Exclude EUs in which no TT-affected eyes were identified among either gender	2	130	219 894	439 788	30	1120	2 137 421	4 274 842
Exclude EUs in which no TT-affected eyes were identified among men	0	216	379 500	759 000	30	904	1 757 921	3 515 842
Exclude EUs in which no TT-affected eyes were identified among women	0	39	71 269	142 538	30	865	1 686 652	3 373 304
Exclude GTMP-surveyed EUs in which the surgical management question was not asked†	0	8	13 994	27 988	30	857	1 672 658	3 345 316
Exclude individuals not examined (i.e. absent/refused examination)	0	0	193 253	386 506	30	857	1 479 405	2 958 810
Exclude individuals known to be without TT in both eyes	0	0	1 458 748	2 917 496	30	857	20 657	41 314
Exclude individuals missing TT status in both eyes	0	0	265	530	30	857	20 392	40 784
Exclude individuals known to be without TT in one eye, and missing status in the other	0	0	427	854	30	857	19 965	39 930
Exclude eyes without TT	0	0	0	10 951	30	857	19 965	28 979

Abbreviations: EU, evaluation unit; GTMP, Global Trachoma Mapping Project; TT, trachomatous trichiasis.
*These generally overlapped with GTMP-surveyed EUs in which the surgical management question was not asked. Overall, this criterion resulted in the exclusion of 781 TT-affected eyes.
†Whether the surgical management question was asked in an EU is not directly indicated in the meta-data; therefore, for GTMP surveys, we assumed the surgical management question was asked if at least one TT-affected eye in the EU had a response to this question.

Table 3. Number of eligible countries, evaluation units, individuals and eyes by WHO region

WHO region	Number of countries	Number of EUs	Number of TT-affected individuals	Number of TT-affected eyes	Number of TT-affected eyes with non-missing response to the surgical management question
All regions	30	857	19 965	28 979	27 800
African	20	817	19 479	28 260	27 176
Eastern Mediterranean	3	17	219	318	309
South-East Asian	2	15	188	273	194
Western Pacific	3	4	46	72	66
The Americas	2	4	33	56	55

Abbreviations: EU, evaluation unit; TT, trachomatous trichiasis.

TT management outcomes

Female eyes had elevated proportions of PTT and having declined surgery (by the individual) compared with male eyes (Figure 2). Declining surgery for the eye was frequent among both female (35.0%) and male (28.7%) eyes with TT and resulted in the maximum observed prevalence difference between genders (6.2 [95% CL: 1.8, 10.7]) across the four outcomes. Male eyes more commonly had never been offered surgery. The QIC model fit statistics were 21 749.2 (PTT), 21 178.1 (never offered surgery), 5012.5 (declined surgery) and 7205.0 (offered epilation only).

Country-specific and survey type-specific estimates of the four outcomes are provided in Supplementary Figures S3–S7.

Discussion

We used existing population-based prevalence survey data to assess potential gender differences in four outcomes of TT

Table 4. Distribution of responses to the trachomatous trichiasis management questions by gender*

	Female eyes	Male eyes	All eyes
Have you ever been offered surgery by a health worker to correct the trichiasis (in-turned eyelashes) in this eye?			
(a) Yes, a health worker informed me and offered me surgery, and I *had surgery*	2996 (14.1%)	739 (12.3%)	3735 (13.7%)
(b) Yes, a health worker informed me and offered me surgery and I accepted the offer, but I have *not yet had surgery*	2037 (9.6%)	566 (9.4%)	2603 (9.6%)
(c) Yes, a health worker informed me and offered me surgery, but I *declined it*	1095 (5.2%)	228 (3.8%)	1323 (4.9%)
(d) No health worker informed me and offered me surgery	15 058 (71.1%)	4457 (74.4%)	19 515 (71.8%)
Subtotal	21 186	5990	27 176
(e) Don't know (or unknown)	843	241	1084
Total	22 029	6231	28 260
Have you ever been offered epilation by a health worker to correct the trichiasis (in-turned eyelashes) in this eye?			
– Yes	2644 (12.1%)	686 (11.1%)	3330 (11.9%)
– No	19 176 (87.9%)	5502 (88.9%)	24 678 (88.1%)
Subtotal	21 820	6188	28 008
– Don't know (or unknown)	209	43	252
Total	22 029	6231	28 260

Table contents are N or N (column percentage).
*Table includes only eligible eyes contributed from the WHO's African region countries.

management. Among countries in WHO's African region (the primary focus in this work), we found that female eyes had an increased prevalence of two outcomes compared with men: PTT and declining surgery (by the individual). While modest, these observed disparities suggest potential gender differences in TT surgical management worthy of further exploration.

PTT

We found that roughly 14% of female and 12% of male eyes with TT demonstrated PTT. While this 2% difference is modest, when considering the absolute number of women with TT compared with men, it may have implications for women's eye health because optimal approaches for the surgical correction of PTT are still being evaluated,[20] and there is some suggestion that outcomes may be worse following repeat surgery.[22] There are several ways this difference in proportions could have arisen (and thus, we caution against overinterpreting the finding). One possible reason for the disparity is a higher PTT incidence after the initial surgery in women than in men. Four trials, however, have reported PTT by gender and found either little difference[23,24] or found PTT to be more common among men,[25,26] despite the current belief that women may delay surgical care, leading to increased TT severity, a risk factor for PTT.[9] We encourage future studies to report gender-disaggregated PTT estimates to answer this question convincingly.

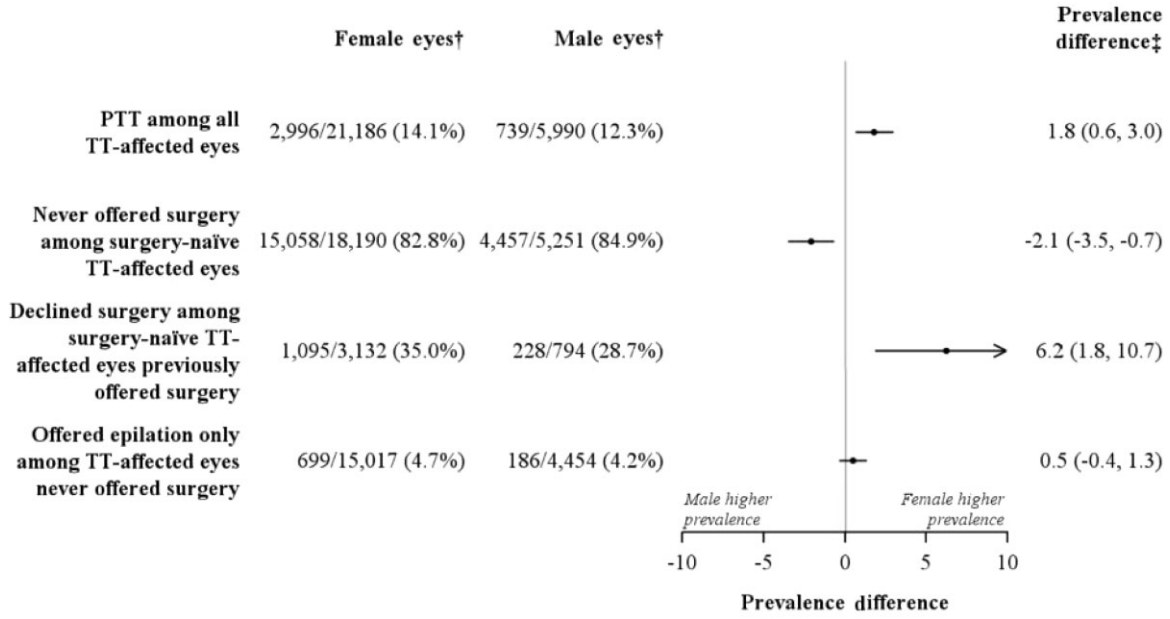
Declining surgery

Among surgery-naïve, TT-affected eyes that were offered surgery, eyes belonging to women were more likely to have had surgery declined by the individual than eyes belonging to men: 35% vs 29%, respectively. This finding is of particular interest because gender-related influences would likely play a more significant role in this measure than in others under study, given the barriers women are believed to face in receiving TT surgery once diagnosed (such as limited decision-making capacity, being unable to travel unescorted, needing spousal permission, or being unable to abandon their primary role as caregivers both to their spouses and children in the household).

A case-control study of surgery acceptors/non-acceptors in the United Republic of Tanzania found that compared with men, women more often reported that they had no one to accompany them to surgery and that they could manage TT on their own without surgery.[27] Similarly, interviews conducted in Ethiopia found that the lack of an escort, fear and being unaware of how to access surgery were more commonly reported by women than men as reasons for not having previously undergone TT surgery.[28] While the case-control study reported 'no evidence of gender bias' in accepting surgery, our estimates suggest further investigation is warranted.

Never offered surgery

The prevalence of having never been offered surgery was approximately 2 percentage points (95% CL: 0.7, 3.5) higher among male



Abbreviations: TT, trachomatous trichiasis; PTT, postoperative trachomatous trichiasis.
**Figure includes only eligible eyes contributed from countries of the World Health Organization's African Region.*
†Numbers shown are the number with outcome/total number (percentage).
‡Numbers shown are the percentage point difference in prevalence and 95% confidence limits with males as the reference group.

Figure 2. Prevalence difference comparing female with male eyes on four outcomes of trachomatous trichiasis management*.

eyes than female eyes. One possible explanation for this finding is that men may be offered surgery less commonly because they may be more frequently asymptomatic than women, as was found in a 2012 study conducted in Ethiopia to determine reasons for not attending surgery.[28] However, this study also found that women had 0.70 (95% CL: 0.53, 0.94) times the odds of being offered surgery, so the contribution of severity is likely only one of a host of determinants. Alternatively, given that men are less likely to be present during health worker screenings, it is possible that men had fewer previous opportunities to be diagnosed prior to the survey that led to the inclusion of their data in this study.

Implications postelimination

Potential gender disparities in PTT and surgical acceptance may affect women's eye health, even after achieving elimination goals. The WHO-defined elimination target of <0.2% $TT_{\geq 15}$ excludes individuals who have PTT, have declined surgery, or have accepted but not yet received surgery.[18] Therefore, as elimination efforts progress and the surgical backlog is cleared, TT-affected individuals who have declined services or who develop PTT will form a progressively greater proportion of all TT cases and presumably continue to be at risk of vision loss until they are appropriately managed. Our findings suggest that women will disproportionately comprise a higher proportion of this group needing interventions in pre- and post elimination settings. Without focused efforts to improve management of women affected by TT, the higher burden of TT among women may persist even after trachoma elimination goals have been met.

Shifting TT landscape

These findings likely will change as different stages of elimination are achieved. A 2019 document recommends that if the previous survey returns a $TT_{\geq 15}$ prevalence <0.2%, then 'ongoing TT management services (for incident or postoperative cases) and any remaining cases would be provided through routine eye health care services offered at district level health clinics,'[29] a move from dedicated case-finding and management during surgical campaigns. This change in the mode of service delivery could potentially lead to an escalation of gender differences in surgical management if barriers such as the need to travel long distances for care and to pay for surgery increase. Additionally, as incident TT cases decrease and as the TT backlog is managed, the relative contribution of PTT to TT prevalence will increase, as will the demand for repeat surgery. The reasons for the observed greater PTT prevalence among female eyes should be explored to determine if programmatic interventions could reduce this inequity.

Limitations

First, this study was designed to leverage existing data to explore evidence of gender disparities in a large, multinational dataset. Our cross-sectional design cannot inform the causes of

differences observed, but rather only provide supporting evidence for the existence or non-existence of potential gender-related disparities. As we highlighted in our conceptual framework, several factors contribute to the compartment in which a TT-affected eye will be located at the time when the survey is conducted. Second, 692 examined individuals with unknown TT status were excluded from this study. While we believe this is unlikely to bias our results given that few would likely have had TT and have been included in this study of TT-affected eyes, we believe this type of missing information would generally be non-differential by gender and, therefore, have minimal impact on the prevalence differences presented. Third, we excluded EUs in which no men or no women with TT were identified because we could not compare the gender-specific prevalences of the outcomes. It is noteworthy that 216 EUs were identified in which women (but not men) had TT, and only 39 EUs identified in which men (but not women) had TT. While it is beyond the scope of this work, disparities in surgical management in these EUs could be present and should be explored to ensure all women and men are adequately receiving care. Fourth, while we invited all countries that have conducted surveys supported by GTMP/TD to participate, our text focuses on the WHO African region due to the limited sample size elsewhere. Fifth, it is important to acknowledge potential gender-related biases that can affect response patterns among men and women. For example, men could be more reluctant to report having declined surgery, possibly leading them to indicate that it was never offered. A nuanced understanding of this bias is essential when interpreting the data in each context. Finally, we reported region-specific results from this study due to cultural and social drivers of gender differences and programmatic and economic differences that may dictate access to and availability of TT surgery. Generalizability is therefore limited to locations comparable in factors such as these.

Conclusions

This exploratory study strengthens the evidence for potential gender disparities in TT management but cannot identify specific drivers. Given the many suggested gender-related drivers associated with trachoma, we call for additional research into the implications and sources of gender differences identified in this study and recommend continued exploration of these issues in regions of the world not covered in this text. We encourage the continued promotion of gender-sensitive approaches to TT interventions and encourage all future studies to conduct gender-disaggregated analyses to understand better how to serve women in trachoma-endemic areas.

Supplementary Data

Supplementary data are available at *International Health* online (http://inthealth.oxfordjournals.org).

Authors' contributions: KMS, EMHE, AWS, EWG, AK, DW and JM conceived the study and designed the study protocol. KMS carried out the analysis. KMS, EMHE, AWS, EWG, AK, DW and JM contributed to the interpretation of these data. KMS drafted the manuscript. All authors not previously mentioned substantially contributed to the collection of the data. All authors critically revised the manuscript for intellectual content. All authors read and approved the final manuscript. KMS is the guarantor of the paper.

Acknowledgements: We acknowledge the dedicated staff who are essential to the success of these surveys, with special appreciation for fieldwork staff who endure long hours, difficult terrain and unforeseen challenges in their pursuit of reaching these often-remote communities. We also acknowledge the men, women and children who participate in these surveys so that the epidemiology of trachoma in their communities can be better understood and addressed.

Data were collected as part of surveys supported by the Global Trachoma Mapping Project and Tropical Data. The Global Trachoma Mapping Project was funded by a grant to Sightsavers from the United Kingdom's Department for International Development (DFID; ARIES: 203145); and by the United States Agency for International Development (USAID) through the ENVISION project, implemented by RTI International under cooperative agreement number [AID-OAA-A-1100048], and through the END in Asia project, implemented by FHI360 under cooperative agreement number OAA-A-1000051. Tropical Data funding was provided by the International Trachoma Initiative, Sightsavers, and RTI International through the USAID Act to End NTDs | East program.

Funding: KMS received funding through a Graduate School Summer Research Fellowship and an American Rescue Plan Act Graduate Degree Completion Grant from the University of North Carolina at Chapel Hill. ABK and AWS are staff members of WHO. EWG received salary support from the National Eye Institute (#EY025992). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: CM and MD are Guest Editors of this supplement but had no role in the review of this manuscript. AB is employed by the International Trachoma Initiative at The Task Force for Global Health, which receives an operating budget and research funds from Pfizer Inc., the manufacturers of Zithromax (azithromycin); EMHE is funded by the International Trachoma Initiative, a program of The Task Force for Global Health, which receives funding from Pfizer Inc., the manufacturers of Zithromax (azithromycin). All other authors have no completing interests to declare. The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated, USAID or the United States Government.

Ethical approval: The ethics committee at the University of North Carolina at Chapel Hill determined that this study did not constitute human subjects research (18-2360). The ethics committee at the London School of Hygiene & Tropical Medicine (17934) approved our protocol.

Data availability: The data used for the analyses in this paper are owned by the governments of the countries in which the original surveys were conducted. Permission to use the data for our analyses was obtained via formal agreements between those governments and involved universities and organizations; all data were de-identified before use. Researchers are welcome to request access to the same deidentified datasets by contacting support@tropicaldata.org.

References

1 WHO Alliance for the Global Elimination of Trachoma: Progress report on elimination of trachoma, 2021. Wkly Epidemiol Rec. 2022;97: 353–64.

2 World report on vision. Geneva, Switzerland: World Health Organization; 2019.

3 Cromwell EA, Courtright P, King JD, et al. The excess burden of trachomatous trichiasis in women: A systematic review and meta-analysis. Trans R Soc Trop Med Hyg. 2009;103(10):985–92.

4 Bero B, Macleod C, Alemayehu 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(6):392–405.

5 Courtright P, West SK. Contribution of sex-linked biology and gender roles to disparities with trachoma. Emerg Infect Dis. 2004;10(11):2012–6.

6 Merbs S, Resnikoff S, Kello AB, et al.,Trichiasis Surgery for Trachoma –2nd Ed. Geneva, Switzerland: World Health Organization; 2015.

7 Women and Trachoma: Achieving Gender Equity in the Implementation of SAFE. Elfenworks Foundation, The Carter Center, International Trachoma Initiative, Kilimanjaro Centre for Community Ophthalmology. Women and Trachoma Manual, 2nd ed. 2023.

8 Wharton-Smith A, Rassi C, Batisso E, et al. Gender-related factors affecting health seeking for neglected tropical diseases: Findings from a qualitative study in Ethiopia. PLoS Negl Trop Dis. 2019;13(12):e0007840.

9 Gower EW, Merbs SL, Munoz BE, et al. Rates and risk factors for unfavorable outcomes 6 weeks after trichiasis surgery. Invest Ophthalmol Vis Sci. 2011;52(5):2704–11.

10 West S, Nguyen MP, Mkocha H, et al. Gender equity and trichiasis surgery in the Vietnam and Tanzania national trachoma control programmes. Br J Ophthalmol. 2004;88(11):1368–71.

11 Ezz al Arab G, Tawfik N, El Gendy R, et al. The burden of trachoma in the rural Nile Delta of Egypt: A survey of Menofiya governorate. Br J Ophthalmol. 2001;85(12):1406–10.

12 Mousa A, Courtright P, Kazanjian A, et al. Prevalence of visual impairment and blindness in Upper Egypt: A gender-based perspective. Ophthalmic Epidemiol. 2014;21(3):190–6.

13 Solomon AW, Pavluck AL, Courtright P, et al. The Global Trachoma Mapping Project: Methodology of a 34-country population-based study. Ophthalmic Epidemiol. 2015;22(3):214–25.

14 Design Parameters for Population-based Trachoma Prevalence Survey. Geneva, Switzerland: World Health Organization; 2018.

15 Design and Validation of a Trachomatous Trichiasis-only Survey. Geneva, Switzerland: World Health Organization; 2017.

16 Solomon AW, Zondervan M, Kuper H, et al. Trachoma Control: A Guide for Programme Managers. Geneva: World Health Organization; 2006.

17 Thylefors B, Dawson CR, Jones BR, et al. A simple system for the assessment of trachoma and its complications. Bull World Health Organ. 1987;65(4):477–83.

18 Validation of Elimination of Trachoma as a Public Health Problem. Geneva, Switzerland: World Health Organization; 2016.

19 Report of the 3rd Global Scientific Meeting on Trachoma. Geneva, Switzerland: World Health Organization; 2010.

20 Report of the 4th Global Scientific Meeting on Trachoma, Geneva, 27–29 November 2018. WHO/CDS/NTD/PCT/2019.03. Geneva, Switzerland: World Health Organization; 2019.

21 WHO. WHO Gender Mainstreaming Manual for Health Managers: A Practical Approach: Module 1.

22 Reacher MH, Huber MJ, Canagaratnam R, et al. A trial of surgery for trichiasis of the upper lid from trachoma. Br J Ophthalmol. 1990;74(2):109–13.

23 Rajak SN, Habtamu E, Weiss HA, et al. Absorbable versus silk sutures for surgical treatment of trachomatous trichiasis in Ethiopia: A randomised controlled trial. PLoS Med. 2011;8(12):e1001137.

24 Habtamu E, Wondie T, Aweke S, et al. Oral doxycycline for the prevention of postoperative trachomatous trichiasis in Ethiopia: A randomised, double-blind, placebo-controlled trial. Lancet Glob Health. 2018;6(5):e579–92.

25 West SK, West ES, Alemayehu W, et al. Single-dose azithromycin prevents trichiasis recurrence following surgery: randomized trial in Ethiopia. Arch Ophthalmol. 2006;124(3):309–14.

26 Burton MJ, Kinteh F, Jallow O, et al. A randomised controlled trial of azithromycin following surgery for trachomatous trichiasis in the Gambia. Br J Ophthalmol. 2005;89(10):1282–8.

27 Bickley RJ, Mkocha H, Munoz B, et al. Identifying patient perceived barriers to trichiasis surgery in Kongwa District, Tanzania. PLoS Negl Trop Dis. 2017;11(1):e0005211.

28 Rajak SN, Habtamu E, Weiss HA, et al. Why do people not attend for treatment for trachomatous trichiasis in Ethiopia? A study of barriers to surgery. PLoS Negl Trop Dis. 2012;6(8):e1766.

29 Transition planning for trichiasis management services. International Coalition for Trachoma Control (ICTC); 2019.