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Elizabeth Plunkett Date

Operational Implications of Trachomatous Trichiasis Prevalence Estimation and Pilot Guide for Assessing Trachomatous Trichiasis in Low Burden Areas

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By

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Abstract

Operational Implications of Trachomatous Trichiasis Prevalence Estimation and Pilot Guide for Assessing Trachomatous Trichiasis in Low Burden Areas

By Elizabeth Plunkett

Introduction: Trachoma is the leading infectious cause of preventable blindness. To reach the goals of the Global Elimination of Trachoma by the year 2020 (GET 2020) initiative, global partnerships are implementing trachoma elimination activities in Mozambique and across the globe.

Objective: The purpose of this research is to investigate the operational implications of recalculating prevalence estimates of trachomatous trichiasis (TT); this study examined expected cases and surgical backlog estimates using population figures from various sources to provide information on methods related to calculating these figures. Critically analyzing the survey methods and figures used to calculate TT surgery backlog will allow a better assessment of methods and progress towards identifying and managing unknown TT cases. This research also aims investigate the process of implementation for a pilot guide for assessing trichiasis cases in low burden areas in Mozambique. This analysis, as well as approaches to case finding in Mozambique, will contribute towards the development of new methods for evaluating trachoma elimination activities and provide guidance to other countries faced with similar challenges in TT case finding and management activities.

Methods: Baseline prevalence surveys from three districts of Mozambique were analyzed to estimate TT prevalence at the enumeration unit (EU) and cluster level, and to estimate the expected TT surgical backlog. In depth interviews with key informants were conducted to document the implementation of a pilot guide for identifying TT cases.

Results: TT prevalence estimates calculated in this analysis using 2013 census data for weighting were much higher than those calculated in the original analysis. EU-level adjusted TT prevalence ranged from 1.25% (95% CI: 0.66, 2.37) in Namuno, to 1.35% (95% CI: 0.82, 2.23) in Balama, and 1.45% (95% CI: 0.87, 2.67) in Montepuez. Cluster level average TT prevalence ranged from 1.20% in Namuno, to 1.33% in Balama, and 1.59% in Montepuez. This increase in prevalence estimate calculations resulted in subsequent increases in TT surgical backlog estimates. The pilot guide for identifying TT cases in low burden areas was successfully piloted in all three districts and reflection on the implementation process yielded numerous suggestions for strengthening the guide before implementation in further districts.

Recommendations: As Mozambique moves toward elimination of trachoma as a public health problem and transitions trachoma program activities solely to the health system, clear and transparent methods for data analysis should be created and standardized to allow national program staff to support elimination objectives. This research and the pilot guide can serve as tools to support completion and submission of the WHO dossier for certification of elimination of trachoma as a public health program.

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1. Introduction

Trachoma is a preventable blinding disease caused by infections of the bacterium Chlamydia trachomatis (WHO 2017). It causes billions of dollars in lost productivity in affected countries every year, and is a disease of poverty that disproportionately affects women (Burton and Mabey 2009, WHO 2017). In 1996, WHO announced an initiative to eliminate trachoma as a public health problem by 2020. The initiative, called WHO Alliance for the Global Elimination of Trachoma by the year 2020 (GET2020), has resulted in a wide range of partnerships and funding for trachoma elimination activities in affected countries. In response to WHO's call, countries and partner organizations have embarked on elimination activities. In 2012, the Global Trachoma Mapping Project (GTMP) undertook mapping of all remaining suspected endemic districts to determine trachoma prevalence and acquire data to support decision making for elimination activities. To reach elimination of trachoma as a public health problem, countries must reach a set of criteria and receive certification from WHO.

Certification for elimination is based on results of epidemiologic surveys in each formerly endemic district, where 1) prevalence of trachomatous trichiasis (TT) not known by the health system is less than 1 case per 1000 total population (the equivalent of <.2% in the population 15 years and older), and 2) prevalence of trachomatous inflammation-follicular (TF) in children 1-9 years is less than 5%. As we approach 2020, there is a need to scale up and accelerate activities to reach the trachoma elimination goal by 2020 (Solomon et al 2006, World Health Organization 2016).

1.1 Problem statement

Trachoma is a devastating and largely preventable infectious cause of blindness, mainly affecting developing countries. In order to address this public health problem, GET 2020 was adopted by WHO and member countries to elimination trachoma as a public health problem. Mozambique has undertaken elimination activities since baseline prevalence mapping started in 2011. As part of the WHO endorsed SAFE strategy, there is a need to critically analyze the survey methods and prevalence figures used to calculate trachomatous trichiasis (TT) surgery backlog to better assess methods and progress towards identifying and managing unknown TT cases. The analysis of prevalence survey methods and backlog estimate calculations, as well as approaches to case finding in Mozambique, will contribute towards the development of new methods for evaluating trachoma elimination activities and provide guidance to other countries faced with similar challenges in TT case finding and management activities.

1.2 Purpose statement

The purpose of this research is to investigate the operational implications of recalculating trachomatous trichiasis (TT) prevalence estimates, expected cases and surgical backlog estimates using population figures from various sources, to provide information on methods related to calculating these figures, and to investigate the process of implementation for a pilot guide for assessing trichiasis cases in low burden areas in Mozambique.

1.3 Research Goals

This research seeks to achieve the following goals:

1. Investigate the results of a pilot guide for identifying trichiasis in low burden areas (“pilot guide”) in 3 districts and describe the method of implementation of the guide.
2. Investigate the impact of different population figures on TT prevalence estimates and associated confidence intervals, expected TT cases, and TT backlog.
3. Explore the impact of pilot guide activities in Mozambique and potential implications for other trachoma eliminations programs worldwide.

1.4 Significance statement

This research will provide further information on methods for calculating TT prevalence estimates and surgical backlog that can be used for operational decision making. It will also provide documentation of the process of implementation for the pilot guide and provide an analysis of the challenges, successes and opportunities for improvement in using the pilot guide in Mozambique and other locations. As countries strive to reach the trachoma elimination by 2020 and undertake activities and documentation necessary for certification of elimination, this analysis could serve as a resource to support good practices for the trachoma elimination program in Mozambique and programs in other countries to assist with trichiasis case finding in low burden areas.

1.5 Definition of terms

WHO: World Health Organization

Trachoma: an infection caused by the bacterium *Chlamydia trachomatis,* specifically serovars A, B, Ba, and C that affect the eyes and surrounding area (Taylor et al 2014)

Global Trachoma Mapping Project (GTMP): collaborative partnership among various global actor to map the world’s trachoma endemic areas

SAFE: WHO strategy to achieve elimination of trachoma. The acronym SAFE stands for "Surgery to correct trichiasis, Antibiotic to clear Chlamydia trachomatis infection, Facial cleanliness and Environmental improvement to reduce transmission" (Smith et al 2013)

Trachomatous trichiasis (TT): one grade of the WHO simplified system for the assessment of trachoma

Ultimate intervention goals (UIG): the ultimate intervention goals for trachoma are 1) prevalence of trachomatous trichiasis (TT) not known by the health system is less than 1 case per 1000 total population (the equivalent of <.2% in the population 15 years and older), and 2) prevalence of trachomatous inflammation-follicular (TF) in children 1-9 years is less than 5%.

Low burden areas: classification of one type of area for trachoma elimination activities, definition of "low burden" has yet to be developed and standardized

Pilot guide: Guide entitled "Approaches for Identifying Trichiasis Cases in Low Burden Areas: Methods for evaluating trichiasis backlog and achieving elimination targets in 3 districts of Mozambique: Balama, Montepuez, and Namuno," hereafter referred to as "pilot guide"

TF: trachomatous inflammation – follicular, one grade of the WHO simplified system for the assessment of trachoma

TI: trachomatous inflammation – intense, one grade of the WHO simplified system for the assessment of trachoma

TS: trachomatous scarring, one grade of the WHO simplified system for the assessment of trachoma

2. Literature Review

2.1 Global Burden of Trachoma

2.1.1 Clinical description and epidemiology

Globally, trachoma is the leading infectious cause of blindness and the eighth most common blinding disease; it is estimated to cause blindness or visual impairment in 1.9 million people (WHO 2017). Trachoma is an infection caused by the bacterium *Chlamydia trachomatis*, specifically serovars A, B, Ba, and C, that affect the eyes and surrounding area (Taylor et al 2014). Active trachoma infection is characterized by inflammation of the follicles around the eye ("follicular inflammation of the tarsal conjunctiva") (Burton and Mabey 2009). Trachoma has various stages, starting with active disease, usually in childhood. Repeated infection and inflammation throughout childhood and into adulthood lead to further follicular inflammation and scarring (Hu et al 2010). Scarring from active infection can cause in-turning of the eyelids (entropion) and cause eyelashes to touch the eyeball (trichiasis). This can eventually lead to blindness (corneal opacification) likely as a result of trauma from eyelashes, other bacterial or fungal infections and a "dry ocular surface" (Hu et al 2010). Blindness from trachoma is considered irreversible. The progression of trachoma is well summarized in the WHO simplified grading system. The clinical manifestations of trachoma include trachomatous inflammation – follicular, trachomatous inflammation – intense, trachomatous scarring, trachomatous trichiasis and corneal opacity which are shown in Table 1 (WHO 2017).

Table 1. WHO simplified grading system for trachoma

Grade	Abbreviation	Description
Trachomatous inflammation – follicular	TF	The presence of five or more follicles (. 0.5 mm) in the upper tarsal conjunctiva
Trachomatous inflammation – intense	TI	Pronounced inflammatory thickening of the tarsal conjunctiva that obscures more than half of the deep normal vessels
Trachomatous scarring	TS	The presence of scarring in the tarsal conjunctiva
Trachomatous trichiasis	TT	At least one lash rubs on the eyeball
Corneal opacity	CO	Easily visible corneal opacity over the pupil

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Source: Burton and Mabey 2009

Trachoma is transmitted through several routes, including direct spread through person-to person contact (such as among families and within households), fomites (such as clothes or bedding), and eye-seeking flies (Burton and Mabey 2009). Trachoma is mainly a disease of "resource poor-rural communities" (Burton and Mabey 2009). Risk factors for transmission in communities include: limited access to water and latrines, fecal contamination of the environment, crowding, and migration between communities (Burton and Mabey 2009, Hu et al 2010). Trichiasis and corneal opacification are found more commonly in women than men, likely due to greater exposure to C. trachomatis infection over their lifetime through close contact with children (Burton and Mabey 2009).

2.1.2 Global Distribution and Morbidity

Estimates of the distribution and morbidity of trachoma have changed over time due to better estimation techniques and trachoma mapping activities across the globe. According to information published by the World Health Organization (WHO), as of 2016, 200 million people continue to live in trachoma endemic areas, trachoma was responsible for visual impairment of approximately 1.9 million people, and the disease continues to be a public health problem in 42 countries (Table 2) (WHO 2017). Africa carries the largest burden of trachoma, with 33 of 56 countries believed to be endemic (Smith et al 2013). A 2014 estimate found that active trachoma affected 21 million people, with approximately 2.2 million people visually impaired and an additional 7.3 million people suffering from trachomatous trichiasis (Taylor et al 2014). As of April 2017, ten countries - Cambodia, China, Gambia, Ghana, the Islamic Republic of Iran, Lao People's Democratic Republic, Mexico, Morocco, Myanmar and Oman – had reported elimination of trachoma as a public health problem. Of these countries, Mexico, Morocco and Oman have been validated as having eliminated trachoma as a public health problem by WHO (WHO 2017, "Trachoma Factsheet").

Table 2. Population estimates in WHO Regions with Trachoma

WHO Region – Région de l'OMS	Population living in endemic areas – Population vivant en zone d'endemie	Surgeries for trachomatous trichiasis – Chirurgie du trichiasis trachomateux	Antibiotic treatments – Traitements antibiotiques
African – Afrique	177 571 840	204 023	53 712 333
Americas – Amériques	189 402	1 195	221 426
South-East Asia – Asie du Sud-Est	4 389 641	5 781	763 042
Eastern Mediterranean – Méditerranée orientale	41 575 305	3 291	212 949
Western Pacific – Pacifique occidental	7 943 215	19 686	NA
Global – Monde	**231 669 403**	**233 976**	**54 909 750**

Source: WHO Alliance for the Global Elimination of Blinding Trachoma by the year 2020, 2014.

2.2 History of Trachoma Elimination

Written record of trachoma appears as far back as 2600 B.C. in China. It spread widely from Central Asia to other parts of the world during mass population movements associated with wars, such as the Peloponnesian War (431-404 B.C.) and the Crusades (beginning 1095 A.D.). It is thought that trachoma later spread across Europe as a result of Napoleonic conquest and resulted in the early founding of ophthalmic hospitals (Schlosser 2011). In 1973, WHO incorporated trachoma elimination into its blindness prevention efforts (Schlosser 2011). In 1996, a large partnership between WHO, member states, NGOs, philanthropic foundations and the pharmaceutical industry established the Alliance for Global Elimination of Trachoma by 2020 (GET 2020) (Mariotti et al 2003). GET 2020 supports "country implementation of the SAFE strategy and the strengthening of national capacity through epidemiological assessment, monitoring, surveillance, project evaluation and resource mobilization" (WHO 2014). WHO and GET 2020 set specific targets for elimination of trachoma as a public health problem as: 1) a prevalence of the clinical signs of trachomatous inflammation-follicular (TF) of <5% in children ages 1-9 years and 2) <1 case of trachomatous trichiasis (TT) unknown to the health system per 1000 total population (WHO 2014).

2.2.1 SAFE Strategy

In 1996, WHO adopted the SAFE strategy to combat trachoma (WHO 2014). The components of the SAFE intervention include “Surgery to correct trichiasis, Antibiotic to clear Chlamydia trachomatis infection, Facial cleanliness and Environmental improvement to reduce transmission” (Smith et al 2013, 1). By 1998, the World Health Assembly (WHA) adopted resolution 51.11 for the global elimination of trachoma (WHO 1998). In 2011, the International Coalition for Trachoma Control published “The end insight,” a strategic plan for accelerating trachoma elimination activities ahead of the 2020 elimination threshold (ICTC 2011). ICTC lays out five challenges moving forward two of which include:

1. Trachoma can be prevented by using the SAFE strategy, but this requires roll out of facial cleanliness and environmental components in all districts where TF prevalence is greater than 5% in children ages 1-9 years, district wide distribution of antibiotics where prevalence of TF is higher than 10%, and robust surgery programs in districts where TT prevalence is greater than 0.1%.
2. Fourteen countries compromise more than 80% of the population in confirmed or suspected endemic areas. These areas also account for approximately 80% of the total surgery backlog (ICTC 2011).

ICTC recommended a scale up of all aspects of the SAFE strategy as well as epidemiological assessment, and surveying and mapping of all suspected endemic districts (ICTC 2011). At the fastest possible rate of scale up, it takes between 4 to 6 years to move from planning to elimination in a district, which requires thoughtful and tailored approaches to elimination activities focused on high burden countries as well as planning for post-elimination (ICTC 2011). The Global Trachoma Mapping Project launched in 2012 with the goal of "mapping all remaining suspected endemic districts by the end of 2015" (Solomon et al 2015).

Table 3. Countries based on trachoma elimination status, 2011

	Have reported achieving UIGs	**High burden countries**	**Other countries**	
Countries	Algeria Ghana Iran Libya Mexico Morocco Oman The Gambia Vietnam	Burkina Faso Ethiopia Sudan South Sudan Guinea Kenya Mozambique Niger Nigeria Pakistan Senegal Tanzania Uganda Zambia	Afghanistan Australia Benin Botswana Burundi Cambodia Cameroon Central African Republic Chad Côte d'Ivoire Djibouti Egypt Eritrea Fiji Guatemala Guinea Bissau Iraq	Kiribati Laos Mali Malawi Mauritania Myanmar Namibia Nauru Nepal Papua New Guinea Solomon Islands Somalia Togo Vanuatu Yemen Zimbabwe
# of countries	9	14	33	
% of endemic population	0%	83%	17%	
% of TT burden	6%	71%	23%	

Ghana and Vietnam have only reported reaching Ultimate Intervention Goals (UIGs) for active trachoma, not yet for surgery; The Gambia is awaiting final results from surveys, however, preliminary data show that UIG have been reached.

Source: ICTC 2011

2.2.2 Validation of elimination as a public health problem

In order to achieve validation of elimination of trachoma as a public health problem, countries must meet sub-elimination thresholds for TF and TT prevalence as shown by pre-validation surveillance surveys. The threshold for elimination as a public health problem are: "(i) a prevalence of trachomatous trichiasis (TT) 'unknown to the health system' of < 1 case per 1000 total population; and (ii) a prevalence of trachomatous inflammation-follicular (TF) in children aged 1–9 years of < 5%, in each formerly endemic district" (WHO 2016). A country must implement the SAFE strategy in all affected districts, show achievement of elimination prevalence thresholds through surveillance and surveys, then submit evidence of achievement of elimination through a dossier submitted to WHO for review (WHO 2016). The dossier is reviewed by a WHO working group and is validated or not. After validation, countries must still conduct post-validation surveillance, a plan for which must be included in their dossier submission to WHO (WHO 2016). The dossier requires an extensive background section, data methodology for how trachoma was classified as a public health problem or not, SAFE intervention implementation, information on impact and pre-validation surveys, as well as post validation surveillance information (World Health Organization 2016). See Appendix A, "Template for the dossier documenting elimination of trachoma as a public health problem."

2.3 Elimination Activities and Trachomatous Trichiasis

The first step in trachoma elimination activities is determining baseline levels of trachoma prevalence in all districts, with priority to those districts suspected to be endemic, and mapping prevalence for each district.

2.3.1 Survey Methodology

As ramp up toward the trachoma elimination goal has occurred, a variety of survey methods to determine trachoma prevalence have been tried and documented across countries. The WHO gold standard for surveying trachoma is the population based prevalence survey (PBPS) using cluster random sampling (CRS) (Ngondi et al 2009). Other survey methodologies include trachoma rapid assessment (TRA), and acceptance sampling trachoma rapid assessment (ASTRA) which are described below.

1. Population based prevalence surveys (PBPS)

   PBPS are the WHO gold standard for estimating trachoma prevalence. The most common survey design for PBPS is a two-stage cluster random sampling (CRS) design. The clusters are selected based on geographical or administrative boundaries—such as districts, regions or provinces—which are then used to select villages in these areas. Within each village, random sampling of household is carried out using random walk or compact segment sampling methods. This design can be modified to be multi-stage or to use probability proportional to size (PPS) sampling based on the population in each cluster.

<u>Strengths:</u>

PBPS is efficient in that it allows enumeration of only populations in the selected clusters to draw prevalence estimates rather than a complete population census. CRS can be used to assess multiple indicators at the same time, such as data on active trachoma, trichiasis, water access and other risk factors.

<u>Limitations:</u>

CRS cannot be used to give accurate estimates for each individual cluster included. There is wide variability in the specifics of the design and methods for PBPS such as standardization of geographical or administrative units and grading, reporting of confidence intervals for estimates and adjustments for clustering. (Ngondi et al 2009).

2. Trachoma Rapid Assessment (TRA)

   Trachoma rapid assessment uses a convenience sample to identify trachoma endemic communities. TRA does not rely on probability sampling and therefore cannot be used to estimate prevalence. TRA is an operational tool to prioritize intervention areas (Ngondi et al 2009).

3. Acceptance Sampling Trachoma Rapid Assessment (ASTRA)

   ASTRA uses lot quality assurance sampling (LQAS) to classify communities as either high or low prevalence for trachoma. LQAS uses a fixed sampling size and a pre-determined decision rule on whether a "lot" is acceptable or not acceptable. Sampling is undertaken until the decision rule is reach or until the maximum sample size is achieved. ASTRA is advantageous in that the smaller sample size reduces costs and time necessary to survey. However, the small sample size also results in imprecise estimates of prevalence (Ngondi et al 2009).

2.3.2 Recently Published Studies Measuring Country-specific Trachoma Disease Burden

In searching the literature, four studies were published in the last five years that included confidence intervals for trachoma prevalence estimates and took place in African countries. These studies took place in Tanzania, South Sudan, and two regions of Cameroon.

Cameroon

In 2010-2011 epidemiological mapping of trachoma was undertaken in 27 health districts of the Far North region of Cameroon. The survey was done using a cross sectional two stage cluster random sampling design to measure TF in children aged 1-9 years and TT in adults aged 15 and above. The survey found the overall prevalence of TF in the region to be 11.2% (95% CI: 11.0-11.5%) ranging from 0% to 42.5% across health districts. The prevalence of TT in those ages 15 or older was 1.02% (95% CI: 0.93-1.13%) across the region, ranging from 0% to 7.3% across districts. The survey also estimated trichiasis cases across the region using the TT prevalence in each district. It estimated an expected 17,193 (95% CI: 12,579-25,860) cases across the region (Noa Noatina et al 2013).

The authors did a second survey between 2011 and 2012 in 15 health districts in the North Region of Cameroon using the same methodology listed above. The overall prevalence of TF in the region was 4.2% (95% CI: 4.0-4.5%), ranging from 0% to 14.5% across health districts. In those aged 15 and above, TT prevalence was 0.25% (95% CI: 0.20-0.33%) across the region, ranging from 0% to 1.8% in surveyed districts. Based on an overall TT prevalence of 0.1% (95% CI: 0.1-0.2) among all ages, an estimated 1245 cases of TT are expected across the region. (Noa Noatina et al 2014)

South Sudan

In Unity State, South Sudan, a population-based prevalence survey was undertaken in eight counties, selecting clusters based on proportion to the county population size. (Edwards et al 2012). This study looked at TF as well as TI in those aged 1-9, TF and TT in those aged 10 to 14, and TT in those aged 15 and up. The overall adjusted prevalence of TF in those aged 1-9 was 74% (95% CI: 70-72%). The adjusted prevalence of TT in those aged 15 and above was 13.5% (95% CI: 12.0-15.1%) (Edwards et al 2012)

Tanzania

In 2013 and 2014, trachoma rapid assessments were undertaken in 12 districts in proximity to known endemic districts. In 2014, 19 additional districts were chosen from un-surveyed rural districts. Across the three years of surveys, prevalence of TF ranged from 0.0% (95% CI: 0.0-0.1%) to 11.8% (95% CI: 6.8-16.5%) across districts. TT prevalence ranged from 0.9% (95% CI: 0.00-0.24%) to 1.08% (95% CI: 0.74-1.43%) across surveyed districts (Upendo et al 2016).

2.3.3 SAFE Implementation and TT activities

Once the prevalence of TF, TI, TS and TT have been identified at the district, regional or national level, action steps must be taken to treat or manage these conditions in order to reach the ultimate intervention goal for elimination of trachoma as a public health problem. The goal of trichiasis management is to prevent blindness due to further trauma from eyelashes on the cornea (Burton et al 2015). Trichiasis management is divided into surgical and non-surgical options. Non-surgical treatment includes epilation (manually removing eyelashes), electrolysis (using a fine needle to pass an electric current on base of lash follicle), and cryotherapy (a freezing treatment done on base of lash follicle). Surgical treatment options include excision of "lash-bearing tissues" (Burton et al 2015). In trachoma endemic countries, there are three common surgical options, or procedures:

1. "bilamellar tarsal rotation" (BLTR) procedure: full-thickness incision through the eyelid, including the scarred tarsal plate, orbicularis oculi and the skin, fixation with everting sutures;

2. “posterior lamellar tarsal rotation” (PLTR)/Trabut procedure: incision through the scarred tarsal plate and conjunctiva only, leaving the skin and orbicularis oculi intact, fixation with everting sutures;
3. “tarsal advance and rotation” procedure: incision of the tarsal plate and rotation of the terminal portion. The upper part of the tarsus is separated from the anterior lamellar, advanced and fixed with sutures.”

A recent report of a randomized controlled trial in Ethiopia compared BLTR with PLTR procedures for trachomatous trichiasis, and concluded that “PLTR surgery was superior to BLTR surgery for management of trachomatous trichiasis, and could be the preferred procedure for the programmatic management of trachomatous trichiasis” (Habtamu et al 2016). Oral azithromycin or topical tetracycline are often used after treatment to prevent recurrence of trachoma (Taylor et al 2014).

2.3.4 TT elimination activities in areas with limited disease

Once prevalence surveys have been completed, planning for elimination activities involving TF and TT can commence. Based on the prevalence estimate levels in each district for TF and TT elements of the SAFE strategy can be implemented as appropriate. This section focuses specifically on TT elimination activities to achieve the WHO elimination threshold. Each country creates a Trachoma Action Plan (TAP) to achieve elimination as a public health problem. Any country with areas of trichiasis prevalence over 1 case per 1,000 total population must create a plan for reducing trichiasis prevalence. Trichiasis planning for the TAP involves three main goals:

1. Calculating the number of interventions necessary to achieve a trichiasis prevalence less than 1 per 1,000 total population in each district.

2. Determine by district the number of interventions needed per year to reach the ultimate intervention goal and use the district by district number to calculate the total national figure for interventions each year.
3. Determine the activities needed at the national, regional, and district levels to achieve these goals.

Where there is weak evidence, it is also necessary to undertake operational research to determine preferred practices for mobilization and case finding activities (ICTC 2015). Trichiasis planning requires data in order to establish a backlog of trichiasis cases per district needed to plan trichiasis management activities. Backlog estimation requires:

1. the population of the district,
2. the prevalence of trichiasis (generally in the age group 15+)
3. the proportion of the population age 15+, and
4. the number of people receiving trichiasis surgeries or other management since the survey.

The above information should be readily available based on prevalence survey data and, if appropriate, data from partner organizations in country (specifically in regard to trichiasis management). These data can be used to calculate the estimated TT backlog by

*TT backlog = (population * trichiasis prevalence * % population age ≥15) - the number of people receiving trichiasis management since the survey* (ICTC 2015).

This, in turn, is used to calculate the ultimate TT intervention goal (UIG), or number of surgeries needed to achieve a prevalence less than 1 per 1,000 total population, which is equivalent to less than .2% in the population 15 years and older;

*TT UIG = TT backlog - the allowable number of people with TT where the allowable number with TT = total population * 0.001* (ICTC 2015).

The S component of the SAFE strategy calls for management of all trichiasis cases, usually through surgery or epilation, to achieve the ultimate intervention goal in each country. The S component is completed by conducting trichiasis outreach campaigns and TT case finding in order to connect as many trichiasis cases as possible to management. The current preferred practice is using surgical outreach teams to complete trichiasis surgeries in order to reduce the surgical backlog swiftly (ICTC 2015). Surgical outreach campaigns require:

1. Determining if and where an outreach is necessary, planning for the venue and outreach site, the expected number of cases, liaising with local and traditional authorities, organizing proper equipment and staff, and a plan for management of non-trichiasis patients.
2. Mobilization activities prior to outreach campaign including creating awareness, creating access to trichiasis management through mapping, case finding, word of mouth and referrals, and effective counseling to encourage patients to accept trichiasis management
3. At the outreach site itself, organization of patient flow, registration and consent for surgery, plans for surgery refusals, and logistics for surgical room, staff, and instruments (such as sterilization and campaign clean up)
4. Follow up of patients one-day post operation, two weeks post operation and 3-6 months post operation
5. Record keeping and reporting of patient information, summary statistics for program.

Broad-based awareness of trichiasis and surgical outreach programs is often not enough to increase surgical uptake and decrease surgical backlog due to “fear of surgical failure/recurrence, a belief that long wound healing is required after surgery, lack of social support," and other barriers. In order to overcome some of these identified barriers in case finding and surgical uptake, a training curriculum for TT case finders was created. TT case finders are usually influential community members and are often chosen by communities themselves. Community-based workers ("case finders") help address difficulty in identifying trichiasis cases. They also serve as focal points to increase awareness of trichiasis, provide counseling to trichiasis patients and families, refer individuals for care, and record and report trichiasis cases. TT case finders serve a crucial role in identifying trichiasis cases and connecting these individuals with services.

2.4 Trachoma Elimination Activities in Mozambique

Beginning in 2011, 96 baseline population-based cross-sectional surveys were carried out across Mozambique to assess trachoma prevalence. Based on the prevalence estimates determined by these surveys, trachoma elimination activities were planned and are being carried out across districts in Mozambique. As discussed above, there are specific thresholds for elimination of trachoma as a public health problem. Based on the findings of baseline surveys in each district, WHO provides recommended interventions from the SAFE strategy based on the prevalence of TF and TT.

For "S" surgical interventions, WHO recommends providing surgery to all people with TT, regardless of severity, as TT becomes progressively more severe with time. This means that any district with TT cases should offer surgical treatment or management to all with TT (Solomon et al 2006). WHO recommends antibiotics in the form of 1% tetracycline eye ointment and azithromycin. Tetracycline eye ointment is provided after surgery to prevent re-infection.

Mass drug administration is recommended for districts with trachomatous follicular (TF) above the specified threshold in children 1-9 years old. For districts with TF prevalence greater than 10% in 1-9 year olds, mass drug administration should be conducted annually for three years. After three years, a repeat survey should be carried out. If TF prevalence remains above 5%, annual treatment must continue until it falls below 5%. If TF prevalence has fallen below 5%, treatment can be stopped and focus shifted to hygiene and environmental interventions (Solomon et al 2006). In communities with TF prevalence between 5% and 10%, facial cleanliness and environmental interventions should be carried out for three years. After three years, if TF prevalence has not dropped below 5%, hygiene and environmental interventions must continue for an additional three years. If TF prevalence has dropped below 5%, interventions can be stopped. In districts with TF prevalence below 5%, the A, F, and E components of the SAFE strategy are not prioritized for implementation.

Facial cleanliness interventions include health promotion activities for “educating people about trachoma and how it is spread; encouraging acceptance of surgery; increasing acceptance of antibiotics; encouraging facial cleanliness; promoting a clean environment; and creating demand for household latrines” (Solomon et al 2006). Health promotion activities could include person to person sensitization, small group discussion, school lessons, or mass media campaigns. The “E” component of the SAFE strategy calls for improvement of water and sanitation to reduce transmission. This is focused on access to water sources and availability of clean water as well as building latrines and ensuring their use. In Mozambique, a mix of these activities is taking place at the district level depending on the findings around TF and TT prevalence from prevalence surveys. TT surgical interventions are being carried out in any areas with TT cases. This includes:

- finding and training TT case finders and having them identify cases and refer those cases for surgery
- training, equipping and mobilizing trichiasis surgeons for TT surgery outreach campaigns and to staff static centers such as health clinics and hospitals
- conducting mass drug administration in districts with TF prevalence above the designated threshold
- mobilizing existing organizations, partners, and stakeholders to scale up water and sanitation interventions
- training community health workers, existing organizations and partners on health promotion for facial cleanliness

Based on results from trachoma prevalence surveys, 12 enumeration units (EU) out of 96 had TF prevalence greater than 10% among children ages 1-9 years old. These 12 EUs are composed of 20 districts and must conduct mass treatment with azithromycin annually for three years (Abdala et al 2017). In an additional 17 EUs, consisting of 28 districts, TF prevalence was between 5% and 10%. These districts will be considered for one round of azithromycin before re surveying after three years. All 29 EUs and their component districts must implement the “F” and “E” components of the SAFE strategy (Abdala et al 2017). A separate round of surveying in Niassa province in 2011 resulted in mass drug administration with azithromycin in 10 of 16 districts in 2013, and in all 16 districts that comprise the province in 2014. In Cabo Delgado province (the focus of this research) approximately 580 TT surgeries were carried out between 2012 and 2015 (Downs, personal communication, 2016). Approximately 172 TT surgeries have been carried out in Balama district, 281 surgeries in Montepuez district, and 84 surgeries in Namuno district, the three districts of interest for this paper (Downs, personal communication, 2016). TT

Impact surveys are planned for 2017 and 2018 in specified districts across Cabo Delgado and other provinces. The specifics of TT case finding and outreach activities will be discussed more fully in the results and discussion sections of this paper.

2.5 Summary of Problem and Relevance

National programs plan their resources and trichiasis case management activities based on the estimated number of TT cases in each district, based off prevalence survey estimates and calculations of backlog and UIG targets. In some districts, it may be unclear whether estimates reflect the true number of TT cases remaining to be treated, due to difficulty in case findings, possible undocumented cases being previously managed or various inclusion criteria being used to calculate TT backlog ("Approaches for Identifying Trichiasis Cases in Low Burden Areas," 2017). Importantly, the survey tools currently used to estimate TT prevalence are designed to accurately estimate TF prevalence, making them under-powered for TT estimation and providing wide confidence intervals on TT estimates. There is a need to further investigate trichiasis prevalence estimates and the operational implications of various population figures and confidence intervals on prevalence estimates and TT surgical backlog numbers in light of difficulty identifying and finding patients based on projected backlog estimates ("Approaches for Identifying Trichiasis Cases in Low Burden Areas," 2017).

In the last several years, there have been increasing numbers of published articles from surveys which include confidence intervals on prevalence estimates for trachoma. Additionally, the use of standard survey methodology through the Global Trachoma Mapping Project has helped standardize and clarify estimates for suspected trachoma endemic districts across countries. With increased publication of trachoma prevalence surveys, there are now more robust sources of data to rely on. However, the trachoma prevalence data in published literature remains relatively limited because of the wide range of survey methods that were used over the past two decades, and differences in national and local context that decrease the comparability of findings from one country to another. Additionally, while there is increasing grey literature regarding implementation and best practices from trachoma elimination activities, there is limited well substantiated guidance on TT activities in low burden areas.

This research project will assess the TT activities in Mozambique, considered a low trachoma burden country, to help bridge gaps in characterizing required resources for conducting TT activities in low burden areas and provide a resource for national trachoma elimination programs to assist in their elimination activities.

3. Methods

This research project was conducted to supplement operational research and trachoma elimination activities undertaken by the Research Triangle Institute (RTI) in Mozambique through support of the ENVISION project and funding from the Queen Elizabeth Diamond Jubilee Trust project (The Trust). RTI conducted trachoma baseline prevalence surveys in various districts of Mozambique from 2011 onward. The Trust project is currently focused on trachoma case finding activities, including finding trichiasis (TT) cases and connecting them with surgical treatment or management options. The program is also preparing for trachoma impact surveys which are scheduled to be implemented later in 2017. This assessment will examine the results of a guide for trachoma case finding piloted in three districts of Mozambique; it will also examine the implications of different prevalence rates and population figures at the district level on expected TT cases and TT backlog, as well as determine confidence intervals around trachoma prevalence estimates. Lastly, this assessment will explore the impact of pilot guide activities in Mozambique and provide potential implications for other trachoma elimination programs worldwide.

3.1 Research Design

Between July 2012 and May 2015, population-based cross-sectional surveys to assess trachoma prevalence were carried out in 96 evaluation units (EUs) across 137 districts in Mozambique (Figure 1, 2). Surveys were conducted using two-stage cluster random sampling methodology. Two phases of surveying were carried out. The first phase of surveys encompassed five evaluation units – including Erati, Memba, Nacala-a-Velha, Ribaue, and Malema districts in Nampula Province – and used paper-based questionnaires which followed recommendations from WHO's manual "Trachoma Epidemiologic Survey Protocol" (WHO 1993). The second phase of surveys encompassed 91 evaluation units using GTMP standard protocol and survey forms collected electronically with open data kit (ODK) software. Surveys in Mozambique were conducted by government trained staff, with subsequent trachoma control activities planned in collaboration with RTI, Sightsavers, and Light for the World.

Figure 1. Map of Provinces in Mozambique

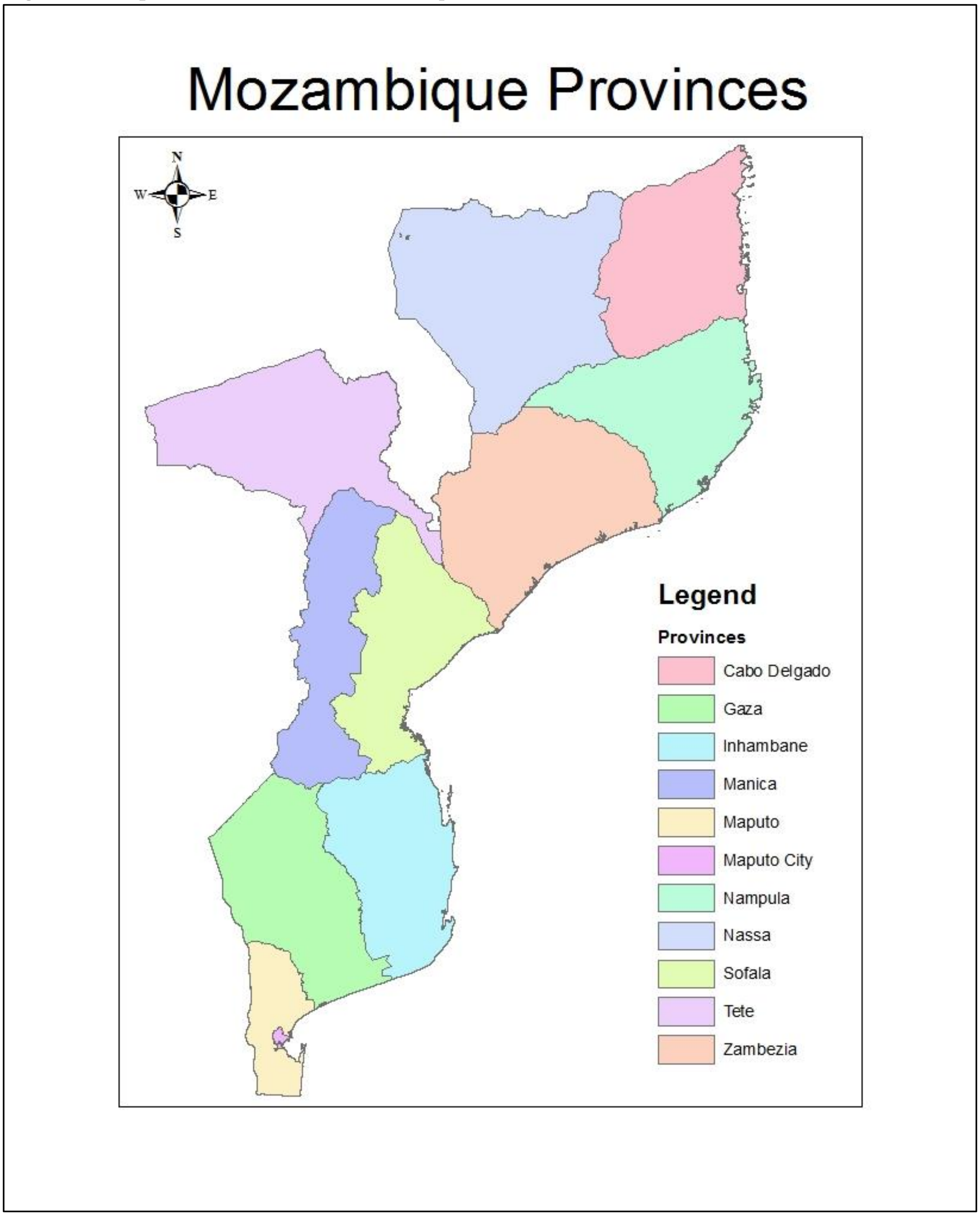
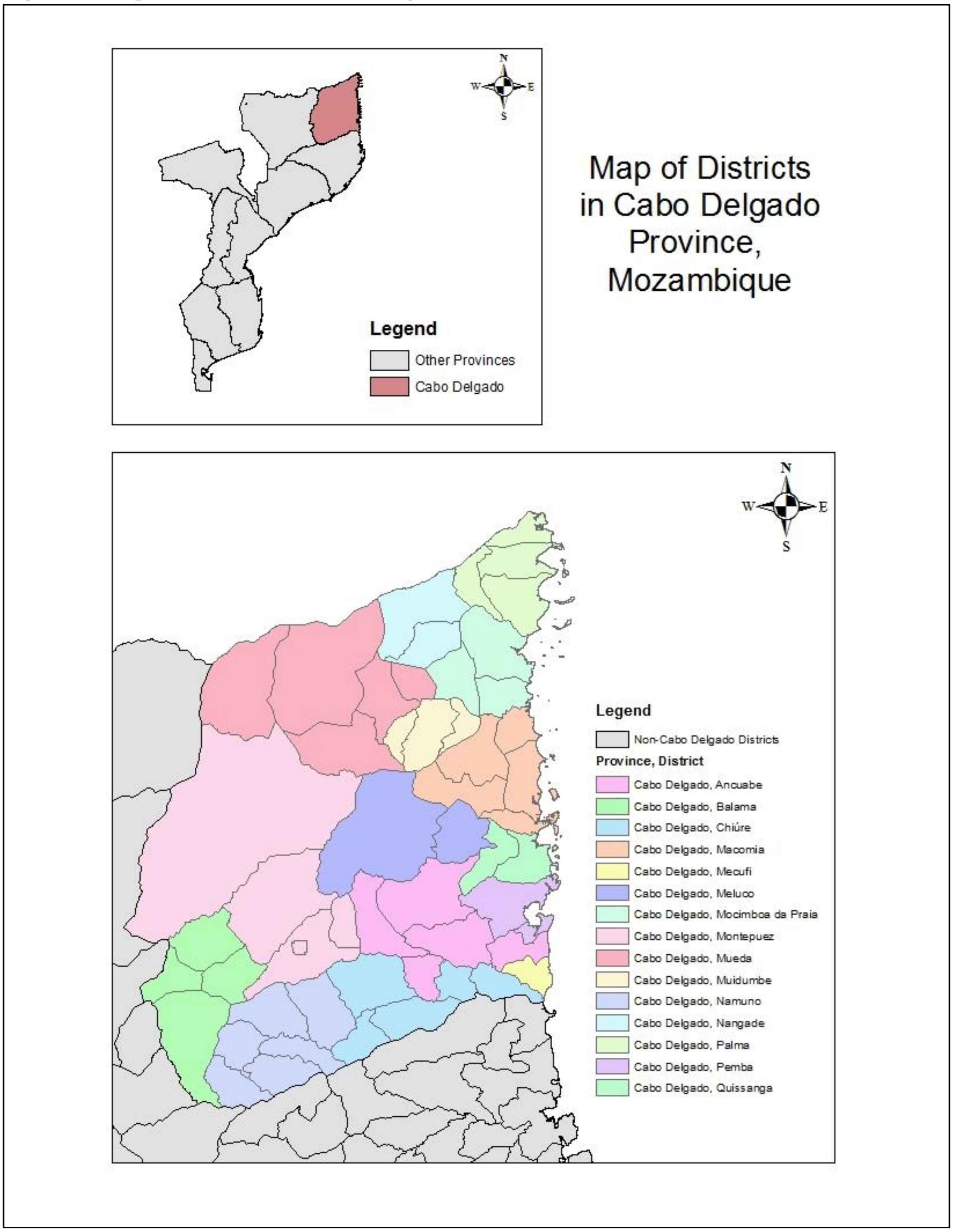


Figure 2. Map of Districts in Cabo Delgado Province



In 2016, program staff piloted a guide to find and assess TT cases in areas of Mozambique with limited disease burden. The guide was piloted in Balama, Montepuez, and Namuno districts of Cabo Delgado province. An in-depth interview guide instrument was developed by the author (EKP) to conduct qualitative analysis on the progression of pilot guide activities and lessons learned with program staff. Key informants were selected by the Field Supervisor at RTI based on his knowledge and familiarity with program staff member involvement. In depth interviews were conducted using the interview guide and iteratively adjusted for emerging themes throughout.

3.2 Population and Sample

Mozambique is a country on the coast of eastern Africa bordered by South Africa, Zimbabwe, Zambia, Malawi and Tanzania. Mozambique has a tropical to subtropical climate including coastal lowlands, highlands in the central region, plateaus in the northwest, and mountains in the western region of the country. Mozambique has a population of approximately 28,751,000 as of 2016 (United Nations Statistics Division 2017). Mozambique is a country with a high level of poverty due to natural disasters, including civil war, high population growth, low agricultural productivity and lack of other productive industries, unequal distribution of wealth, and high rates of morbidity and mortality from disease. The population of Mozambique is growing rapidly and has a high proportion of youth, 45% of the population is younger than 15 (The World Bank Group 2017). Mozambique has a high prevalence of HIV/AIDS infection, greater than 10% in the adult population and has a high burden of other infectious diseases including food and waterborne diseases, malaria, dengue fever, schistosomiasis and rabies (UNAIDS 2015). Mozambique had a GDP of approximately $14.87 billion in 2015 with 7% of GDP used on health expenditures (The World Bank Group 2017, United Nations Statistics Division 2017). Agriculture accounts for 81% of GDP and 52% of the population lived below the poverty line (as of 2009 data). Mozambique’s average life expectancy is approximately 56 years for females and 53 years for males, the maternal mortality rate is 489 deaths per 100,000 live births, and the infant mortality rate is 64 deaths per 1,000 live births (The World Bank Group 2017, United Nations Statistics Division 2017).

In Mozambique, based on the demographic features, disease burden and nature of poverty in communities, many districts were suspected to be endemic across all 11 provinces. Guidance provided by Sightsavers indicated that prior to mapping, based on knowledge of disease burden and epidemiology of selected countries, around 50% of suspected endemic districts would be identified as confirmed endemic by baseline surveys (Aboe and Bush 2011). As such, trachoma prevalence surveys were conducted across the country to determine the prevalence of trachoma across all districts between July 2012 and May 2015. Across 96 evaluation units, 2,375 clusters were visited, enrolling 76,000 households. In total, 249,257 people were examined including 101,845 children and 122,657 adults (Abdala et al 2017).

3.3 Study Procedures

Rural districts in Mozambique were divided into 96 evaluation units by pairing administrative districts with varying population levels so that each evaluation unit covered approximately 100,000 to 250,000 people. A two-stage cluster random sampling methodology was used in each evaluation unit. The primary sampling unit for each was the village or enumeration area, using probability proportional to size based on the total number of households from 2007 Mozambique census data. The secondary sampling unit was the household selected through random walk (in first phase surveys) or compact segment sampling (in second phase surveys). An enumerated list of households was kept, and field teams were encouraged to return later in the day to houses with absent inhabitants at the time of initial survey. Based on the epidemiology of trachoma, communities classified as urban, defined nationally as a population of greater than 5,000 inhabitants, were excluded from the sampling frame.

The surveys were undertaken in two phases. The first phase, encompassing five evaluation units in Nampula Province, was undertaken prior to the Global Trachoma Mapping Project (GTMP). In phase one, field teams were trained on data collection using paper-based questionnaires and participants were examined for clinical signs of trachoma using the WHO simplified grading system. In the first phase EUs, information on TF and trichiasis was collected including presence and absence of trachomatous scarring (TS) among all participants (Abdala et al 2017).

In phase two, the remaining 91 evaluation units were mapped using GTMP procedures. In 9 evaluation units in Niassa province, data were collected using version 3 of the GTMP training system for TF and trichiasis and included information on presence and absence of trachomatous scarring (TS) in eyes with trichiasis (Solomon et al 2015). The remaining 82 evaluation units were mapped using version 1 of the GTMP training. Field teams completed a five-day training led by a GTMP-certified master grader and a GTMP-certified grader trainer. Data collectors had to first pass an examination using standard GTMP procedure with kappa scores of at least 0.7 in an inter-grader agreement exercise in order to collect data. For phase two, data were collected using Android smartphones loaded with standard survey forms. In both phases of data collection, survey teams were trained to obtain permission from traditional leaders before commencing.

Sample size was calculated using 2007 census data in which 1.59 children aged 1 to 9 years were estimated per household. Based on this estimate, if teams visited 32 households per day, 24 clusters would be required per EU to complete sampling of 1,019 children needed to estimate TF prevalence of 10% at precision of ±3% at the 95% confidence level, and a design effect of 2.65 to account for clustering.

Statistical analysis

Across 96 evaluation units, 2,378 clusters were visited, enrolling 76,757 households between July 2012 and May 2015. In total, 249,257 people were examined out of 269,351 residing in sampled households, including 101,845 children and 122,657 adults (Abdala et al 2017). In the first phase, 20,691 individuals participated across 138 clusters including 5,244 households. In the second phase, 228,595 individuals participated across 2,240 surveyed clusters including 70,757 households.

Table 4. Survey Sampling and Participation

Phase	**First**	**Second**
No. Clusters	138	2,240
No. Households Sampled	-	70,757
No. Households Consented	5,244	70,663
Household Participation Rate	-	99.0%
No. Individuals Sampled	-	248,494
No. Individuals Consented	20,691	228,595
Individual Participation Rate	-	92.0%

Source: Abdala et al 2017

In 12 EUs, TF prevalence in 1-9 year olds was greater than 10% (20 districts, 2,455,852 total population). In 17 EUs, TF prevalence in 1-9 year olds was between 5.0-9.9% (28 districts, 3,753,039 total population). TF prevalence in children aged 1-9 years was less than the 5% threshold for elimination in 67 EUs. Trichiasis prevalence in those aged 15 and above was ≥0.2% in 22 EUs, exceeding the WHO trichiasis elimination threshold. In the remaining 74 EUs, trichiasis prevalence was beneath the WHO elimination threshold of <0.2% of those aged 15 years and above.

The original estimates of TF and trichiasis prevalence from Balama, Montepuez, and Namuno districts of Cabo Delgado are listed in Table 5.

Table 5. Original Estimates of TF and Trichiasis Prevalence, three districts

Province	Evaluation unit	1-9 years		15 years and above	
		Examined (n)	Adjusted TF[a] (%, 95%CI[b])	Examined (n)	Adjusted trichiasis[c] prevalence (%, 95%CI[b])
Cabo Delgado	Balama	1,019	5.3 (3.7-7.3)	1,275	0.8 (0.4-1.1)
Cabo Delgado	Montepuez	820	7.8 (5-11.5)	1,233	0.6 (0.4-1)
Cabo Delgado	Namuno	835	4.8 (2.9-6.6)	1,106	0.6 (0.2-1.1)

[a]Population-based trachomatous inflammation-follicular (TF) prevalence derived from cluster-level proportions adjusted for age in 1 year age bands using the latest available census data
[c]Population-based trichiasis prevalence derived from cluster-level proportions adjusted for sex and age in 5 year age bands using the latest available census data

3.4 Plans for data analysis

Primary survey data were collected by program staff. Information regarding population figures used in baseline prevalence surveys was aggregated at the district level and associated calculations using prevalence estimates from surveys were recorded in an Excel file. Population figures compiled from census projections based on 2007 Mozambique census data will be used to calculate potential expected TT cases and TT surgical backlogs based on TT prevalence estimates calculated using population-based surveys. Confidence intervals on TT prevalence rates, expected TT cases and TT backlog will be calculated using SAS version 9.4 and SUDAAN version 11.0.1. As national census data in Mozambique provides both rural and urban estimates for individual districts, the differences in prevalence rates based on rural-only population figures will be calculated for the three selected districts. In-depth interviews with key informants will be analyzed to describe the process of pilot guide implementation, identify themes and lessons learned, and draw out best practices according to program staff members.

3.5 Ethical Considerations

This project was determined to be IRB-exempt after review by Emory IRB. Based on submitted materials, the project was determined by IRB to be best classified as public health practice/program evaluation, and therefore meeting "non-research" criteria.

3.6 Limitations

The research set forth in this study is specific to Mozambique and the prevalence estimates are not generalizable to other locations. The author did not participate in data collection for these baseline surveys. The data used in this analysis for population figures and weighting is census data from 2007 from Mozambique. TT surgical needs and referrals are based on data collected by case finders, as such there is no way to evaluate the reliability or comprehensiveness of this data. This research is programmatically operational in nature and while it may contribute to the operational objectives of other national trachoma programs and to the body of knowledge, its primary purpose is to inform future programmatic directions for the successful implementation of high impact trachoma elimination activities in Mozambique.

4. Results

There is wide variation in the prevalence estimates for each district depending on method of calculation. Prevalence estimates varied based on application of sampling weights, method of calculation, and aggregation. This in turn impacted the backlog estimation for expected TT surgeries at the level of each enumeration unit. Difficulties in replicating the original analysis method may account for the wider variations seen in this analysis as compared to the original.

The process of implementing a pilot guide for finding TT cases is described below. Challenges, successes and lessons learned from this pilot guide are further explored in the discussion section.

4.1 Trachoma Prevalence Survey Results

In 2013, baseline population-based surveys for trachoma prevalence were conducted in Balama, Montepuez and Namuno districts of the Cabo Delgado province in Mozambique. The surveys recorded demographic factors, graded trachoma stages, and measured other water, sanitation and hygiene indicators. The descriptive statistics for the variables of interest for this analysis are listed below in Table 6.

Complex survey procedures in SAS and SUDAAN were used to determine the prevalence of trachomatous trichiasis (TT) in those 15 years or above at the enumeration unit level. The variables for TT presence in the right eye, left eye or any eye and the variable for age 15 or above were used to calculate the proportion of the sample with TT signs present. Sample weights were creating using the sex and age group variables, weighted based on the district level population proportions provided by 2013 Mozambique census data. For this analysis, enumeration unit and district are used interchangeably, as these districts each encompassed their own enumeration unit and were not combined with other districts for the purpose of sampling and analysis.

Table 6. Descriptive Statistics from Trachoma Prevalence Baseline Surveys in 3 Districts

	District		
Variable	**Balama**	**Montepuez**	**Namuno**
Observations, N	2902	2559	2443
Sex, N (%)			
Male	1338 (46.11)	1200 (46.89)	1123 (45.97)
Female	1564 (53.89)	1359 (53.11)	1320 (54.03)
Age Group, N (%)			
1-4	514 (17.71)	453 (17.70)	436 (17.85)
5-9	578 (19.92)	435 (17.00)	436 (17.85)
10-14	281 (9.68)	238 (9.30)	240 (9.82)
15-19	205 (7.06)	182 (7.11)	161 (6.59)
20-24	188 (6.48)	174 (6.80)	177 (7.25)
25-29	239 (8.24)	217 (8.48)	240 (9.82)
30-34	156 (5.38)	193 (7.54)	186 (7.61)
35-39	194 (6.69)	188 (7.35)	142 (5.81)
40-44	135 (4.65)	114 (4.45)	124 (5.08)
45-49	106 (3.65)	111 (4.34)	85 (3.48)
50-54	72 (2.48)	64 (2.50)	37 (1.51)
55-59	52 (1.79)	38 (1.48)	53 (2.17)
60-64	68 (2.34)	40 (1.56)	46 (1.88)
65-69	37 (1.27)	48 (1.88)	35 (1.43)
70-74	34 (1.17)	39 (1.52)	28 (1.15)
75-79	24 (0.83)	14 (0.55)	12 (0.49)
80+	19 (0.65)	11 (0.43)	5 (0.20)
TT Presence in Left Eye			
Sign absent	2499 (98.97)	2232 (99.02)	2134 (99.44)
Sign present	20 (0.79)	21 (0.93)	12 (0.56)
Not able to grade	6 (0.24)	1 (0.04)	-
TT Presence in Right Eye			
Sign absent	2501 (99.05)	2232 (99.02)	2135 (99.49)
Sign present	17 (0.67)	21 (0.93)	11 (0.51)
Not able to grade	7 (0.28)	1 (0.04)	-
TT Presence in Any Eye			
Sign absent	2497 (98.89)	2230 (98.94)	2131 (99.30)
Sign present	22 (0.87)	23 (1.02)	15 (0.70)
Not able to grade	6 (0.24)	1 (0.04)	-
Age 15 or Above			
No	1373 (47.31)	1126 (44.00)	1112 (45.52)
Yes	1529 (52.69)	1433 (56.00)	1331 (54.48)

For reference, the TT prevalence estimate for each district was calculated using the sample data with no weighting. The unweighted prevalence for each district ranged from 0.99% in Namuno to 1.78% in Montepuez. Some variation is seen when comparing the presence of TT in the left or right eye, with a combined variable of TT presence in any eye encompassing observations in which TT was present in either the right or left eye (Table 7).

Table 7. TT Prevalence (aged 15 or above) – Unweighted

	District		
Variable, N (%)	**Balama**	**Montepuez**	**Namuno**
TT Presence in Left Eye			
Sign present	20 (1.57)	20 (1.62)	12 (1.08)
TT Presence in Right Eye			
Sign present	17 (1.33)	20 (1.62)	11 (0.99)
TT Presence in Any Eye			
Sign present	22 (1.73)	22 (1.78)	15 (1.36)

To compare prevalence estimates and confidence intervals across statistical software packages, TT prevalence estimates were calculated using survey sampling procedures (including surveyfreq, descript and crosstabs procedures) in SAS version 9.4 and SUDAAN version 11.0.1. To calculate weighted estimates, strata and cluster were specified using enumeration unit and cluster variables and weight was calculated by adjusting for sex and age in 5 year increments. Results were displayed by enumeration unit (districts: Balama, Montepuez, and Namuno). Column percentages and 95% confidence interval limits are reported in Tables 8 and 9 below.

Table 8. TT Prevalence (aged 15 or above) – Weighted using 2013 census data, total district population figures, SAS

	District		
Variable, % (CI)	**Balama**	**Montepuez**	**Namuno**
TT Presence in Left Eye			
Sign present	1.23 (0.53, 1.93)	1.28 (0.52, 2.04)	0.99 (0.22, 1.77)
TT Presence in Right Eye			
Sign present	1.08 (0.39, 1.76)	1.31 (0.50, 2.12)	0.90 (0.31, 1.49)
TT Presence in Any Eye			
Sign present	1.35 (0.65, 2.1)	1.45 (0.52, 2.37)	1.25 (0.42, 2.09)

Table 9. TT Prevalence (aged 15 or above) – Weighted using 2013 census data, total district population figures, SUDAAN

	District		
Variable, % (CI)	**Balama**	**Montepuez**	**Namuno**
TT Presence in Left Eye			
Sign present	1.23 (0.71, 2.13)	1.28 (0.72, 2.26)	0.99 (0.47, 2.10)
TT Presence in Right Eye			
Sign present	1.08 (0.58, 1.98)	1.31 (0.72, 2.38)	0.90 (0.48, 1.69)
TT Presence in Any Eye			
Sign present	1.35 (0.82, 2.23)	1.45 (0.78, 2.67)	1.25 (0.66, 2.37)

The analysis represented and described above was rerun using weighting for rural only population figures. However, Montepuez is the only district that has a large enough urban area to have differentiation between urban and rural populations in Mozambique census data. Therefore, rural only estimates are only calculated for Montepuez in Tables 10 and 11 below. The analysis found a TT prevalence of 1.63% (95% CI: 0.87, 3.03) for Montepuez district. The TT prevalence calculated for the rural-only population was higher than that calculated using total district population figures.

Table 10. TT Prevalence (aged 15 or above) – Weighted using 2013 census data, rural only district population figures, SAS

	District		
Variable, N (%)	**Balama**	**Montepuez**	**Namuno**
TT Presence in Left Eye			
Sign present	-	1.44 (0.60, 2.28)	-
TT Presence in Right Eye			
Sign present	-	1.47 (0.57, 2.37)	-
TT Presence in Any Eye			
Sign present	-	1.63 (0.61, 2.64)	-

Table 11. TT Prevalence (aged 15 or above) – Weighted using 2013 census data, rural only district population figures, SUDAAN

	District		
Variable, N (%)	**Balama**	**Montepuez**	**Namuno**
TT Presence in Left Eye			
Sign present	-	1.44 (0.80, 2.56)	-
TT Presence in Right Eye			
Sign present	-	1.47 (0.79, 2.71)	-
TT Presence in Any Eye			
Sign present	-	1.63 (0.87, 3.03)	-

As part of the original analysis from this data set, EU-level adjusted prevalence estimates were created by calculating the cluster level adjusted TT prevalence for each cluster in each EU, then averaging together the cluster proportions to find the EU-level adjusted prevalence and bootstrapping the 2.5 and 97.5th centiles for confidence intervals. The re-calculated TT prevalence for each cluster, by district, are listed below in Table 12. The average cluster TT prevalence for each district is listed in Table 13.

Table 12. TT Prevalence (aged 15 or above) by cluster

Balama		Montepuez		Namuno	
Cluster	**TT Prevalence**	**Cluster**	**TT Prevalence**	**Cluster**	**TT Prevalence**
49	1.46	1	0.00	217	4.96
50	0.00	2	0.00	218	0.00
51	0.00	3	0.00	219	2.32
52	1.02	4	4.72	220	1.90
53	4.32	5	0.00	221	0.00
54	0.00	6	2.82	222	0.00
55	0.00	7	11.02	223	0.00
56	2.94	8	0.00	224	5.56
57	0.00	9	0.00	225	0.00
58	0.00	10	3.38	226	0.00
59	4.56	11	2.97	227	0.00
60	0.00	12	5.32	228	1.76
61	0.81	13	1.18	229	0.00
62	1.39	14	0.00	230	0.00
63	0.00	15	1.15	231	2.36
64	1.81	16	0.00	232	5.88
65	0.00	17	0.00	233	0.00
66	1.22	18	0.00	234	0.00
67	4.16	19	2.15	235	2.08
68	0.00	20	1.45	236	0.00
69	3.18	21	1.18	237	0.00
70	1.28	22	0.81	238	0.00
71	0.00	23	0.00	239	0.00
72	3.82	24	0.00	240	2.06

Note: Not all clusters had recorded TT cases, those with TT prevalence of 0 had no recorded TT cases in those aged 15 or above

Table 13. Average Cluster TT Prevalence (aged 15 or above) by Enumeration Unit

Enumeration Unit	Average Cluster TT Prevalence (%)
Balama	1.33
Montepuez	1.59
Namuno	1.20

4.2 TT Surgery Backlog Estimates

The TT prevalence estimates created from the original baseline surveys are used to calculate the expected number of cases in each district and the number of interventions needed to treat or manage the estimated number of TT cases. Estimated cases and TT backlog were calculated using the EU-level adjusted prevalence from Table 9. In Balama, a TT prevalence of 1.35% in those aged 15 and above would mean a backlog of 971 expected cases based on a population of 71,924 people above age 15. In Montepuez, a TT prevalence of 1.45% in those aged 15 and above would mean a backlog of 1832 expected cases based on a population of 126,317 people above age 15. In Namuno, a TT prevalence of 1.25% in those aged 15 and above would mean a backlog of 1328 expected cases based on a population of 106,207 people above age 15.

Table 14. TT Backlog Estimate – EU adjusted prevalence, total district population, 2013

District	**District Population - 2013**	**Population ≥ 15 years - 2013**	**TT Prevalence (15+ years) (%)**	**CI low**	**CI high**	***TT Backlog (Population >15 years * TT prevalence)***
Balama	139,508	71,924	1.35	0.82	2.23	971
Montepuez	221,915	126,317	1.45	0.78	2.67	1832
Namuno	205,368	106,207	1.25	0.66	2.37	1328

When applying TT prevalence estimates to rural only populations, there appears to be some variation based on different population proportion and sampling weights. Within the three districts examined in this analysis, only Montepuez has urban areas that are distinct enough to have different population figures for rural and urban areas based on census data. Additionally, trachoma population-based sampling is only done in rural areas, not urban areas, as trachoma is viewed as mainly a problem in non-urban areas (Solomon et al 2015, ICTC 2011). When examining TT prevalence and backlog estimates using rural-only population figures, the estimated TT prevalence was higher than that seen with the total district population weighting. Using rural-only population weights, the TT prevalence for Montepuez is 1.63%, higher than the 1.45% prevalence seen using total district population weights in Table 14. Although the prevalence seen with rural-only population was higher, the TT backlog estimate was lower due to a smaller population size overall and among those aged 15 and above (Table 15).

Table 15. TT Backlog Estimate – EU adjusted prevalence, rural only district population, 2013

District	**Rural Population - 2013**	**Population ≥ 15 years - 2013**	**TT Prevalence (15+ years) (%)**	**CI low**	**CI high**	***TT Backlog (Population >15 years * TT prevalence)***
Balama	139,508	71,924	1.35	0.82	2.23	971
Montepuez	132, 587	73, 264	1.63	0.87	3.03	1194
Namuno	205,368	106,207	1.25	0.66	2.37	1328

Note: Montepuez is the only district that also has a separate urban area according to Mozambique census data, therefore the rural only figures for Balama and Namuno are the same are the total district population figures in Table 14

The TT prevalence and TT backlog estimates were also calculated using the average of cluster level prevalence proportions for each enumeration unit. Compared to EU level TT prevalence estimates, cluster level average proportions were slighter lower for Balama (1.35% versus 1.33%) and Namuno (1.25% versus 1.20%), while the estimate was slightly higher for Montepuez (1.45% versus 1.59%).

Table 16. TT Backlog Estimate – Average Cluster TT Prevalence by EU

District	**District Population - 2013**	**Population ≥ 15 years - 2013**	**TT Prevalence (15+ years) (%)**	***TT Backlog (Population >15 years * TT prevalence)***
Balama	139,508	71,924	1.33	957
Montepuez	221,915	126,317	1.59	2008
Namuno	205,368	106,207	1.20	1274

4.3 Limitations

Data reported from Namuno district only reported sign present or sign absent for TT grading. The GTMP standard for grading eyes for TT calls for three levels: sign present, sign absent and not gradable. The third level, not gradable was not reported at all in Namuno district.

One objective of this thesis analysis was to replicate the method of prevalence calculation from the original baseline surveys conducted through the Global Trachoma Mapping Project and used by the national trachoma program in Mozambique to determine TT prevalence and backlog for planning programmatic activities. The original analysis calculated EU-adjusted prevalence estimates for TT by adjusting the proportion of people with TT in each cluster by sex and age in five-year age groups then calculated the mean of all such clusters. Confidence intervals for these prevalence estimates were calculated by bootstrapping the adjusted cluster proportions over 10,000 iterations and taking the 2.5th and 97.5% centiles (Abdala et al 2017). One limitation of this analysis is that I was not able to successfully replicate the bootstrapping technique from the original analysis using SAS. While I was successfully able to create weights using 2013 census data and calculate prevalence estimates at the cluster and EU levels using various methods, I was not able successfully replicate code for bootstrapping that yielded results.

4.4 Pilot Guide Implementation

The trachoma elimination program in Mozambique created and piloted a guide for identifying trichiasis cases and evaluating trichiasis treatment and management backlog toward achieving elimination targets in three districts (Balama, Montepuez, and Namuno) in Mozambique. The pilot guide called for a multi stage process to determine the number and distribution of TT patients and then plan programmatic activities to reach elimination targets. Step one of the pilot guide is a data review to determine patient distribution, and based on this information, determine the TT backlog and number of cases necessary to be treated or managed to reach the ultimate intervention goal. Then information is collected on each community to conduct a geographic analysis including information on number of case finders and case finder activities. Information from case finders – such as TT cases, case clustering, outreach activities, and surgeries completed - is compared to the information collected in the data review.

Step two in the process is a burden reassessment based on the data review and geographic analysis conducted in step one. The number of case finders necessary to locate and conduct outreach activities to households in each community and reach TT cases is calculated. Based on this number, additional case finders can be trained if necessary. The next part of step two is conducting a mass media campaign to reach TT cases and encourage them to seek services. The guide helps think through the appropriate communication strategy and opportunities for and barriers to effective outreach communication. If additional TT cases cannot be identified by case finder activities, referrals, or a mass media campaign then a trachoma impact survey or trachoma surveillance survey must be planned to reassess TT prevalence.

See Appendix B "Approaches for Identifying Trichiasis Cases in Low Burden Areas: Methods for evaluating trichiasis backlog and achieving elimination targets in 3 districts of Mozambique: Balama, Montepuez, and Namuno" for the completed guide.

In order to implement the data collection section of the pilot guide in communities, program team members worked with provisional health directorate and health authorities to collect data at the household level. Within communities, teams undertook three main activities:

1. Teams counted the number of households in each community to determine the necessary number of TT case finders (if needed).
2. Teams mapped all locations where outreach activities for trachoma surgery occurred.
3. Teams mapped all locations where TT surgical operations took place – in some areas, multiple communities joined together to form a joint location for surgical operations.

To conduct data collection, teams required permission from local authorities and an administrator of the district secretariat. Mozambique program staff have established relationships with district authorities, health authorities and religious leaders and are trusted by them.

4.5 Summary

In summary, TT prevalence estimates calculated for this analysis weighted using 2013 census population data were much higher than the estimates calculated in the original analysis. In Balama district, TT prevalence ranged from 1.35% (95% CI: 0.82, 2.23) calculated with EU-level adjusted weights to 1.33% calculated with cluster level average prevalence. In Montepuez district, TT prevalence ranged from 1.45% (95% CI: 0.87, 2.67) calculated with EU-level adjusted weights to 1.59% calculated with cluster level average prevalence. In Namuno district, TT prevalence ranged from 1.25% (95% CI: 0.66, 2.37) calculated with EU-level adjusted weights to 1.20% calculated with cluster level average prevalence. The application of these TT prevalence estimates to calculate expected cases and TT surgical backlog increased these estimates by an order of magnitude over the original analysis. This analysis was limited in that it was not possible to fully replicate the cluster adjusted proportion bootstrapping method used in the original analysis.

5. Discussion

5.1 TT Prevalence Estimates, Expected Cases and Surgical Backlog

Table 17. TT Prevalence Estimate Comparison

District	TT Prevalence – Original Analysis (%, 95% CI)	TT Prevalence – EU level weighted, total district population (%, 95% CI)	TT Prevalence – Cluster average (%)
Balama	0.8 (0.4-1.1)	1.35 (0.82, 2.23)	1.33
Montepuez	0.6 (0.4-1.0)	1.45 (0.87, 2.67)	1.59
Namuno	0.6 (0.2-1.1)	1.25 (0.66, 2.37)	1.20

As indicated above in Table 17, TT prevalence estimates varied based on method of estimation and level of aggregation. TT prevalence estimated at the EU-adjusted level were much higher than those seen in the original analysis. There is also variation seen between calculating TT prevalence at the cluster level and then averaging to determine EU level estimates and calculating prevalence for the EU level itself. It is not possible to compare the confidence intervals between these two prevalence estimates due to difficulties replicating bootstrapping methods for calculating confidence intervals in the TT prevalence cluster average calculations. The results of this analysis indicates a much higher TT prevalence in each district, regardless of method of calculation, than the prevalence estimates indicated in the original analysis. It is unclear what accounts for the differences in prevalence estimates between these two analyses. It is possible that differences in weighting from using 2010 versus 2013 census population figures accounts for some variation. The inability to successfully replicate the bootstrapping technique used to calculate prevalence estimates for the original analysis leaves more questions than answers as to why the figures seen between these two analyses vary so widely.

The higher TT prevalence estimates seen in this analysis also lead directly to higher expected TT case estimates and higher surgical backlog estimates. While this backlog estimate does not account for surgeries already completed as part of trachoma elimination activities in Mozambique, the prevalence estimates in this analysis yield expected case and surgical backlog estimates an order of magnitude higher than those seen from the original analysis (Table 18). These higher expected cases and surgical backlog estimates would have programmatic implications requiring identification, management and treatment of many more individuals than previously expected or planned for.

Table 18. District TT Prevalence and Backlog Estimate Comparison

	Original Analysis		**EU level weighted, total district population**		**Cluster average**	
District	**TT Prevalence (%, 95% CI)**	**TT Backlog**	**TT Prevalence (%, 95% CI)**	**TT Backlog**	**TT Prevalence (%)**	**TT Backlog**
Balama	0.8 (0.4, 1.1)	575	1.35 (0.82, 2.23)	971	1.33	957
Montepuez	0.6 (0.4, 1.0)	758	1.45 (0.87, 2.67)	1182	1.59	2008
Namuno	0.6 (0.2, 1.1)	637	1.25 (0.66, 2.37)	1328	1.20	1274

However, one reason for piloting a guide for assessing TT cases in low burden areas is that the expected number of TT cases have been difficult to find in communities. This was reflected through in depth interviews conducted with program staff. Issues in finding cases that were expected based on the original prevalence calculations necessitated creating and piloting a guide for finding cases. Higher prevalence estimates than those originally calculated indicates that there may be more undetected cases than previously thought, but this information is contradicted by the difficulty in finding expected cases on the ground in communities as part of activities to reach trachoma elimination.

The ultimate intervention goal for trachoma elimination as a public health problem is a TT prevalence less than 1 case per 1000 people in the population. Discrepancies in the TT prevalence estimate directly impact programmatic planning and implementation but also impact the ability to meet the ultimate intervention threshold for trachoma elimination. Looking at the variation in prevalence estimates between analyses and between calculation methods, the variation in estimates puts TT prevalence in all three districts below the ultimate intervention goal in the original analysis but above the threshold in this analysis.

When conducting the literature review for this analysis and in conducting the analysis itself, it became apparent that statistical analysis techniques referenced in published studies on trachoma prevalence surveys are not consistent and are often vague. A variety of statistical packages are used including R, SPSS, Epi Info, STATA (Noa Notina 2014, Upendo 2016). While the general methods of calculation are similar across published studies, for example, calculating TT prevalence using weights based on census data, specification of method for calculating 95% CI, the details of statistical analysis and coding to reach these results are not listed, and are not found via published studies or papers. The GTMP preferred survey analysis methodology is provided in “The Global Trachoma Mapping Project: Methodology of a 34-Country Population-Based Study,” but the actualization of the methods listed in this article is difficult, as shown by the limitations of this analysis (Solomon et al 2015). A standardized methodology for analysis of trachoma prevalence data collected from population based studies, and guidelines on completing analysis would be useful for national trachoma programs and others involved in trachoma research. A standard methodology and guidance to complete analysis would ensure comparability of prevalence data across countries.

5.2 Pilot Guide Implementation

Based on in depth interviews with program staff, there are a variety of challenges, successes and lessons learned that can be gleaned from implementation of the pilot guide for assessing TT cases in low burden areas in these three districts.

5.2.1 Challenges and Successes

One of the main challenges experienced by program staff in implementing the guide was compiling information for the data review. They found locating the data from various entities, including district health teams and TT case finders to be difficult. However, once information was compiled, staff reflected that it was very useful in filling out the rest of the guide and making programmatic decisions. Another noted challenge in piloting the guide was gaps in posting of TT case finders and coverage of communities and households in implementation versus planning. This was two-fold in that TT case finders did not necessarily cover the area they were supposed to and calculating the necessary number of case finders for full coverage was not necessarily completed or implemented. These gaps in coverage and posting of case finders also contributed to discrepancy in location and distribution of TT cases. Without full coverage from case finders, TT cases could be difficult to locate or be lost to follow up.

Additionally, with a lack of coverage with TT case finders and reliance on those posted case finders for accurate information, there was difficulty in evaluation and validation of the number of households in each community and coverage of households. TT case finders were often a main source of information about households and coverage, but case finders could have incentives to misreport household numbers and coverage to reflect higher coverage than actually achieved. The guide also does not cover a full spectrum of trachoma outreach activities; it only asks about a specific subset. For example, surgeries for TT are often performed in government clinics, but these clinics do not collect information on the district of origin of these patients, so the treatment and management of these cases cannot be accounted for toward the UIG. However, the acknowledgement of these gaps in the information the guide collects and the difficulties in collection creates an opportunity for more robust documentation of activities and outcomes in the future. Since these gaps have been identified, there is an opportunity to provide further technical assistance to case finders, health clinics, and hospitals. The pilot guide created a form for case finders to register TT cases and report their information to outreach teams. There is an opportunity to have similar activities in health clinics and hospitals as national trachoma programs move toward transitioning elimination activities to the health care system. Based on the guide, additional guidance on how to use registries and their importance to programmatic goals and elimination could be provided to case finders, health clinics, and others. Any guidance on registries, whether in the guide itself or elsewhere would need to reflect the benefit and importance of filling out the registers provided in the guide. This information can be used for programmatic decision making and for completion of WHO trachoma elimination dossier.

An important piece of information gathered from attempts to map communities and cases while implementing the guide was discrepancies in available maps. While attempting to implement the guide, the team discovered that the current district administrative divisions do not appear on Google maps. Their solution to this was to use the district administrative divisions, but use Google maps to add additional levels of detail to the administrative divisions of communities. This discrepancy is something to consider in implementing this guide in other districts of Mozambique or elsewhere. Use of GPS coordinate mapping, or collaboration with other government entities to use this as an opportunity for better mapping could be considered to foster collaboration and institutionalize the strategies used by the team to accurately map communities and cases.

The final steps in the pilot guide call for a TT impact survey or additional TT surveillance survey if cases cannot be found through case finding activities, referrals, and mass media campaigns in low burden areas (World Health Organization 2016). Large scale surveys to find the last few cases in a district are costly and require considerable human resources. The difficulties in finding that last few expected cases in low burden areas has led to a reconsideration of the use of these large-scale surveys versus increase in case finder or community health worker coverage and a more robust referral system to health clinics and static surgery centers. In reaching trachoma end game activities, and preparing for the shift of responsibility for cases to the health care system, it may be more effective and cost efficient to allocate resources to case finder coverage, training, and referral system processes to catch the last TT cases needed to reach the UIG rather than large scale district surveys.

5.2.1 Guide Strengthening

A variety of recommendations to strengthen the pilot guide came out of in depth interviews with staff and review of literature. First, national trachoma elimination program staff recommended that the "Burden Reassessment" table provided in the guide should be fully filled out for all districts of interest (See Appendix A). They noted that if the number of households and TT case finders is disproportional, the needed number of case finders should be calculated, rather than left blank or as a question mark, and this number should be used for accurate operational planning. The activities required by the guide are also important components needed to complete the WHO dossier required for certification of elimination of trachoma as a public health problem. The sections of the pilot guide that require documents from local hospitals, health clinics, and other organizations can be used to show due diligence of trachoma elimination teams. Collecting and collating this information can be facilitated by providing survey questionnaires to local hospitals and clinics for record keeping. The patient registers mentioned above can also be used as a tool for record keeping. Additional guidance should be given on how the pilot guide and registers contribute to follow up on trachoma and TT outreach activities and TT management coverage for national programs.

It is also important to clarify and emphasize the linkage between activities toward and completion of pilot guide activities and the WHO certification dossier. Completion of a WHO dossier is required for certification of elimination of trachoma as a public health problem in countries. Entering information into the pilot guide and activities necessary to complete the guide provide essential documentation that is needed to complete the WHO dossier.

In summary, implementation of the pilot guide provides important documentation of programmatic activities and processes and provides information that is necessary to complete the WHO dossier to certify elimination of trachoma as a public health problem. Use of the guide in Mozambique showed it to be a valuable tool in documenting program activities and gathering information for programmatic decision making. Operational research looking at different methods of calculating trachoma prevalence at the district and cluster levels is one way to examine the impact of different data on program objectives and the steps that are required to reach those objectives. Examining these prevalence estimates, in coordination and collaboration with pilot guide information, provides important information for operational decision making and allows programs to see a full spectrum of potential programmatic implications from various sources of information and estimates.

6. Implications and Recommendations

The analysis undertaken in this thesis has operational implications for public health practice in Mozambique and possibly across other countries approaching trachoma elimination end game activities. As country programs transition toward being responsible for data collection and analysis with less support from external partners, a clear and transparent method for analysis of prevalence survey data and impact survey data will be necessary to accurately assess progress toward elimination goals. Further research should be undertaken to clarify and codify standard methods for analysis of population based trachoma prevalence surveys and guidance should be provided to allow country programs to undertake analysis of baseline prevalence surveys and impact surveys that occur later as necessary. These methods and information are necessary so that country programs can replicate analysis done by partners and use these data and analyses for decision making and to support and justify achievement of program objectives. Additional research and clarification should be undertaken on the end game stages of trachoma elimination. For example, there is not a standard definition of a low burden area for trachoma elimination. Moving toward the end game of trachoma elimination, more research and guidance should be provided on end game strategies when national programs are reaching low numbers of cases.

Mozambique, and a number of other countries, are facing issues completing the dossier stemming from the necessity of documenting all elimination activities in low burden areas. The pilot guide provides a method of assisting in collecting and synthesizing information required for dossier completion and provides information necessary for programmatic decision making. As other countries approach trachoma end game, the guide piloted in Mozambique could be used as a valuable tool by other countries seeking to document their programmatic activities and document information for completing their WHO dossiers.

In discussion with external partners on transitioning trachoma elimination activities solely to the Ministry of Health and health system in Mozambique, there is also a potential role for the pilot guide to contribute toward a transition guide for country programs moving toward elimination certification. The pilot guide could inform transition activities and provide existing tools and materials to support transition activities in Mozambique and elsewhere. The information codified in the pilot guide and the difficulties in completing some of the analysis for this thesis also raise further discussion about the role of external partners in interpreting and analyzing survey data, in advising and giving technical assistance on technical strategies for achieving UIG, and transitioning support to health systems. The roles and expectations for external partners and national program teams need to be clarified as countries move toward trachoma end game and role transitions. It is necessary that partners and national program staff ensure that the appropriate materials, resources, and guidance exist for national program staff to continue analyzing data and using it for programmatic decision making.

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Appendices

Appendix A. Template for the dossier documenting elimination of trachoma as a public health problem

TEMPLATE FOR THE DOSSIER DOCUMENTING ELIMINATION OF TRACHOMA AS A PUBLIC HEALTH PROBLEM

This template dossier was designed to help managers of national trachoma programmes prepare a dossier with supporting evidence for presentation to WHO, requesting validation that trachoma has been eliminated as a public health problem. The information presented in the dossier will help reviewers understand programme achievements, by providing both epidemiological evidence and the broader context.

Sections of the template that are marked "required" are for information that must be included; sections that are marked "optional" may be completed or left blank, at the discretion of the national trachoma programme.

[Country]

Date of submission:

Date of review:

1. BACKGROUND

1.1 DEMOGRAPHIC AND DEVELOPMENT CONTEXT (OPTIONAL)

- *In narrative form,* summarize the demographic and economic features of the country, referencing the most recent census, Demographic and Health Survey, and/or other relevant documents, as desired. Describe the systems for delivery of WASH services, particularly to rural areas.
- It may be helpful to provide information and/or maps on poverty, infrastructure, and household access to water and sanitation.

1.2 HEALTH SYSTEM (OPTIONAL)

- *In narrative form*, provide an overview of the health system, describing:
  - the formal health system structure, including the delivery of primary healthcare services; and
  - the local epidemiology of any other endemic diseases that may be relevant to the actions of the trachoma programme.

1.3 TRACHOMA HISTORY (OPTIONAL)

- *In narrative form*, describe the history of the trachoma programme. This might include, for example:
  - a brief description of historical information about trachoma epidemiology in the country; and
  - a brief description of any interventions against trachoma prior to the launch of the current national trachoma programme.

1.4 TRACHOMA PROGRAMME OVERVIEW (REQUIRED)

- *In narrative form*, describe:
  - which organization established the trachoma programme, and in which year;
  - the internal structure of the trachoma programme, describing who or what takes responsibility for implementation of each component of the SAFE strategy;
  - whether or not the trachoma programme is integrated or coordinated with other public health programmes, with WASH programmes and/or with the education system; and if it is, how this is done; and
  - the data collection and management system used by the trachoma programme, focussing on how data from cross-sectional surveys (at baseline, impact and pre-validation surveillance stages) and data on implementation of each component of the SAFE strategy, are or were collected, aggregated and transmitted from community to national level.

2. DELINEATION OF AREAS REQUIRING INTERVENTION

2.1 DEFINITION OF EVALUATION UNITS (REQUIRED)

- *In narrative form:*
  - define the administrative units in the country ("states" and "districts", for example; going from largest units to the smallest units);
  - quantify the number of administrative units of each type; and
  - describe the basis for the formation of evaluation units (EUs) used, and whether this changed from baseline mapping to programme completion. Please include:
    - the number of EUs at the start of the programme — (a)

- the number of EUs at the end of the programme, or at the time of dossier submission — (b)
- an explanation of any changes that occurred to the number of EUs between (a) and (b) due to restructuring of administrative boundaries

2.2 DATA USED TO CLASSIFY EVALUATION UNITS (REQUIRED)

- *In narrative form*, describe*:*
  - the methods used to determine whether or not trachoma was a public health problem at baseline in each EU, including, for any surveys, the protocol followed and the sampling methodology; and
  - if the status of any EU (with respect to whether or not trachoma was a public health problem in it) was reassessed during the course of the programme, why and how the EU was reassessed.
- *In the accompanying data spreadsheet*, enter baseline survey data (where collected), for trichiasis (tab 1) and active trachoma (tab 2), for each EU.
- *Insert maps here* to display those data and identify areas that were determined not to need baseline surveys. One map should be used to display data on trichiasis (trichiasis prevalence categories, in adults: < 0.20%, 0.20–0.99%, 1.00–4.99%, ≥ 5.00%); one map should be used to display data on active trachoma (trachomatous inflammation—follicular prevalence categories, in children aged 1–9 years: < 5.0%, 5–9.9%, 10.0–29.9%, ≥ 30.0%).

3. IMPLEMENTATION OF SAFE INTERVENTIONS

3.1 SURGERY (REQUIRED)

- *In narrative form*, describe:
  - the selection, training and certification of trichiasis surgeons;
  - the indications, contraindications and techniques used for trichiasis surgery;
  - the indications, contraindications and methods used for any non-surgical management of trichiasis;
  - the methods used for case-finding of individuals with trichiasis;
  - the modes of delivery of trichiasis surgery (fixed site, surgical camps, mobile teams);
  - whether adjunctive antibiotics were routinely given at the time of trichiasis surgery;
  - the in-service supervision of trichiasis surgeons;
  - the routine follow-up of operated patients; and
  - any surgical audits performed as part of the programme.
- *In the accompanying data spreadsheet*, on tab 1, enter data, for each programme year, on the number of people (not the number of eyes) given operations for trichiasis in each EU.

3.2 ANTIBIOTICS (REQUIRED)

- *In narrative form*, describe:
  - the antibiotic regimens used for community-level interventions against trachoma;
  - the indications and contraindications for the use of those antibiotics;
  - the methods used for community sensitization and antibiotic distribution; and
  - any serious problems encountered when offering antibiotics, particularly widespread refusal or serious adverse events.
- *In the accompanying data spreadsheet*, on tab 2, enter data, for each programme year, on the number of people given antibiotics, and the antibiotic coverage, in each EU.

3.3 FACIAL CLEANLINESS (REQUIRED)

- *In narrative form*, describe:
  - the channels, messages and materials used to promote facial cleanliness;
  - for each type of activity intended to promote facial cleanliness, its frequency of implementation; coverage or scale of implementation; setting (e.g. school, or community during antibiotic mass drug administration); and target audience (e.g. mothers of preschool-aged children, or school-aged children);
  - the types of personnel used to undertake promotion of facial cleanliness; and
  - the training and supervision of personnel undertaking promotion of facial cleanliness.

  For each type of personnel, include details on frequency of training and supervision, and who was responsible for delivering training and supervision.

  Describe all activities intended to promote facial cleanliness, whether undertaken by the trachoma programme, by trachoma programme partners or by other programmes (e.g. as part of broader hygiene promotion initiatives).

- *In the accompanying data spreadsheet*, on tab 2, identify, for each trachoma programme year, which facial cleanliness activities were delivered in each EU.

3.4 ENVIRONMENTAL IMPROVEMENT (REQUIRED)

- *In narrative form*, describe:
  - the activities undertaken to improve water availability in trachoma-endemic populations, including their intensity, scale, and the agencies responsible for delivery;
  - the activities undertaken to improve access to sanitation in trachoma-endemic populations, including their intensity, scale, and the agencies responsible for delivery; and
  - whether there were any coordination or collaboration mechanisms between the trachoma programme and other WASH programmes?

- *In the accompanying data spreadsheet*, on tab 2, identify, for each trachoma programme year, which environmental improvement interventions were delivered in each EU.

4. IMPACT AND PRE-VALIDATION SURVEILLANCE SURVEYS

4.1 IMPACT SURVEYS (REQUIRED)

- *In narrative form*, describe:
  - the timing and methods used for impact surveys, including the protocol followed and sampling methodology.
- *In the accompanying data spreadsheet*, enter impact survey data, for trichiasis (tab 1) and active trachoma (tab 2), for each EU.

4.2 PRE-VALIDATION SURVEILLANCE SURVEYS (REQUIRED)

- *In narrative form*, describe:
  - the timing and methods used for pre-validation surveillance surveys, including, for any surveys, the protocol followed and sampling methodology.
- *In the accompanying data spreadsheet*, enter pre-validation surveillance survey data, for trichiasis (tab 1) and active trachoma (tab 2), for each EU.
- *Insert maps here* to display those data.

4.3 REGIONAL CONTEXT (REQUIRED)

- *In narrative form,* briefly describe the current epidemiology of trachoma in bordering countries, and comment on whether the disease in those countries is considered to present a risk to the achievements of your programme. (Trachoma prevalence data can be found at the Trachoma Atlas: www.trachomaatlas.org)
- If possible, *in the maps requested in section 4.2*, display data on the current epidemiology of trachoma in bordering countries.

5. POST-VALIDATION SURVEILLANCE (REQUIRED)

- *In narrative form,* describe:
  - national plans (if any) for post-validation trachoma surveillance;
  - national plans for provision of TT surgical services until there are no longer any incident cases of TT; and
  - national plans for continued Ministry of Health engagement with other government ministries and partners responsible for the provision of WASH services, to ensure prioritization of EUs with the lowest levels of WASH service access.

6. SPECIAL ISSUES (OPTIONAL)

- *In narrative form*, describe:
  - any special circumstances that have affected the programme; these could include, but are not limited to:
    1. stability or security issues in the country; and/or
    2. immigration from other trachoma-endemic countries.
  - any specific efforts to investigate trachoma prevalence and/or intervention coverage in difficult-to-reach populations (e.g. nomadic peoples, internally displaced persons, or refugees).

7. RESOURCES AND PARTNERSHIPS (OPTIONAL)

- *In narrative form*:
  - briefly describe the human resources employed to implement the programme; and
  - estimate internal and external financial resources utilized for the programme.
- *Complete the following table*, listing the partners of the programme:

Table 7.1. Partners of the trachoma elimination programme, [Country]

Partner name	Nature of support	Geographical areas of support	Year support started	Year support ended
e.g. Foundation X	*Financial support for trichiasis surgery*	*Regions A and C*		

8. BIBLIOGRAPHY (REQUIRED)

- *Insert here* a bibliography of all data sources used to develop this dossier, including:
    - Ministry of Health records
    - published papers
    - academic theses and dissertations

  Copies of unpublished documents may be requested by WHO.

9. ABBREVIATIONS (REQUIRED)

- *Insert here* a list of all abbreviations used in the dossier, with their definitions.

Appendix B. Approaches for identifying trichiasis cases in low burden areas: Methods for evaluating trichiasis backlog and achieving elimination targets in 3 districts of Mozambique: Balama, Montepuez, and Namuno

APPROACHES FOR IDENTIFYING TRICHIASIS CASES IN LOW BURDEN AREAS

Methods for evaluating trichiasis backlog and achieving elimination targets in 3 districts of Mozambique: Balama, Montepuez, and Namuno

Contents

Introduction

The World Health Organization (WHO) established the year 2020 as the target date for eliminating blinding trachoma as a public health problem. A key component of elimination is to reduce the number of unmanaged trachomatis trichiasis (TT) cases to less than 1 per 1,000 population in affected areas. This has been translated to mean <.1% in total population or approximately <.2% in the adult population (population 15 years or older). Achieving elimination targets by 2020 may require countries to greatly increase the number of individuals managed, either through surgery or epilation, including targetd areas where the estimated backlog may have been over or under estimated.

Current estimates suggest that up to 8 million individuals may need trichiasis surgery. Based on the estimated number of TT cases that remain in a district, National programs plan resources and activities to manage individual trichiasis cases. In certain districts it may appear unclear whether estimates reflect the true number of TT cases remaining, given the possibility of undocumented cases being previously managed or different inclusion criteria being used to calculate TT backlog. In addition, survey tools currently available to programs are under-powered for TT giving estimates wide confidence intervals.

TT is currently defined as trichiasis with co-existent trachomatous conjunctival scarring (TS). To achieve elimination TT cases must be reached by the health systems and offered surgery or other management (e.g. epilation).

Purpose of Guide

The purpose of this guide is to provide a practical methodology for identifying trichiasis patients in low burden areas, or areas where program staff are unable to identify patients, despite projected backlog estimates. Countries are encouraged to use this guide to improve estimations and identification of TT cases to ensure that surgery and self-care training (epilation) is available where needed.

STEP 1: Data Review

Organize current data by districts - define the burden of TT, the number of people needing management to reach elimination, and the districts anticipating trachoma impact surveys (and year of survey). Answer each of the following questions and complete the suggested tables. It is suggested that the Excel-based **Trachoma Dossier Template** be used to manage data collected through this guide.

1.0 TT patient distribution

- Use the Excel tool **'Population Comparison for Estimating Number of Trichiasis Patients'** (Annex 1), to critically analyze the estimated district populations. Based on the characteristics of individual districts and differences in estimates, update district populations in the Trachoma Dossier template as appropriate; make sure to provide the source of population data (e.g. national census, community census, WHO), whether urban or rural data is being used, the # of people ≥ 15 years and older, and the percentage of total population ≥ 15 years and older). Provide output below:
    - How were these estimates calculated (what TT prevalence data was used)? TT w/TS
    - What denominators were used (source of data)?
      Because population baseline surveys were conducted in 2013, 2013 population estimates were used from 'Projecá‰es_distritais_2007_2024

	Select					
				>15 yrs pop.		
District	**Source**	**Baseline TT% w/ TS (15+ years)**	**District Population**	**>15 population**	**% total Population**	**estimated backlog**
Balama	Projeções _distritais_2007_2024;	0.75%	139,508	71,924	52%	539
Montepuez	Projeções distritais_2007_2024;Projecá‰es_distritais_2007_20240;	0.63%	132,587	73,264	55%	462
Namuno	Projeções _distritais_2007_2024;	0.64%	205,368	106,207	52%	680

- Use the Trachoma Dossier Template to organize by district the most recent estimates of patients with trichiasis over the last 5 years. If applicable, note in the comments section the following:
    - Any evidence that TT surgeries may have been conducted within a district or province, but never formally recognized by the trachoma program as counting towards the estimated backlog.

- Any evidence to show that individuals within a district may be accessing surgical support in another neighbouring district or country (particularly for those districts without TT management services).
- Any evidence of mass migration out of a district.

- In the table below, record implementation units (IUs) and remaining backlog of Trichiasis

District (IU)	TT Backlog	UIG Number to operate	No. of TT cases reported as managed (operated or epilation 2014 - 2016)	Number of TT cases remaining to be operated
Balama	539	400	173	227
Montepuez	462	329	281	48
Namuno	680	474	84	390

- If the number of TT cases remaining to be operated in a district has remained unchanged for several years, i.e. current strategies are not able to identify new (cases not known by the program), list the names of those districts below.

1.1 Geographic Analysis and Case Finder Results of selected IUs

- Provide geographic coordinates (latitude/longitude) for all communities in a selected IU in the table below (decimal degrees; e.g. Beira Lat -19.81067, Long 34.87286). In addition, include the results of case finder activities in each community, the number of a safe water sources, and the number of TT cases operated and refused (see Appendix 2)

- As part of conducting a geographic analysis of the data:
  a. Assess if trichiasis cases are clustering in certain areas/villages.
  b. What is the readiness of Surgical Outreach Sites to perform trichiasis surgeries? The Outreach team are available at provincial level and they are ready whenever there is a plan do to so.
  c. How many people in the District are trained in trichiasis surgeries? Entire province of Cabo Delgado there are 5 TT surgeons trained.

STEP 2: Burden Reassessment

2.0 Place and structure of Trichiasis outreach

- In the table below enter the current number of trained case finders and the number of communities per implementation unit. What is the percentage of households that have been visited by a case finder?
- If 100% of households have still not been visited, what is the additional number of case finders needed per IU in order to achieve this goal and what are the additional costs (# of additional cases finders needed * cost per person to train = additional costs)?

District (IU)	**# of Communities**	**# of HH**	**#of Case finders**	**% of all household visited**	**# of additional Case finders needed**	**Estimated Additional Cost**
Balama	15	7,292	??		??	97.760
Namuno	18	6,850	??		??	97.760
Montepuez	12	1,132	??		??	97.760

- As part of analysing the Case Finder Strategy
  a. Determine if additional case finders are needed in specific IUs
  b. Report on the results of the most recent case search. How many new TT cases (previously unknown) were identified?

2.1 Conduct Mass Media Campaign

- Use an appropriate communication strategy to encourage TT patients to either go to a scheduled surgical outreach site, or to the nearest clinic for consultation. In collaboration with the national program provide all clinics a contact name and number to report TT referrals for follow-up.

- In developing a communication strategy, what are the factors that might influence delivery of services and/or patient access to trichiasis surgical services? These could include:
    - Religious influences
    - Special groups or indigenous populations
    - Languages spoken and read
    - Literacy
    - Economic status
    - Decision-making structures in households

- Access to clean water
- Access to transportation/distance to health facilities
- Access to footwear for lymphedema patients
- Access to assistive technology and devices
- Rainy season period
- Agricultural cycles (planting, harvest)

District (IU)	Communication strategy (e.g. radio announcements about benefits of eye surgery and where to go for free surgery; bullhorn announcements in local markets about when surgical teams are arriving; etc..)	Planned Dates for implementing communication strategy	Name of contact person for TT referrals	Contact number
Balama	Radio Anouncements and House to House visits	April, May and June	Sergio Luis Mosse	843129085; 848198648
Namuno	Radio Anouncements and House to House visits	April, May and June	Sergio Luis Mosse	843129085; 848198648
Montepuez	Radio Anouncements and House to House visits	April, May and June	Sergio Luis Mosse	843129085; 848198648

2.2 TT-only survey

- If no additional TT cases can be identified through case finders or referrals after a mass media campaign, conduct TT only a survey to verify the TT rate. If a Trachoma Impact Survey or a Trachoma Surveillance Survey is planned obtain TT prevalence data to reassess current status.

District (IU)	Are Trachoma Impact or Trachoma Surveillance Surveys planned for this IU? (Y/N)	Is a TT-only survey recommended for this IU? (Y/N)

Annex 1. Population Comparison for Estimating the Number of Trichiasis Patients

Annex 2. Geographical coordinates for communities in selected Districts