THESIS TITLE:

PREVALENCE OF TRACHOMA AND RISK FACTORS FOR DISEASE IN BENUE STATE, NIGERIA.

By

SELASSIE TAGOH (TGHSEL001)

Submitted in partial fulfillment of the requirements for the degree

Master of Public Health (Community Eye Health Specialization)

in the

School of Public Health and Family Medicine

Faculty of Health Sciences

University of Cape Town

Cape Town

South Africa

Supervisors: Professor Caleb Mpyet

Submitted: November, 2017

COPYRIGHT

PART 0 (PREAMBLE)

.

DECLARATION

MPH (COMMUNITY EYE HEALTH TRACK)

I **Selassie Tagoh** Student Number **TGHSEL001** declare that the work that I have submitted for the award of this degree is my original work and has not been presented before for the award of a Masters' Degree in Public Health in this University or elsewhere. Where the work of others has been used (whether quoted verbatim, paraphrased or referred to) it has been appropriately acknowledged and attributed to those authors.

Signature: S T

Date: 08/11/2017

DEDICATION

I dedicate this work to my mum, dad, brothers, sisters and loved ones.

THESIS ABSTRACT

Background: Trachoma is a common contagious bacterial eye infection caused by *Chlamydia trachomatis* serovariants A, B, Ba or C. It is the leading infectious cause of blindness worldwide and is responsible for about 3% of global blindness. World Health Organization (WHO) reports suggest that of the 2.2 million people who have been rendered visually impaired worldwide by trachoma, 1.2 million are irreversibly blind while an additional 7.3 million people are suffering from trachomatous trichiasis (TT) and are at risk of developing blindness. According to WHO 2007 reports, globally about 84 million people suffer from active trachoma while an estimated 299 million people still live in trachoma endemic districts. In order to eliminate trachoma as a public health problem, The Global Trachoma Mapping Project (GTMP) was initiated on 23 July 2012 as a first step in generating population-level prevalence estimates of the disease so as to determine the need for intervention. Between 2013 and 2015, the GTMP mapped suspected endemic districts including Benue state of Nigeria. This current study took advantage of this data to generate prevalence information on Trachomatous inflammation Follicular (TF) and Trichiasis for Benue state and to describe the some of the household risk factors associated with the disease. The thesis is structured in three parts 0(Preamble), A (Protocol), B (Literature Review), C (Article) and D (Appendix).

Methods: A two-stage cluster random sampling technique was utilized in a population based prevalence survey to generate estimates for TF and Trichiasis.

Results: Overall unadjusted prevalence of TF among persons 1-9 years was 2.00% (95% CI: 1.20 – 2.98) and that of trichiasis among persons ≥15 years was 0.11% (95% CI 0.06 – 0.12). Trichiasis was more prevalent among adult women 0.05% (95% CI: 0.03 – 0.07) compared to males 0.03 % (95% CI: 0.02 – 0.05), (p=0.13). LGA-level prevalence of TF and Trichiasis among persons 1-9

years and persons ≥15 years ranged from 0.30% (95% CI: 0.1–0.5) to 5.30% (95% CI: 3.30–7.70) and 0.00% to 0.35% (95% CI: 0.12–0.50) respectively. Two LGAs had trichiasis prevalence above 0.2%. TF prevalence was between 5% and 9.9% in 2 LGAs. The common risk factors identified included age, sex, inaccessibility to water and latrine facility. Adults ≥15 years were 8.94(95%CI: 2.79 – 29.64) times more likely to have trichiasis compared to persons between 1-9 years of age.

Conclusion: Trachoma was found to be a public health problem in 3 LGAs of Benue state. One round of mass antibiotic distribution will be required in 2 LGAs. With an estimated trichiasis backlog of 1,064, about 173 individuals with trichiasis needed to be managed to reduce the prevalence to less than the elimination threshold.

Key words: Prevalence, Trachoma, Nigeria, Benue State, trichiasis.

ACKNOWLEDGEMENT

I would like to convey my profound gratitude to the Almighty God for the mercies, protection and blessings granted me throughout my study. My heartfelt gratitude and appreciation goes to my supervisors Prof. Caleb Mpyet, Prof. Colin Cook and Prof. Paul Courtright. Your wisdom, support and good counsel have been very valuable in encouraging me to persevere. I also thank the Nigerian Ministry of Health for allowing me to use the GTMP data for this work.

Finally to my family, friends and loved ones for the support and prayers that kept me going till now especially my dear Dr. Efuwa Seiwa Entsiwah for her unrelenting support and encouragement. Thank you and God richly bless you all.

ACRONYMS AND ABBREVIATIONS

AOR	Adjusted Odds Ratio
CI	Confidence Interval
CO	Corneal Opacity
COR	Crude Odds Ratio
FCT	Federal Capital Territory
GET 2020	Global Elimination of Trachoma by 2020
GPS	Global Positioning System
GTMP	Global Trachoma Mapping Project
IAPB	International Agency for the Prevention of Blindness
ICD	International Classification of Disease
JMP	Joint Monitoring Programme
LGA	Local Government Area
MDA	Mass Drug Administration
MPH	Masters in Public Health
NTDs	Neglected Tropical Diseases
NGDOs	Non-governmental Development Organizations
PI	Principal Investigator
SAFE	Surgery, Antibiotics, Facial cleanliness and Environmental changes

SDGs	Sustainable Development Goals
TI	Trachomatous inflammation Intense
TF	Trachomatous inflammation Follicular
TS	Trachomatous Scaring
TT	Trachomatous Trichiasis
UCT	University of Cape Town
UIG	Ultimate Intervention Goal
UNICEF	United Nations International Children's Emergency Fund
WaSH	Water Sanitation and Hygiene
WHO	World Health Organization

PART A (PROTOCOL)

Table of Contents

THESIS TITLE: i
COPYRIGHT ii
PART 0 (PREAMBLE) iii
DECLARATION iv
DEDICATION v
THESIS ABSTRACT vi
ACKNOWLEDGEMENT viii
ACRONYMS AND ABBREVIATIONS ix
PART A (PROTOCOL) 0
Table of Contents 1
1.0 Background 4
2.0. Purpose of the Study 9
2.1 Aim 9
2.2 Objectives 9
3.0. Methodology 10
3.1 Definition of terms 10
3.2 Study Design 11
3.3 Sample size 11
3.4 Characteristics of Study population 12
3.4.1 Inclusion Criteria 12
3.4.2 Exclusion Criteria 12
3.4.3 Sample recruitment and enrolment 12
3.5. Variables 13
3.6. Procedure and data collection 15
3.7. Data Safety and Monitoring 16
3.8. Data Analysis Plan 16
4.0. Description of Risks and Benefits 18
4.1. Potential Risks 18
4.2 Potential Benefits 18
5.0. Ethical Considerations 18
5.1 Informed Consent Process 18
5.2 Capacity to consent 19

5.3 Comprehension of information 19
5.4 Privacy and Confidentiality 19
5.5 Emergency Care and Insurance for Research-related Injury 20
5.6. Institutional Review Board Approval 20
6.0. Justification for the study 20
7.0. Budget 22
8.0. Available Resources 22
9.0. Timeline 22
10.0. Dissemination of Results 23
11.0. References 24
PART B: LITERATURE REVIEW 1
1.0 Objectives of Literature Review 2
2.0 Literature Search Strategy 2
3.0 Summary and Interpretation of Literature 3
3.1 Background 3
4.0. Individual and Environmental Risk Factors for Trachoma 5
4.1. Lack of potable water 5
4.2. Distance to and type of water source 6
4.3. Clean face 6
4.4. Practice of good WaSH habits 7
4.5. Age 7
4.6. Gender 8
4.7. Access to latrine 8
4.8. Vectors 9
5.0. Control Initiatives and Strategies 9
5.1. Vision 2020 10
5.2. Global alliance for the Elimination of Trachoma (GET 2020) 11
6.0. Trachoma Burden in Africa 11
7.0. Gaps in knowledge and Conclusion 13
8.0 References 17
PART C: Journal "Ready" Manuscript 1
TITLE PAGE 2

ABSTRACT 3
INTRODUCTION 4
MATERIALS AND METHODS 5
Study design and setting 5
Sampling and procedure 6
Operational definitions 7
Data management and analysis 7
Ethical Considerations 8
RESULTS 9
Sociodemographic characteristics 9
Access to water and sanitation 9
Prevalence of trachoma among children 1-9 years old and adults ≥15 years 10
Household and environmental determinants of trachoma 11
DISCUSSION 12
DECLARATION OF INTEREST 16
Funding 16
Appendix 17
REFERENCES 18
PART D: APPENDICES 1
APPENDIX A: Informed Consent Forms 2
Participant Information Form 2
Consent Forms 4
APPENDIX B: Data collection tools 5
APPENDIX C: Letter of approval from research ethics committees 8
Approval from NHREC of Nigeria 8
UCT ethics approval letter 9
APPENDIX D: Instructions for authors 11
APPENDIX E: Supplementary tables 1
APPENDIX F: Figures 8

1.0 Background

Trachoma is one of the over 13 Neglected Tropical Diseases (NTDs) responsible for different forms of disability in many low and middle income countries worldwide (Neglected Tropical Diseases...WHO, 2009). It is a major cause of visual impairment and blindness globally and estimated to be endemic in 33 countries in Africa. It also has significant presence in other under-developed continents including Asia, Latin America, Middle east and the Western Pacific (Alemayehu et al., 2015; Polack et al., 2005).The continuous presence of trachoma in these regions, is in spite of the fact that its natural history, including treatment, control and elimination mechanism have been widely studied and recommended by the WHO (WHO, 2013). Recent reports have shown that trachoma is the leading infectious cause of blindness worldwide (Asres, Endeshaw & Yeshambaw, 2016; WHO, 2013) and is responsible for 3% of global blindness (Pascolini & Mariotti, 2011). According to the same report, out of the over 2.2 million people rendered visually impaired worldwide by trachoma, 1.2 million are irreversibly blind. Additionally, 2007 reports by the WHO showed that globally about 84 million people suffer from active trachoma (Trachomatous inflammation, Follicular [TF] and/or Intense [TI]) (Burton & Mabey, 2009; Ketema et al., 2012) while an estimated 299 million people still live in trachoma endemic districts (WHO, 2014) including 7.3 million people suffering from TT and at risk of developing blindness (WHO, 2012) from recurrent trachoma infections.

Trachoma infection is characterized initially by an inflammation of the inner lining of the eye lids (palpebral conjunctiva) usually in childhood. Recurrent episodes of infection eventually results in conjunctival scars leading to entropion and trachomatous trichiasis (Mariotti, Pascolini & Rose-Nussbaumer, 2009). Persistent rubbing of eyelashes on the cornea results in complications causing severe pain, corneal opacity and subsequent vision loss in older children and adults (Thylefors et

al., 1987). Transmission of trachoma has been known to be facilitated through direct contact from dirty fingers, fomites such as cloths, towels, bed sheets as well as the eye-seeking fly *Musca sorbens* which predominantly prefers human faeces as a best larval medium for breeding purposes (Emerson et al., 2001; Taylor, 2008) and are responsible for the increased prevalence of the disease especially in Africa.

The prevalence and risk factors for trachoma in Africa have been reported on by several population based studies including a recent study by Asres et al (Asres, Endeshaw &Yeshambaw, 2016). In this study, it was observed that communities endemic of trachoma were usually located in dry and dusty regions with insufficient or distant water sources, for which reason they practice poor face washing and general personal hygiene habits (Asres, Endeshaw &Yeshambaw, 2016). Additionally, findings from this survey showed that other socio-demographic factors like age, sex, educational level of child and parents, presence of trachoma in other family members, poor household economy and poor personal and environmental hygiene were predictors of trachoma in children 1-9 years old. In 2005, a study by Polack et al also reported on the difference in prevalence of trachoma in the different climatic zones. Dry climatic zones were found to have the highest prevalence of 24.2 % (Polack et al., 2005). Factors like poverty, poor sanitation, high fly density, absence of latrine and low socio-economic status have also been reported to be strongly associated with the regions where the condition is hyperendemic (Asres, Endeshaw &Yeshambaw, 2016; Ketema et al., 2012).

Trachoma has been eliminated as a public health problem in many developed countries even though high prevalence of the disease has been recorded in some parts of Northern, Southern and Western Australia (Lansingh et al., 2001; Tellis, Keeffe & Taylor, 2006). Successful elimination in most developed countries was largely due to socio-economic development, improved access to

water and improved sanitation in the areas of personal and environmental hygiene (WHO, 2013). The disease however persists in some vulnerable communities especially in Africa as most of the countries with excess burden of the disease are located in this region (Polack et al., 2005).

In Africa and globally, Ethiopia carries the largest burden of the disease (WHO, 2014). The national survey of blindness and low vision (2007) in Ethiopia reported that trachoma was the second largest cause of visual disability. It was responsible for 7.7% of low vision and 11.5% of blindness. The overall prevalence in this survey was greater in rural populations and among women. It was concluded that trachoma was hyperendemic, with prevalence estimates as high as 40.1% found among children aged 1-9 years (Berhane et al., 2007). Other surveys have however reported not so high prevalence estimates of TF and TT among children and adults respectively in Ethiopia (Yalew et al., 2006). Nevertheless, the reported prevalence estimates were still higher than the WHO elimination threshold of <5% for TF and < 0.1% for TT.

Studies in Malawi by Kalua et al., reported a 17.1% {95% CI: 14.9 – 19.4} prevalence of (TI) and (TF) among children aged 1 - 9 years. Furthermore, it was observed that prevalence of TF tended to reach peak between two and four years of age as children this age are more likely to play around and live in unhygienic environments. In addition, prevalence of TF was found to be significantly higher among girls than in boys {19.4% versus 14.6%; p = 0.034} (Kalua et al., 2014). The prevalence of (TT) in women aged 15 years and above was 1.3% {95% CI: 0.7– 2.3}, while the prevalence in men was zero. The high prevalence in women compared to men could be explained by the increased probability of recurrent infection of women since they are most likely to take care of the infected children. TF was significantly correlated with absence of a "clean face" {P < 0.001} and absence of a toilet facility {p< 0.001}, but results differed in terms of presence of solid waste, animal pens and distance to water source (Kalua et al., 2014). Similar population based surveys

conducted in endemic districts in Senegal (Saal et al., 2003), Gambia (Dolin et al., 1998) and Nigeria (Jip et al., 2008; Mansur, Muhammad & Liman, 2007; Mpyet, Ogoshi & Goyol, 2008) also yielded similarly high levels of prevalence values that far exceeded the WHO stipulated threshold (TF≥5% and TT >0.1%) for intervention. Even though these studies may have differed slightly in terms of sample size, methodology and outcome measures examined, they however provide an idea of the global picture of the burden of trachoma on the continent, to which Nigeria contributes significantly.

Nigeria is the most populous nation in Africa, with a population of about 186.1 million (US Census Bureau, 2016). Due to its size and land area (923,768 sq km), a large portion of its land mass falls within the dry and arid Sahel region of West Africa with climatic conditions which reportedly favour trachoma endemicity (Rabiu & Abiose, 2000). The National survey of causes of blindness and visual impairment in Nigeria (2005-2007) reported an overall blindness prevalence of 5.5% among individuals ≥50 years and 1.5% of severe visual impairment (National Blindness Survey..., 2008). In the same report, Trachoma was mentioned to be responsible for 4.2% of blindness. Blindness from trachoma has been predominantly reported in the northern part of the country (Rabiu &Abiose, 2000).

WHO has a recommended elimination strategy for trachoma. This includes the four pronged combination of interventions referred to as "SAFE" strategy (S: Surgery of the eyelids for those with TT and are at immediate risk of blindness, A: Antibiotics to treat individual cases and to reduce infection in a community, F: Facial cleanliness and hygiene promotion to reduce transmission and E: Environmental changes such as provision of water and household sanitation (Bailey & Lietman, 2001). However, the only way to know which aspect of the "SAFE" strategy to be implemented is by assessing all persons in suspected endemic communities who are 1 year

old and above for the presence of the five common signs that characterize the clinical features of trachoma under the WHO simplified grading system; Trachomatous inflammation Follicular (TF), Trachomatous inflammation Intense (TI), Trachomatous Scarring (TS), Trachomatous Trichiasis (TT) and Corneal Opacity (CO) (Thylefors et al., 1987).

In order to properly assess the distribution and magnitude of trachoma globally so that elimination strategies can be planned and targeted at the countries and communities most at risk, the Global Trachoma Mapping Project (GTMP) was undertaken between January 2012 and December 2015 to generate prevalence data on the burden of trachoma in communities in 34 countries globally including Benue state in Nigeria.

Benue is one of the states in the North-Central part of Nigeria. It has 23 LGAs with a population of about 4.2 million (Population and Housing Census, 2006). Due to its location in the dry, arid climatic zones of the country with maximum temperatures ranging between 36.0°C-38.0°C during the hot season (Nigeria Climate Review, 2012), coupled with reports of trachoma endemicity in neighbouring Nasarawa and Plateau states (King et al., 2010), it was suspected that trachoma may be endemic in some districts of Benue state. Even though there have been reports of river blindness (Onchocerciasis) in most communities in this state (Gemade & Utsalo, 1990; Manyi, Obi & Iortyom, 2014), little or no published information exists on prevalence of trachoma. This study therefore seeks to ascertain the prevalence and risk factors for TF and trichiasis among children 1-9 years old and adults ≥ 15 years old respectively in Benue state so as to decide whether it is necessary to establish an elimination programme in communities within this state.

2.0. Purpose of the Study

2.1 Aim

The aim of this study is to determine the prevalence and risk factors for trachoma among children between 1 -9 years old and adults ≥15 years old in Benue state of Nigeria.

2.2 Objectives

1. To determine the prevalence of Trachomatous inflammation Follicular (TF) and Trichiasis among children 1-9 years and adults ≥15 years old respectively in Benue State of Nigeria and to decide which Local Government Areas (LGAs) are endemic of the disease and warrant a trachoma control programme.

2. To describe the demographic distribution of TF and Trichiasis among children 1-9 years old and adults ≥15 years old respectively in Benue state, Nigeria.

3. To describe the individual and environmental risk factors associated with Trachoma in Benue state, Nigeria.

4. To determine the association between the prevalence of Trachoma (TF, Trichiasis) and gender in the population studied.

5. To determine the association between the prevalence of Trachoma (TF, Trichiasis) and age in the population studied.

6. To estimate the number of antibiotics treatments and trichiasis surgeries to be performed to eliminate trachoma as a public health problem in Benue state.

3.0. Methodology

3.1 Definition of terms

Table. 1 Definition of terms used in the protocol

Term	Definition
Active trachoma	Trachomatous inflammation, follicular or Trachomatous inflammation intense
Binocular Loup	Potable optical magnifying instrument for observing the external structures of the eye.
Confounding factors	A variable that is correlated (directly or inversely) to both the dependent variable and independent variable.
Demographic variable	"Personal statistics that include such information as income level, gender, educational level, location, ethnicity, race, and family size"
Entropion	Inward folding of the eyelids
Epilation	Removal of in-turned lashes
Tarsal conjunctivae	The epithelial tissue that lines the inside of the eyelids
Trachomatous Trichiasis	At least one eyelash rubbing the eyeball or evidence of recent removal of in-turned eyelashes.

Trachoma Grader	An eye care professional trained and certified to assess patients for signs of trachoma.
Trachomatous Inflammation Follicular	Presence of at least five or more follicles in the upper tarsal conjunctiva each at least 0.5mm in size.

3.2 Study Design

The study will be a population-based analytical cross-sectional study using pre-existing data obtained from a GTMP survey conducted in Benue state between April and September 2014. The data from this project were obtained through a multi-stage cluster random sampling technique as recommended by WHO. The methods and techniques described in this study will therefore be significantly consistent with the methodology as described elsewhere (Solomon et al., 2015). This study will essentially be an analysis of the data from a combination of examination of clinical signs for trachoma and questionnaire-based assessment of potential household-level risk factors for trachoma in the study population.

3.3 Sample size

In LGAs, 25 villages will be selected using a multi-stage approach with probability of selection of the village being proportional to the village population size. In each village 25 households will be selected according to the single population proportion for precision formula. In order to estimate expected TF prevalence of 10% and to report a 95% Confidence Interval (CI) with absolute precision of 3%, a minimum of 384 children aged 1–9 years selected by simple random sampling would be required. This number will be adjusted by a design effect of 2.65 and further inflated by

a factor of 1.2 to account for non-response rate to arrive at a final minimum. This sampling strategy was designed to promote recruitment of a sample of at least 1019 children aged 1–9 years. The low prevalence of TT (nearly always <2% in adults except in the most hyperendemic areas) means that accurately estimating its prevalence requires prohibitively large samples, and we will accept the loss of precision in the estimate of trichiasis prevalence inherent in this approach. It is planned to examine all adults found in each selected household.

3.4 Characteristics of Study population

The study population will be a cross-section of the population of Benue state, Nigeria. The state is located in the North– Central zone of Nigeria with a population of about 4.2 million and a land area of 34,059 square km. It is predominantly an agricultural rich region transcended by numerous rivers and is sometimes referred to as the "food basket" of Nigeria because of the abundant production of crops like yam, potatoes, cassava, soya bean, guinea corn and flax among others. Data from the Nigeria population census in 2006 shows that 50% of the population are females while 34% of the population is between 0-9 years old. The population includes a diverse number of ethnic groups distributed in 23 different districts (LGAs).

3.4.1 Inclusion Criteria

All residents of Benue state 1 year and older in the selected clusters will be included in the study. Data obtained from all participants included in the survey will be analysed.

3.4.2 Exclusion Criteria

Children who did not fall within the study age group (<1year old) and population will be excluded.

3.4.3 Sample recruitment and enrolment

The data from this project will be obtained through a Multi-stage cluster random sampling technique as recommended by WHO. Surveys will be conducted in all 23 LGAs of Benue State. In each LGA a 2-stage cluster random sample technique will be used to randomly select the study

subjects. In stage 1, 25 villages (clusters) will be selected from a list of all villages in the LGA using probability proportional to the village population size technique. In stage 2, twenty-five households will be randomly selected from each selected village to be included in the study.

With the help of a local guide, the centres of the villages will be located. A pen will be spun on the ground at this location and the direction which the pen points will be observed. This direction will then be followed by a survey team and all eligible households in this direction will be selected and their residents examined (Random walk method) until the required number of households have been assessed. Survey teams will examine all residents for clinical signs of trachoma and also question household heads about water and sanitation facilities. Team members will also directly observe sanitation facilities available in the households selected.

3.5. Variables

Table 2. Variables that will be used for data analysis

Name	Type of variable	Unit	Possible value
Age	Numerical	years	1-9 for children, ≥15+ for adults
Enumeration Unit	Categorical	-	Coded:380-402
Sex	Categorical	-	Male. Female
Trachomatous Follicular (TF)	Categorical	-	Present, Absent
Trachomatous Trichiasis	Categorical	-	Sign Present, sign Absent, Not able to grade
Drinking water source, Face washing water source	Categorical	-	Improved (Piped water into dwelling, Piped water into yard, Tub well, Protected spring, Borehole, Protected dug well, Rainwater collection Unimproved (Unprotected dug well,

			Unprotected spring, Water vendor, Surface water, Other)
Distance from drink water source, Distance from face washing water source	Categorical	-	Less than 30 minutes, Between 30 minutes 1 hour,
Latrine Facility	Categorical	-	Present (Shared latrine, Private latrine), Absent (No structure outside/ near house, No structure in the bush or field)
Type of latrine	Categorical	-	Improved (Flush/ pour Flush/pour flush to septic tank Flush/pour flush to pit Latrine Ventilated improved pit latrine (VIP), Composting toilet, Pit latrine with slab) Unimproved (Flush/pour flush to open drains Flush/pour flush to unknown place Bucket Hanging toilet/hanging latrine No facilities or bush or field, Others)
Hand washing facility within latrine facility.	Categorical	-	Yes, No
Water available at hand washing facility	Categorical	-	Yes, No

Soap/ash available at hand washing facility	Categorical	-	Yes, No

3.6. Procedure and data collection

In the randomly selected households, all residents over the age of 1 will be invited to participate. After exchanging pleasantries with the head of household, the conduct of the survey will then be thoroughly explained and his/her consent will be sought, after he or she has demonstrated adequate understanding of the survey protocols and is satisfied with measures to ensure confidentiality and privacy.

If household head consents to participate, global positioning system (GPS) coordinates will then be collected from outside the front door of the house or compound. Information on potential household-level environmental risk factors for trachoma will then be obtained through household heads responses to questions on a pre-validated WaSH questionnaire. The questionnaire that will be used in this survey will be that of the WHO/UNICEF (United Nations International Children's Emergency Fund) Joint Monitoring Programme (WHO/UNICEF, 2006) and will be administered by the survey team. Visual inspection of household latrine and hand washing facilities will also be carried out.

Participants who will give consent to participate in the study will then be examined by trained and certified GTMP graders for signs of TF and trichiasis according to the WHO simplified grading system (Thylefors et al., 1987). This exercise will be conducted using a 2.5x magnifying binocular loupe in bright sunlight or with torchlight for adequate illumination. The process is estimated to last maximum of about 15 minutes so as to avoid participant fatigue. Households with absent residents on first visit will be re-visited by the team at the end of the day to get them examined.

Adequate precautions will be taken to prevent microbial cross-infection of participants of the study by using alcohol based hand sanitizers in-between examination of study subjects.

All the data will be electronically captured using a purpose-built Open Data Kit-based Android smart phone application called LINKS developed by the Task Force for Global Health, Atlanta, GA, USA (Pavluck et al., 2014).The data will be kept on the Smartphone's micro-secured digital card, which will allow continuous storage of the data until a data-enabled mobile network or WiFi signal is available for the data to be transmitted.

3.7. Data Safety and Monitoring

The GTMP data will be geographically referenced using GPS system coordinates. They will then be transmitted to a high security server for cleaning by designated data managers and to undergo the various levels of approval by persons at the Ministry of Health who will endorse the adequacy of data collection and appropriateness of the data cleaning process. To ensure inter-and intra-rater reliability, survey team members will be well trained on data collection protocols and procedures.

3.8. Data Analysis Plan

The main aim of this study is to determine the prevalence of trachoma marked by the main signs of the disease in children 1-9 years old (TF) and in adults 15 years and above (Trichiasis). In this research, the de-identified cleaned GTMP electronic data will be imported into Stata (Version 14.0) for analysis.

Exploratory statistical techniques will be conducted to ascertain the appropriateness of intended statistical tests. For objectives 1 and 2, the data will be summarized using appropriate descriptive statistics such as frequencies and percentages for categorical variables while numerical variables will be summarized using means and medians. Additionally the risk factors for trachoma and percentage prevalence of TF in 1-9 year olds and trichiasis in adults ≥ 15 years including the

demographic distribution of these parameters will be explored using simple descriptive statistical tests. This will include calculation of the proportion of subjects in the overall sample and within each LGA with the relevant signs of trachoma for the two age categories.

With respect to objective 3, the independent individual and household risk factors for trachoma will be determined by univariate and multivariate logistic regression models, while adjusting for relevant potential confounding factors like, age, gender, household source of drinking water in the dry season, household source of face washing water in the dry season, distance of household from water source, presence of latrine in household, type of latrine, presence of hand washing facility close to latrine, presence of water and soap close to latrine for hand washing. Prevalence of trachoma (TF/trichiasis) will be used as dependent variable. Crude and adjusted Odds ratios, p-values and 95% Confidence Intervals will be generated and reported for the precision of estimates.

For objectives 4 and 5, correlation coefficients will be calculated to determine how prevalence of trachoma relates to gender and age. Objective 6 will be achieved based on the prevalence estimates of trachoma and the projected population of the respective LGAs.

TF prevalences of >10% is considered a public health problem, however who recommends that TF prevalences of between ≥5%- 9.9 % and ≥10-20.9% will require one round and three rounds of mass distribution of antibiotics (azithromycin) respectively in addition to environmental and facial cleanliness campaigns. TT prevalence of ≥0.2% in persons ≥15 years also calls for implementation of the "S" component of the "SAFE" strategy (WHO, 2003).

4.0. Description of Risks and Benefits

4.1. Potential Risks

Examination for trichiasis is harmless and if any at all, participants will experience only a transient discomfort (minimal risk) during eversion of the tarsal conjunctivae to allow examination for TF and TI. Qualified well trained trachoma graders will be engaged in data collection to ensure minimal or no harm to participants. No risks of any kind are anticipated from this current study as only secondary data will be used for analysis.

4.2 Potential Benefits

The community however stands to benefit from this study in that results will inform government and relevant stakeholders of the need or otherwise to establish trachoma elimination programme in endemic communities in Benue state. Individuals who were found to have signs of TF will also benefit from drugs (1% tetracycline ointment) for treatment of the condition and those suspected of trichiasis will be counselled and referred to nearby hospitals for evaluation and management.

5.0. Ethical Considerations

5.1 Informed Consent Process

The protocols of the study and the examination modalities will be thoroughly explained to each adult before the GTMP data will be collected. They will be allowed to consult with other household members before giving consent. It is anticipated that most of the participants will not be able to read nor write, hence the explanation of the study protocols will be done in a local language by selected survey team members who will be recruited and trained in the sampling protocol, interview process, and the method for completing survey forms.

5.2 Capacity to consent

Verbal consent for enrolment and participation will be obtained from each household head, parents or legal guardians (for minors) before examinations will be conducted. Adult participants will be made to give verbal consent for their own participation. Consent will then be documented on individual consent forms and also stored on the LINKS application purposely designed for this type of surveys. Permission will be sought from relevant stakeholders before using the baseline data for any secondary analysis. .

5.3 Comprehension of information

It will be ensured that participants are given adequate information about the study examination and modalities. Participants will be allowed to give consent only after demonstrating adequate understanding of the information they will be given. Participants will not be directly involved in any way during analysis of the data obtained during the survey.

5.4 Privacy and Confidentiality

The data for the study will be in the custody of representatives of the Nigeria trachoma control programme and persons granted permission by them to use it for publication purposes. Permission will be sought from these representatives before any secondary analysis of the data is done. These representatives therefore reserve the explicit right to an informed release of the data for the purposes of future research. The data will be in an electronic form only and could be assessed only by the researcher. The data will be kept on a personal computer with a password only known to the researcher. The data itself will be kept in a password protected folder that can only be assessed by the researcher.

5.5 Emergency Care and Insurance for Research-related Injury

No research related injury is anticipated in this study. This is because only secondary data will be used in this study for analysis. Since participants are not going to be directly involved, there will be no need for any emergency care or insurance cover for any related injury or harm.

5.6. Institutional Review Board Approval

Copies of the research protocol will be sent to the University of Cape Town Research Ethics Committee and Departmental Research Committee for approval. Prior to collection of the GTMP data, the project will be approved by the Ethics Committee of the London School of Hygiene and Tropical Medicine and the National Health Research Ethics Committee of Nigeria while the government of Benue state will be asked permission for the conduct and appropriate report of the study. Data collection methods will also conform to the guidelines of the Declaration of Helsinki.

6.0. Justification for the study

Trachoma is the most common infectious cause of blindness worldwide hence the WHO has put in place programmes aimed at eliminating trachoma as a public health problem by the year 2020.The "SAFE" strategy is the recommended approach proposed by WHO to deal with the problem of trachoma in endemic communities. However to achieve the aims of the GET 2020 project, there is a need for a complete understanding of the distribution and intensity of the endemicity of blinding trachoma globally. Population based surveys are therefore necessary critical steps in the achievement of this aim, as they provide baseline information on the district-level prevalence of the disease.

Reports have shown that the global burden of trachoma has not been fully assessed. According to 2012 reports in the GTMP methodology paper, population based surveys have been conducted over the years to map trachoma in about 1115 districts worldwide with data thought to be required

from about 1238 more districts so as to complete the global picture. This study is therefore being conducted to generate baseline prevalence data on the clinical signs of TF among children 1-9 years old and trichiasis among adults ≥15 years of age in Benue state of Nigeria. This is vital information that can be used for advocacy purposes aimed at attracting local and international support to eliminate trachoma as a public health concern in Nigeria.

In addition, the results of this research will supplement already existing knowledge about the global burden of trachoma and further help to complete the global trachoma map. It will also enhance the understanding of the true nature of the task involved in eliminating trachoma as a public health problem. Furthermore, the baseline data that will be generated from this study can be used by programme managers as a guide to facilitate the planning of trachoma elimination programmes for endemic communities.

This research is necessary because it will also enable trachoma programme managers estimate the number of antibiotics treatments as well as the number of trichiasis surgeries needed for endemic communities in Benue state in order to eliminate trachoma as a public health problem. This information will be valuable in the control programme planning process in terms of making request for the consumables required for the elimination programme.

If all these purposes are achieved, this study will ultimately be contributing to efforts to reduce avoidable causes of blindness, as many people will be prevented from going blind unnecessarily from trachoma. The study will essentially be contributing significantly to WHO efforts directed at achieving the aims of VISION 2020 and the GET 2020 initiative.

7.0. Budget

No budget is required for this study because there is no direct cost to the researcher except for time and commitment. The survey field work has already been conducted and the data is available for research purposes upon request and approval from relevant institutions.

8.0. Available Resources

Supervision support will be provided by supervisors from University of Jos, Nigeria and University of Cape Town, South Africa. UCT will provide access to bibliographic references and software for the analysis as this final dissertation forms part of the MPH course. No additional resources will be needed as the student researcher's personal computer will be used to do the analysis.

9.0. Timeline

The study will be conducted between October 2016 and October 2017. Table 3 provides a timeline of events from the start of protocol development to final submission to UCT post graduate office and submission to journal for publication.

Table 3: Research timeline

Task	Description	Month	October, 2016				November, 2016				December, 2016				January, 2017				February, 2017				March-November, 2017
		Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1	**Protocol Completion**																						
1.1	Supervisors' Approval																						
1.2	Final draft for Departmental review																						
1.3	Protocol Defence																						
1.4	Feedback for revision																						
1.5	Final draft completed																						
1.6	Submission to ethics																						
1.7	Ethics Approval																						
2	**Data Analysis**																						
2.1	Preliminary Analysis																						
2.2	Data analysis																						
3.0	**Write up**																						
3.1	Draft manuscript																						
3.2	Feedback and review																						
3.3	Draft dissertation to supervisor																						
3.4	Feedback and review																						
3.5	Feedback and review																						
3.6	Finalize dissertation																						
4.0	**Submissions**																						
4.1	Notice of submission to UCT																						
4.2	UCT submission																						
4.3	Submission to Journal																						

10.0. Dissemination of Results

The results of the study will be disseminated to all relevant stakeholders including the Ministry of Health of the Federal Republic of Nigeria. Additionally the results will be published in a peer-reviewed scientific journal so that it can be available to the wider scientific audience.

11.0. References

1. Alemayehu, M., Koye, N. D., Tariku, A., Yimam, K. 2015. Prevalence of Active Trachoma and its Associated Factors among Rural and Urban Children in Dera Woreda, North-west Ethiopia: A Comparative Cross-Sectional Study. *Bio Medical Research International*. 1-8. Available: http://dx.doi.org/10.1155/2015/570898 [2016, July 13].
2. Asres, M., Endeshaw, M. &Yeshambaw, M. 2016. Prevalence and Risk Factors of Active Trachoma among Children in Gondar Zuria District North Gondar, Ethiopia. *Insight Medical Publishing Journals.* (1)1:5. Available: http://preventive-medicine.imedpub.com/ [2016,July 10].
3. Bailey, R. & Lietman, T. 2001. The SAFE strategy for the elimination of trachoma by 2020: will it work? *Bulletin of the World Health Organization.* 79: 233–236. Available: http://www.who.int/bulletin/archives/79(3)233.pdf [2016, July 19].
4. Berhane, Y., Worku, A., Bejiga, A., Adamu, L., Alemayehu, W., Bedri, A., Haile, Z., Ayalew, A., et al.2007. Prevalence and causes of Blindness and Low Vision in Ethiopia. *Ethiopia Journal of Health Development*. 21; (3): 204-210. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.574.3501&rep=rep1&type=pdf [2016, July 11].
5. Burton, M.J & Mabey, D.C.W. 2009. The Global burden of Trachoma: a review. *PLoS Neglected Tropical Diseases*. 3 (10):e460.
   DOI: http://dx.doi.org/10.1371/journal.pntd.0000460.
6. Dolin, P. J., Faal, H., Johnson, G. J., Ajewole, J., Mohamed A.A. & Lee P. L. 1998. Trachoma in the Gambia. *British Journal of Ophthalmology*. 82:930-3. DOI: 10.1136/bjo.82.8.930.

7. Emerson, P. M., Bailey, R. L., Walraven G. E. & Lindsay, S. W. 2001. Human and other faeces as breeding media of the Trachoma Vector *Musca sorbens*. [Abstract]. *Medical and Veterinary Entomology*. 15(3):314–320.
DOI: 10.1046/j.0269-283x.2001.00318.x.

8. Gemade, E. I. &Utsalo, S.J. 1990. Onchocerciasis in Benue State of Nigeria. VI: The Prevalence and Distribution of the Disease among the Human Population in Sati-Ikyov village. *Acta Leiden*. [Abstract]. 59 (1-2):51-8.
Available: www.ncbi.nlm.nih.gov/pubmed/2378227 [2016, July 21].

9. Jip, N. F., King, J. D, Diallo, M. O., Miri, E. S., Hamza, A. T., Ngondi, J.& Emerson, P. M. 2008. Blinding trachoma in Katsina State, Nigeria: Population-based prevalence survey in ten local government areas. [Abstract].*Ophthalmic Epidemiology*. 15(5): 294–302. DOI: 10.1080/09286580802256542.

10. Kalua, K., Isaac Singini, I., Mukaka, M., Msyamboza, K., Masika, M. & Bailey, R. 2014.Scaling up of trachoma mapping in Salima District, Central Malawi. *International Journal of Tropical Diseases & Health.* 4(5) 494-508. Available: http://dx.doi.org/10.4236/health.2014.61009 [2016, July 21].

11. Ketema, K., Tiruneh, M., Woldeyohannes, D., Muluye, D.2012. Prevalence of active Trachoma and associated risk factors among children less than ten years in Baso Liben district, East Gojjam. *Ethiopia. Bio Medical Central, Public Heath.*1-7.
DOI: 10.1186/1471-2458-12-1105.

12. King, D., Jip, N., Jugu Y. S., Othman, A., Rodgers, A. F., Dajom, D. Y., Miri, E & Emerson P. M. 2010.Mapping Trachoma in Nasarawa and Plateau States, Central Nigeria. *British Journal of Ophthalmology*. 94:14–19. DOI:10.1136/bjo.2009.165282.

13. Lansingh, V.C., Weih, L.M., Keeffe, J.E. & Taylor, H.R. 2001. Assessment of Trachoma prevalence in a mobile population in Central Australia [Abstract]. *Ophthalmic Epidemiology*. 8(2-3):97-108.

Available: http://www.ncbi.nlm.nih.gov/pubmed/11471079 [2016, July 10].

14. Mansur, R., Muhammad, N. & Liman, I. R. 2007. Prevalence and magnitude of Trachoma in a Local Government area of Sokoto State, North Western Nigeria. [Abstract]. *Niger Journal of Medicine*. 16: 348–353.

Available: http://www.ncbi.nlm.nih.gov/pubmed/18080594 [2016, July 12].

15. Mariotti, S. P., Pascolini, D., Rose-Nussbaumer, J. 2009. Trachoma: Global magnitude of a preventable cause of blindness. *British Journal of Ophthalmology*. *2009*. 93:563–568. DOI:10.1136/bjo.2008.148494.

16. Mpyet, C., Ogoshi, C. & Goyol, M. 2008. Prevalence of Trachoma in Yobe State, north-eastern Nigeria. *Ophthalmic Epidemiology*. 15: 303–307.

DOI: 10.1080/09286580802237633.

17. National Population Commission. 2006. Population and Housing Census of the Federal Republic of Nigeria. Priority Tables. Volume 1. Available: http://www.population.gov.ng/index.php/publications/138-national-and-state-population-and-housing-tables-2006-census-priority-tables-vol-1. [2016, August 13].

18. Nigerian Climate Review. 2012. Edited Report. 13-14. Available: http://www.nimet.gov.ng/sites/default/files/publications/2012%20NIGERIAN%20CLIMATE%20REVIEW%20EDIT.docx. [2016, August 14].

19. Pascolini, D. & Mariotti, S. P. 2011. Global estimates of Visual Impairment: 2010. *British Journal of Ophthalmology*. 96(5):614–618. DOI: 10.1136/bjophthalmol-2011-300539.

20. Pavluck, A., Chu, B., Flueckiger, M. R. & Ottesen, E. 2014. Electronic Data Capture Tools for Global Health Programs: evolution of LINKS, an Android-, web-based system. *PLoS Neglected Tropical Diseases.* 8(4): e2654. DOI: 10.1371/journal.pntd.0002654.

21. Polack, S., Brooker, S., Kuper, H., Mariotti, S., Mabey, D., Foster, A. 2005. Mapping the global distribution of trachoma. *Bulletin of the World Health Organization*. 83 (12).Available: http://www.who.int/bulletin/volumes/83/12/913.pdf [2016, July 9].

22. Rabiu M, M. & Abiose, A. 2001. Magnitude of trachoma and barriers to uptake of lid surgery in a rural community of northern Nigeria. *Ophthalmic Epidemiology*. (8), 2-3, 181-790. Available: http://www.ph.ucla.edu/epi/rapidsurveys/ophthalmicepid8(2_3)_181_190_2001.pdf [2016, July 17].

23. Saal, M. B., Schemann, J. F., Saar, B., Faye, M., Momo, G., Mariotti, S. & Negrel, A. D. 2003. Trachoma in Senegal: results of a National survey [Abstract]. *Med Trop (Mars)*. 63(1):53-9. Available: https://www.researchgate.net/publication/10634730_Trachoma_in_Senegal_results_of_a_national_survey [2016, July 11].

24. Solomon, A. W., Pavluck, A. L., Courtright, P., Abo, A., Adamu, L., Alemayehu W., Alemu, M. & Alexander N.D.E et al. 2015. The Global Trachoma Mapping Project:

Methodology of a 34-Country Population-Based Study. *Ophthalmic Epidemiology*. 22(3): 214–225. DOI: 10.3109/09286586.2015.1037401.

25. Taylor, H.R. 2008. Trachoma: a blinding scourge from the bronze age to the twenty-first century. South Yarra, Australia. *Haddington Press.* Chapter 6. 124. ISBN: 9780975769591 (hbk.). Available: http://iehu.unimelb.edu.au/__data/assets/pdf_file/0009/719649/Trachoma_Book_HRTaylor.pdf [2016, July 10].
26. Tellis, B., Keeffe, J. E. & Taylor, H. R. 2006. Surveillance Report for Active Trachoma. National Surveillance and Reporting Unit, Annual Report. 31 (4) 366-374. Available: http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi3104-pdf-cnt.htm/$file/cdi3104b.pdf [2016, July 10].
27. The Nigeria National Blindness and Visual Impairment Survey. 2005-2007. Available: http://pbunion.org/Countriessurveyresults/Nigeria/Nigeria_survey_Summary_report.pdf [2016, July 19].
28. Thylefors, B., Dawson, C. R., Jones B. R., West, S. K., Taylor, H. R. 1987. A simple system for the assessment of Trachoma and its complications. *Bulletin of the World Health Organization*. 65 (4): 477-483. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2491032/pdf/bullwho00075-0054.pdf [2016, July 10].
29. World Health Organization (WHO). 2003. Report of the 2nd Global Scientific Meeting on Trachoma. Geneva, 25-27. Available: http://www.who.int/blindness/2nd%20GLOBAL%20SCIENTIFIC%20MEETING.pdf. [2018, June 5].

30. World Health Organisation. 2009. Neglected Tropical Diseases Hidden Successes, Emerging Opportunities. *WHO Press*. Available:http://whqlibdoc.who.int/publications/2009/9789241598705_eng.pdf [2016, July 9].
31. World Health Organisation. 2013. Report of the 17th Meeting of the WHO Alliance for the Global Elimination of Blinding Trachoma.20-21. Available: www.who.int/blindness/publications/GET17Report_final.pdf [2016, July 19].
32. World Health Organization. 2013. Global Alliance for the Elimination of Blinding Trachoma (GET) by 2020. *Weekly Epidemiological Record*. 24 (88): 242–251. Available: http://www.who.int/wer/2013/wer8824.pdf [2016, July 9].
33. World Health Organization. 2014. Key Trachoma Facts and Statistics. International Coalition for Trachoma Control. *Weekly Epidemiological Records*. Available: http://www.trachomacoalition.org/trachomastatistics [2016, July 11].
34. World Health Organization & United Nations International Children's Emergency Fund (WHO/UNICEF) 2006. Core Questions on Drinking water and sanitation for household surveys. 1-25. Available: http://www.who.int/water_sanitation_health/monitoring/jmpfinal.pdf [2016, July 23].
35. World Health Organization (WHO). 2017. Morocco eliminates trachoma – the leading infectious cause of blindness. Available: http://www.emro.who.int/media/news/morocco-eliminates-trachoma-the-leading-infectious-cause-of-blindness.html [2017, May 15].

36. Yalew N. K., Mekonnen, M. G &Jemaneh, A. A. 2012.Trachoma and its determinants in Mojo and Lume districts of Ethiopia. *Pan- African Medical Journal.* 13(1):8. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3587019/ [2016, July 11].

PART B: LITERATURE REVIEW

1.0 Objectives of Literature Review

The main aim of this study is to ascertain the prevalence of trachoma as well as the common household level and environmental risk factors for the disease in Benue state, Nigeria. To contextualize the study, a literature review was conducted on the research topic with an objective to synthesize and summarize existing literature on the global trends in trachoma burden with particular focus on its prevalence in Africa and specifically in Nigeria-Benue state as well as the risk factors associated with it. Finally, the review will identify gaps in the literature which will form the bases for this study.

2.0 Literature Search Strategy

The literature search focused on studies that reported on Trachomatous inflammation Follicular and Trachomatous Trichiasis prevalence among children and adults respectively. Key words and MeSH terms were generated and used to search for literature in the following online databases: Academic OneFile, Academic Search Premier, CINAHL via EBSCOhost, Cochrane Library, EBSCOhost, Eric, Google Scholar, Medline via PubMed, PubMed Central, Science Direct, SciELO and SCOPUS. The following key words were used appropriately to search for relevant literature in the various databases: Prevalence, Trachoma, Trachoma Infection, Child, Adult, Trachomatous Follicular, Trachomatous Trichiasis, Risk factors, Household Latrine, Water, Sanitation, Hygiene, Blindness, Epidemiology, Nigeria and Benue State. Additionally a general Google search was conducted to access available "grey" literature. Experts in the field of trachoma control were contacted for their expert input. The literature search also included a search through the reference list of downloaded peer reviewed articles to find additional relevant literature to be included in the review. Relevant studies conducted in all languages were selected initially based their titles and abstracts review. Full papers regardless of year of publication, were downloaded and reviewed to assess their quality.

3.0 Summary and Interpretation of Literature

3.1 Background

Trachoma is the most common contagious cause of avoidable blindness worldwide (Resnikoff et al., 2002; Pascolini & Marioti, 2011) associated with significant contribution to personal, societal and economic burden through blindness and vision impairment (West et al., 2013). It is a chronic conjunctivitis (Muhammad et al., 2015) initiated in early childhood by repeated conjunctival infection with the bacteria *Chlamydia trachomatis.*

The most recent estimates reported by the WHO indicate that about 200 million people still live in trachoma endemic areas in 42 countries worldwide, 1.9 million people are blind or visually v impaired and about 3.2 million have TT and are at risk of going blind (Ramadhani et al., 2016; WHO, 2016) while approximately 1.2 million of the visually impaired are irreversibly blind (WHO, 2013).

Trachoma is spread by direct contact with eye and nose discharges from infected individuals or by contact with fomites (inanimate objects that carry infectious agents) such as towels and/or wash cloths. Eye-seeking flies, which are attracted to eye and nasal secretions on the faces of infected children, are also believed to be vectors and are a major route of mechanical transmission of the bacteria (WHO, 2013).

Infection with the bacteria triggers an immune response characterized by redness of the eye and discharge as well as inflammatory thickening of the tarsal conjunctiva and development of follicles (whitish inflammatory elevations) within the conjunctiva (Rabiu et al., 2012). Repeated bouts of inflammation from cycles of infection and reinfection results in scarring of the tarsal conjunctiva, forcing the eyelids and by extension the eye lashes to turn inwards (entropion and trichiasis). Inward turning of the lashes exposes the corneal epithelium and the conjunctival surface to

continuous touching and rubbing by the in-turned lashes. Without preventive surgery, and with continuous rubbing of the cornea by the stray lashes, the abrasions coupled with secondary infections of the cornea from the TT then leads to irreversible blindness (Hu et al., 2010; Burton & Marbey, 2009).

Despite projections in 2011 that blindness from trachoma will decrease significantly over a period of 5 years (Courtright & Lewallen, 2011), six years on, the condition still remains a major cause of avoidable vision loss and a significant public health problem in many parts of the world even though significant strides have been made to achieve the projected reduction in its prevalence. Trachoma is a disease that is known to be highly correlated with poverty, lack of personal and community hygiene, limited access to health care and water and for that matter it has been reported to be most prevalent in poor, under privileged communities of Sub-Saharan Africa, Asia, some parts of Latin America, the Middle East, the Western Pacific and in some deprived communities in Australia (Rabiu et al., 2012; Mariotti, Pascolini & Rose-Nussbaumer, 2009; Tellis, Keeffe & Taylor, 2006) where reports show that poverty, overcrowding, poor personal and environmental hygiene, inadequate water supply and low socio-economic status play favorable roles as well as serving as direct channels through which trachoma is transmitted from person to person (Ejere, Alhassan & Rabiu, 2015).

Although trachomatous blindness is untreatable, it is clearly preventable. WHO has decided to lead the effort to prevent avoidable blindness from trachoma by the year 2020. Efforts to eliminate trachoma, as a public health problem and a significant avoidable cause of blindness, have therefore revolved around a comprehensive approach recommended by the WHO known as the "SAFE" strategy (Emerson et al., 2006). For effective planning implementation and evaluation of trachoma elimination programmes, WHO has set out targets that must be achieved in terms of the prevalence

estimates of trachoma in the endemic districts so that programme implementers can know when to stop some aspects of the elimination strategy such as the Mass Drug Administration (MDA) campaigns, this the WHO termed Ultimate Intervention Goals (UIG) (WHO, 2003). However for the strategy to be effective, the distribution of trachoma must be known through district level prevalence surveys (WHO, 2013; Polack et al., 2005).

The prevalence of blindness in Nigeria is one of the highest in Africa with over 80% of blindness due to avoidable causes (Abdull et al., 2009). Inspite of this alarming rate of blindness in Nigeria, blindness prevalence data are available for only a few communities. This literature review is aimed at contextualizing the Global Trachoma Mapping (GTMP) survey conducted in Benue State Nigeria between April and September 2014 according to WHO stipulated standards (Solomon et a 2015) to produce data that will be used to generate prevalence estimates needed to plan elimination of trachoma in Benue state of Nigeria and also to further help complete the Global Atlas of Trachoma (GAT).

4.0. Individual and Environmental Risk Factors for Trachoma

4.1. Lack of potable water

One of the most sited reasons for trachoma transmission from lack of personal hygiene is the unavailability of potable water for basic household and personal use. There have been reports that lack of water sanitation and hygiene, to some extent favors trachoma transmission especially among vulnerable rural poor populations who do not also have the benefit of antibiotic treatment for *chlamydia trachomatis* infections (Traverse et al., 2013). Water scarcity may promote trachoma transmission owing to less water availability for households to use for face washing, washing of dirty cloths, washing of hands after visiting the latrine as well as for other personal hygiene

practices. Unclean environments provide more effective breeding sites for eye-seeking flies and also promotes festering of other conditions responsible for transmission of trachoma infection.

4.2. Distance to and type of water source

Another significant factor relating to water availability has to do with the distance to water source. It has been shown that families who walk more than 30 minutes distance to get water are more likely to have trachoma compared to those who embark on a less than 30 minutes' walk to water bodies to get their water (Ketema et al., 2012; Malhotra et al., 2016). The relationship between distance to water source and the prevalence of trachoma infection has been rather a controversial one. Several studies have indeed found an association between increased distance to water source and the prevalence of active disease (Taylor et al., 1989; West et al. 1989; Schémann et al. 2002; Ketema et al., 2012). However another study did not support that claim (West et al., 1991). According to reports by Hu et al, this finding may be explained by the presence of what they referred to as "water use plateau" "in which per capita water consumption between households often seems to be constant when the round trip to collect water is below a threshold of around 30 min". They therefore argued that the quantity of water brought into a household may be more important than the distance to water source (Hu et al., 2010).

4.3. Clean face

A recent study by Muluneh and colleagues posited that facial hygiene has a positive effect on the reduction of the risk of trachoma. They also noted that at least once a day facial Water, Sanitation and Hygiene (WaSH) practice with soap enhances the effectiveness of reducing trachoma risk (Muluneh, Zewotir & Bekele, 2016). Mengistu et al also found that facial cleanliness of children was significantly associated with trachoma so much so that those children with unclean faces were two times more likely to develop trachoma compared to those children with clean faces (Mengistu et al., 2016). Frequency of face washing has been associated with trachoma (Jip et al., 2008), even

though experts advocate washing face at least once a day, washing ones face at least twice per day was found to be more favorable in reducing trachoma compared to at least once.

4.4. Practice of good WaSH habits

To improve the standard of living of a population, supply of safe drinking Water, Sanitation and Hygiene (WaSH) are fundamental necessities. This has a direct bearing on several aspects of human life including the protection of health and the environment, which can lead to improved educational outcomes, greater convenience and socio-economic status (Hutton & Chase, 2016). It is often common for communities with high levels of poverty to have challenges with meeting the needs of WaSH. Good WaSH practices are essential in reducing the prevalence of infectious diseases including trachoma. For instance a study in Ethiopia has shown that in major towns where sanitation status and water supply is relatively better, the prevalence of active trachoma was very low (Berhane et al., 2007) while high prevalence of active trachoma was recorded in areas where water supply and sanitary conditions were poor.

4.5. Age

Age is also a significant determinant of trachoma infection (Shiferaw & Moges, 2013). Trachoma infection (TF) usually starts in childhood with age 4-6 known to be the age within which the greatest incidence rates of infection have been observed according to some studies (Ketema et al., 2012) while other studies cite age 1-5 as the most critical for trachoma infection (Asres et al., 2016). Children have been shown to be the most susceptible to trachoma infection due to their natural tendency for close contact activities and frequent face-rubbing (WHO, 2013). The predominance of trachoma within the 1-5 age bracket has been attributed to the fact that children within this age group are mainly preschool children who cannot care for themselves, they have more contacts, play close together and have little knowledge about practices that favor trachoma transmission (Asres et al., 2016). It is important to note that some studies have also reported age

6-10 as the most critical age group for trachoma infection (Goldschmid et al., 2007). Though these reports could be valid, they are however not consistent with the widely reported age group range of 1-5 (Edwards et al., 2012; Asres et al., 2016) and this may possibly be because these studies were not standard WHO studies hence the discrepancy in the findings.

4.6. Gender

Gender has always been a factor in the prevalence of trachoma. Several studies have reported extra burden of trachoma among women compared to men (Asres et al., 2016; Mengistu et al., 2016; Xue et al., 2016; Courtright et al., 1989). Studies showing the distribution of trachoma signs by gender indicate that active trachoma which includes both TF and TI is slightly more common among girls (13.5%) than in boys (12.4%) (Noatina et al., 2013).

In a review on the contribution of sex-linked biology and gender roles disparities in trachoma distribution, Courtright and West enumerated several factors that could explain the seemingly huge burden of TT among women compared to men (Courtright & West, 2004). Using research findings from Tanzania as well as other parts of the industrialized world, they examined a number of hypothesis on factors that make females biologically more susceptible to TT. Hormonal changes, heavy bacterial load, greater likelihood of persistent infections, higher possibility of conjunctival scaring, women's role as primary care givers to children as well as certain practices such as the use of Kohl among some Islamic women exposed them to frequent scaring of the tarsal conjunctiva and hence TT. It was however difficult to confirm or dispute some of these hypothesis due to lack of appropriate data and research findings.

4.7. Access to latrine

Limited access to latrines or distance of latrine from household increases the possibilities of fecal contamination of the environment thereby increasing the density and providing breeding material

for the fly *Musca sorbens*, which has been heavily implicated in trachoma transmission (Mengistu et al., 2016). Results from the study by Alemayehu and colleagues revealed that the odds of active trachoma among children who were from households without latrines were 4 times the odds of children from households without latrines (Alemayehu et al., 2015). Latrine access has been found to be associated with a lower risk of trachoma. In a recent study by Muhammad et al, access to latrine was found to be a significant protective measure against trachoma infection (Muhammad et al., 2015). The protective effect of latrine access on trachoma prevalence was attributed to the fact that with the availability of latrines there is constant removal of fecal material from the environment leading to a smaller fly population (Emerson et al., 2004; Hu et al., 2010). Using pit latrines for example may decrease the possibility of fly breeding in the area around the household and hence the fly density (Muluneh, Zewotir & Bekele., 2016). Several other studies have found this relationship between trachoma infection and latrine assess to be true (Abdou et al., 2007; Mpyet et al., 2012) while others found not so much significant association (Muluneh, Zewotir & Bekele., 2016). This discrepancy was explained by possible interaction and for that matter collinearity between the variables compared in the survey.

4.8. Vectors

The fly *Musca sorbens*, a vector of trachoma, has been known to prefer human feces and cattle dung as a breeding media (Alemayehu et al., 2015). The presence of flies on the face, among other findings like a dirty face, and the presence of animal dung in the compound of residence have also been found by Mpyet et al, to be independent risk factors for active trachoma among children in Kano State (Mpyet et al., 2012).

5.0. Control Initiatives and Strategies

According to King et al, the current threshold for intervention with the SAFE strategy at district level is a prevalence of trachomatous inflammation follicular (TF) in children 1–9 years old of ≥

10% (WHO, 2014). WHO also recommends a community-by-community approach to assessment and intervention for district-level prevalence of < 10%. They further suggested that the target prevalence by which mass antibiotic interventions to control trachoma can be ceased is < 5% TF. WHO has therefore encouraged countries to show a prevalence of < 5% TF for at least 3 years after interventions have ceased in order to achieve elimination status (WHO, 2014). For trachomatous trichiasis WHO stipulates the threshold to be a prevalence of TT "unknown to the health system" of less than 0.2% in adults aged 15 years and older (WHO, 2003).

The simplified grading system developed by Thylefors and colleagues has been very useful in trachoma elimination. According to the grade descriptions, Trachomatous inflammation – Follicular (TF) represents the presence of five or more follicles (each >0.5 mm in diameter) in the upper tarsal conjunctiva, Trachomatous inflammation – Intense (TI) is recorded if there is pronounced inflammatory thickening of the tarsal conjunctiva that obscures more than half of the deep normal vessels, similarly Trachomatous Scarring (TS) is the presence of scarring in the tarsal conjunctiva while Trachomatous Trichiasis (TT) represents the presence of at least one lash rubbing on the eyeball and lastly Corneal Opacity (CO) represents an easily visible corneal opacity over the pupil (Fig 1. Appendix F) (Thylefors et al. 1987)

5.1. Vision 2020

Vision 2020 "The right to sight" is a global initiative launched in 1999 by the WHO. The initiative was a joint programme of the WHO and the International Agency for the Prevention of Blindness (IAPB) aimed at eliminating all avoidable causes of blindness by the year 2020 (WHO/IAPB, 1999). WHO sees vision as a fundamental human right and therefore believes all persons should be able to receive quality affordable eye care and have the right to sight. The goal of Vision 2020 was therefore to enable individuals to access vision as a critical component of their fundamental

human rights (Muhammad & Adamu, 2014). Reports by Muhammad and Adamu has shown how the VISION 2020 initiative has been beneficial in raising awareness concerning blindness (Muhammad & Adamu, 2014).

5.2. Global alliance for the Elimination of Trachoma (GET 2020)

In 1999, the World Health Assembly of the WHO passed a resolution to galvanize efforts in order to eliminate preventable blindness from trachoma by the year 2020 (WHO, 2012). This led to the launch of the initiative that has come to be known as Global Alliance for the Elimination of blinding Trachoma by the year 2020 (GET 2020) (Emerson et al., 2006). The GET 2020 initiative was championed by the WHO and the IAPB, a consortium of non-governmental organizations and the health services of member countries. It consists of over 32 signed-up and committed member countries who meet annually to assess and discuss progress and also share new research developments and techniques that could then be translated into policy and practice to further promote the course of the initiative in member countries. The organizations have therefore endorsed, recommended and promoted an integrated strategy known as the "SAFE" strategy aimed at treating and preventing trachoma from causing unnecessary blindness. The SAFE strategy is a comprehensive programme consisting of the following control measures: Surgery for entropion/TT; Antibiotics for infectious trachoma; Facial cleanliness to reduce transmission; and Environmental changes such as control of disease-spreading flies and access to clean water and latrine (WHO, 2012).

6.0. Trachoma Burden in Africa

The burden of blindness in Sub-Saharan Africa has been touted to be the greatest of all the other regions of the world. It is reported that the region contains less than 10% of the world's population, yet about 20% of the world's blind are located in the region (Thylefors et al., 1995; Yalew, Mekonnen & Jemaneh, 2012). In going through the literature, a number of studies have reported

on blindness within the African region. Studies in Cameroon have suggested that blindness prevalence in persons 40 years and above was between 1.1% to 1.4% (Oye et al., 2006). Similarly, reports from blindness surveys in Kenya have indicated a blindness prevalence in persons 50 years and above to be 2.0% (Mathenge et al., 2007). Lawan et al conducted a blindness prevalence survey in northern Nigeria, and found a blindness prevalence among all age groups to be 1.14% (Lawan et al., 2002) while in a previous study by Rabiu and colleagues among persons 40 years and above, the prevalence was 8.2% (Rabiu, 2001). Blindness prevalence in southern Nigeria though lower, its impact becomes more significant when considered among whole populations. The prevalence of blindness range from 9% in rural southern –western Nigerian populations (Adeoye, 1996) to 1.2% (Adeoti, 2004) in tropical African populations. In a sharp contrast to the situation of blindness in the African region, countries with established market economies account for 15% of the global population but only 6% of the world's blind can be found in these populations (Thylefors et al., 1995; Yalew, Mekonnen & Jemaneh, 2012).

Not only is the burden of blindness in the sub-Saharan African region the worst in the world but also reports show that 75% of all blindness in mostly developing countries in this region are from preventable diseases such as trachoma which can either be prevented or cured (Mengistu et al., 2016). In fact reports by Polack et al suggest that in the Sahel region, 100% of blindness observed was avoidable (Polack et al., 2005). It is further reported that more than half of all the districts that are suspected to be trachoma endemic are in Ethiopia and Nigeria alone (Kalua et al., 2014).

In Ethiopia, for instance the national prevalence of active trachoma for children between ages 1-9 was 40.1% (Berhane et al., 2007). National prevalence of TT was 3.1% among persons 15 years and above. Additional mapping surveys done in Nigeria (Mpyet et al., 2012; Mpyet, Ogoshi & Goyol, 2008; King et al., 2009), Ethiopia (Ketema et al., 2012), Cameroun (Noatina et al., 2013),

Mali (Schémann et al., 1998), South Sudan (Edwards et al., 2012), North Western Ethiopia (Shiferaw & Moges, 2013), Guinea Bissau (Last et al., 2014) and in Malawi (Kalua et al., 2015) have all shown high trachoma prevalence rates especially for TF among children 1-9 years old, with TT prevalence almost always being less than 3% in these countries except in the case of Eastern Equatorial and Upper Nile States of Southern Sudan where a study by Ngondi et al reported an overall TT prevalence among persons 15 years and above of 9.2% in 2005. The highest TT prevalence of 17.0% was found in one of the study communities (Ngondi et al., 2005).

7.0. Gaps in knowledge and Conclusion

The literature review has unearthed a number of challenges that befall trachoma elimination initiatives and most have to do with contradictions and inconsistencies in the evidence base especially with reference to the risk factors for the disease. For example while some studies have suggested that trachoma, both TF and TT are more common in women (Asres et al., 2016; Mengistu et al., 2016; Xue et al., 2016; Cromwell et al., 2009; Mpyet, Ogoshi & Goyol, 2008), other studies such as one by Malhotra et al suggest that there was no sex predilection for presence of TF and TT (Malhotra et al., 2016). Indeed some other studies have also found no gender differences in prevalence of active trachoma (Harding –Esch et al., 2008). Additionally Berhane et al in their national survey of blindness in Ethiopia found no marked gender difference in the prevalence of active trachoma (Berhane et al., 2007). Other studies found no such gender difference in trachoma prevalence among adults except among children below 10 years of age (Ngondi et al., 2005).

Another challenge observed through this review was the fact that most of the studies reporting on trachoma were observational studies. Though most of these observational studies especially on the environmental interventions for reducing trachoma infection in communities, suggested a potential

benefit, they most often suffer several validity challenges (Rabiu et al., 2012) while some recent studies also produced inconsistent results (Ejere, Alhassan & Rabiu, 2015).

Adequate knowledge of trachoma prevalence at district level is particularly important in planning the national trachoma control program in order to achieve the goal of eliminating trachoma as a blinding disease by year 2020 (Ngondi et al., 2013). From the review, it was evident that further studies are needed in many areas to bridge this knowledge gap.

With respect to the risk factors for trachoma, the evidence base is not unanimous hence the need to conduct further studies with standard WHO guidelines to be able to generate credible evidence to add to the already existing evidence. For example in terms of latrine use to control fly density to reduce trachoma infection, despite evidence from some studies suggesting that the implementation of a household latrine promotion project is acceptable, feasible and has potential to control trachoma prevalence (Diallo et al., 2007), a systematic review by Rabiu et al., found that several studies on latrine provision as a fly control measure did not demonstrate any significant trachoma reduction potential (Rabiu et al., 2012). A similar study by Haile et al also came to similar conclusions (Haile et al., 2013). In the review by Rabiu et al, apart from the reports on latrine provision as a fly control mechanism, other hygiene and environmental factors were also reviewed and were found to be insignificant in controlling trachoma. The reports on health education and its effectiveness in eliminating trachoma was contradictory between studies reviewed.

Studies by Kalua et al found that hygiene and environmental factors were not significant in controlling trachoma prevalence (Kalua et al., 2014) indeed with regards to risk factors for trachoma, only the presence of a dirty face was associated with TF in this study. It is however important to note that in most of these studies with negative results, serious challenges were raised about sample size. For example in one of such studies, the latrine survey was performed in a sample

of 10 households per community, reducing the certainty of the latrine use estimates (Haile et al., 2013).

While experts are advocating for action from governments, NGOs, private sector and all other health professionals to support and expand the SAFE strategy to combat trachoma, (Mariotti, Pascolini, Rose-Nussbaumer, 2009), the evidence upon which these stakeholders can make decisions on trachoma elimination is significantly lacking.

In order to develop more robust estimates of the burden of trachoma, there needs to be a coordinated effort to conduct population-based surveys with a national sampling frame in representative countries from endemic regions (Burton, & Mabey, 2009).

Despite the wealth of evidence on the prevalence and risk factors for trachoma, many of the studies that adduced these evidence had some limitations in various departments such as their conduct, method of analysis, method and criteria for sample size selection (King et al., 2009) period of study conduct, time of day study was conducted, overall participation rate (Noatina et al., 2013) and other factors that impacted on the results of the studies. This variability in quality and methodology, made it difficult for all studies to be compared to ascertain the quality of the evidence (Smith et al., 2013; Polack et al., 2005). For instance for studies that reported on the availability of water and its impact on trachoma prevalence, the results could not be said to be a true representation of the situation if the study was done in the rainy season when it is likely to rain and therefore make water readily available in this period when in actual fact there may be significant challenges with water in the dry season in such a study area (Rog et al., 2011).

In the survey in Jigawa state the study was limited by the lack of full population data on sex and age, which did not allow for calculation of age-sex adjusted prevalence values for the study

population (Ramyil et al., 2015). Another factor that can affect participation for any trachoma survey is the time of day the study is done. Pre-school children are more likely to be sampled if a study is done at a time of the day when most children of school going age are likely to be in school. Studies done on farm days in certain communities are likely to miss out on adults above 15 years because they may be on their farms at the time the study will be conducted. These scenarios can create a potential for over estimation of TF and TT prevalence if many persons under age 15 or more persons over the age 15 respectively were not present at home to be examined (Ngondi et al., 2005).

Some studies also used small and variable (Polack et al., 2005) sample sizes leading to wide confidence intervals and hence imprecise estimates in addition to the fact that very important confounding factors were not considered or inadequately controlled for (Muhammad et al., 2015) as well as some studies using non-random sampling techniques leading to results not being representative of the entire population (Agarwal et al., 2016).

With respect to the association between water and trachoma prevalence, the review revealed that lack of evidence of the association between water access and trachoma may be due to the low number of available studies (Stocks et al., 2014). Low coverage was a challenge in some studies (Mpyet, Ogoshi & Goyol, 2008). A situation which can significantly affect the validity of the results of the studies. The GTMP provided an opportunity for standard WHO recommended surveys to be conducted with mechanisms and procedures that will invariably rise above some of the numerous challenges unearthed in the review of the existing literature. One such surveys was conducted in Benue state of Nigeria on which bases this current study is being conducted.

In respect of the above mentioned challenges and gaps in the literature relating to trachoma prevalence and its risk factors, this study is being conducted with the main objectives of

determining the prevalence of trachoma and the common risk factors associated with the disease in Benue State, Nigeria.

8.0 References

1. Abdou, A., Nassirou, B., Kadri, B., Moussa, F., Munoz, B. E., Opong, E. & West, S. K. 2007. Prevalence and risk factors for trachoma and ocular *Chlamydia trachomatis* infection in Niger. *British Journal of Ophthalmology*. 91(1): 13- 17. DOI: 10.1136/bjo.2006.099507.

2. Abdull, M. M., Sivasubramaniam, S., Murthy, G. V. S., Gilbert, C., Abubakar, T., Ezelum, C. & Rabiu, M. M. 2009. Causes of Blindness and Visual Impairment in Nigeria: The Nigeria national blindness and visual Impairment Survey. *Clinical and Epidemiologic Research.* 50(9):4114-4120. Available: http://iovs.arvojournals.org/article.aspx?articleid=2186207 [2017, May 1].

3. Adeoti, C. O. 2004. Prevalence and causes of blindness in a tropical African population. [Abstract]. *West African Journal of Medicine*. 23: 249-252. Available: https://www.ncbi.nlm.nih.gov/pubmed/15587840 [2017, May 13].

4. Adeoye, A. 1996. Survey of blindness in rural communities of South-Western Nigeria. *Tropical Medicine & International Health*. 1(5): 672-676. DOI: 10.1111/j.1365-3156.1996.tb00093.x.

5. Alemayehu, M., Koye, N. D., Tariku, A. & Yimam, K. 2015. Prevalence of Active Trachoma and its associated factors among rural and urban children in Dera Woreda, North-west Ethiopia: A Comparative Cross-Sectional Study. *Bio- Medical Research*

International. 2015 (2015): 1-8. Available: http: http://dx.doi.org/10.1155/2015/570898 [2016, July 13].

6. Agarwal, A., Rakesh, M., Nandeswa, S. & Prasad, P. 2016. A clinico-epidemiological study of trachoma in urban and rural population of Sagar District Madhya Pradesh, India. *Community Acquired Infection*. 3(1):1-10. Available: http://www.caijournal.com/ [2016, December 16].

7. Asres, M., Endeshaw, M. &Yeshambaw, M. 2016. Prevalence and risk factors of Active Trachoma among children in Gondar Zuria District North Gondar, Ethiopia. *Insight Medical Publishing Journals*. 1(5): 1-9. Available: http://preventivemedicine.imedpub.com/ [2016, July 10].

8. Berhane, Y., Worku, A., Bejiga, A., Adamu, L., Alemayehu, W., Bedri, A., Haile, Z., Ayalew, A. et al. 2007. Prevalence and causes of blindness and low vision in Ethiopia. *Ethiopia Journal of Health Development*. 21(3): 204-210. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.574.3501&rep=rep1&type=pdf [2016, July 11].

9. Burton, M.J. & Mabey, D.C.W. 2009. The Global burden of Trachoma: a review. *PLoS Neglected Tropical Diseases*. 3 (10):e460. DOI: http://dx.doi.org/10.1371/journal.pntd.0000460.

10. Courtright, P. & Lewallen, S. 2011. Global Blindness 2010: What do we know? [Abstract]. *Expert Review of Ophthalmology*. 6 (3): 385-392. DOI: http://dx.doi.org/10.1586/eop.11.24.

11. Courtright, P., Sheppard, J., Schachter, J., Dawson C. R. 1989. Trachoma and blindness in the Nile Delta: Current patterns and projections for the future in the rural Egyptian population. British Journal of Ophthalmology. 73(7):536-40. DOI:10.1136/bjo.73.7.536.

12. Courtright P. & West S. K., 2004. Contribution of Sex-linked Biology and gender roles to disparities with Trachoma. Emerging Infectious Diseases. 10(11): 2012–2016. DOI: 10.3201/eid1011.040353.

13. Cromwell, E. A., Courtright, P., King, J. D., Rotondo, L. A., Ngondi, J. & Emerson, P. M., 2009. The excess burden of trachomatous trichiasis in women: a systematic review and meta-analysis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 103(10): 985- 992. DOI:10.1016/j.trstmh.2009.03.012.

14. Diallo, M. O., Hopkins, D. R., Kane, M. S., Niandou, S., Amadou, A., Kadri, B., Amza, A., Emerson, P. M. & Zingeser, J. A. 2007. Household latrine use, maintenance and acceptability in rural Zinder, Niger. *International Journal of Environmental Health Research*. 17(6): 443 – 452. Available: https://www.ncbi.nlm.nih.gov/pubmed/18027197 [2017, May 13].

15. Edwards, T., Smith, J., Sturrock, H.J.W., Kur, L.W., Sabasio, A., Finn, T.P., Lado, M., Haddad, D. & Kolackzinsky, J. H. 2012. Prevalence of Trachoma in Unity State, South Sudan: Results from a Large-Scale Population-Based Survey and potential implications for further surveys. *PLoS Neglected Tropical Diseases*. 6(4): e1585. DOI:10.1371/journal.pntd.0001585.

16. Emerson, P. M., Lindsay, S. W., Alexander, N., Bah, M., Dibba, S. M., Faal, H. B., Lowe, K. O., McAdam, K. P. et al. 2004. Role of flies and provision of Latrines in

trachoma control: Duster Randomized Controlled Trial. *Lancet*. 363(9415):1093-8. DOI:10.1016/S0140-6736(04)15891-1.

17. Emerson, P. M., Burton, M., Solomon, A. W., Bailey, R. & Mabey, D. 2006. The SAFE strategy for Trachoma control: Using Operational Research for Policy Planning and Implementation. *Bulletin of the World Health Organization*. 84:613-619. Available: http://www.who.int/bulletin/volumes/84/8/05-028696.pdf [2016, July 19].

18. Ejere, H. O.D., Alhassan, M. B. & Rabiu, M. 2015. Face washing promotion for preventing active trachoma. *Cochrane Database of Systematic Reviews*. 2015 (2): 1-27. DOI: 10.1002/14651858.CD003659.pub4.

19. Goldschmidt, P., Zago, V. V., Vargas, L. D., Garcia, L. E, Montoya, C. M., Peralta, B. & Mercado, M. 2007. Chlamydia Trachomatis in the conjunctiva of children living in the three rural areas in Mexico. *Rev Panam Salud Publica*. 22(1):29-34. Available: http://dx.doi.org/10.1590/S1020-49892007000600004 [2017, May 1].

20. Haile, M., Tadesse, Z., Gebreselassie, S., Ayele, B., Gebre, T., Yu, S. Y., Stoller, N. E., Gaynor, B. D. et al. 2013. Short Report: The Association between Latrine use and Trachoma: A Secondary Cohort Analysis from a Randomized Clinical Trial. *American Journal of Tropical Medicine & Hygiene.* 89(4):717–720. DOI: 10.4269/ajtmh.13-0299.

21. Harding-Esch, E. M., Edwards, T., Sillah. A., Sarr-Sissoho, I., Aryee, E. A., Snell, P., M.J. Holland, M. J., Mabey, D. C. 2008. Risk factors for active trachoma in the Gambia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 102(2): 1255–1262. DOI: 10.1016/j.trstmh.2008.04.022.

22. Hu, V. H., Harding-Esch, E. M., Burton, M.J., Bailey, R. L., Kadimpeul, J. & Mabey, D.C.W. 2010. Epidemiology and control of trachoma: systematic review. *Tropical Medicine and International Health*. 15 (6): 673–691. DOI :10.1111/j.1365-3156.2010.02521.x

23. Hutton, G. & Chase, C. 2016. The Knowledge Base for Achieving the Sustainable Development Goal Targets on Water Supply, Sanitation and Hygiene. *Review. International Journal of Environmental Research and Public Health.* 2016(13):1-35. DOI: 10.3390/ijerph13060536.

24. Kalua, K., Isaac Singini, I., Mukaka, M., Msyamboza, K., Masika, M. & Bailey, R. 2014.Scaling up of trachoma mapping in Salima district, Central Malawi. *International Journal of Tropical Diseases & Health.* 4(5) 494-508. Available: http://dx.doi.org/10.4236/health.2014.61009 [2016, July 21].

25. Kalua, K., Phiri, M., Kumwenda, I., Masika, M., Pavluck, A. L., Willis, R., Mpyet, C., Lewallen, S. et al. 2015. Baseline Trachoma Mapping in Malawi with the Global Trachoma Mapping Project (GTMP). *Ophthalmic Epidemiology*. 22(3): 176–183. DOI: 10.3109/09286586.2015.1035793.

26. Ketema, K., Tiruneh, M., Woldeyohannes, D. & Muluye, D. 2012. Prevalence of active trachoma and associated risk factors among children less than ten years in Baso Liben district, East Gojjam, Ethiopia. *Bio Medical Central, Public Health.* 2012 12:1105. DOI: 10.1186/1471-2458-12-1105.

27. King, J. D., Eigege, A., Richards, F. J., Jip, N., Umaru, J., Deming, M., Miri, E., McFarland, D. & Emerson, P.M. 2009. Integrating NTD Mapping Protocols: Can

Surveys for Trachoma and Urinary Schistosomiasis be done simultaneously? *American Journal of Tropical Medicine Hygiene*. 81(5): 793–798. DOI:10.4269/ajtmh.2009.09-0236.

28. King, D., Jip, N., Jugu Y. S., Othman, A., Rodgers, A. F., Dajom, D. Y., Miri, E. & Emerson P. M. 2010. Mapping Trachoma in Nasarawa and Plateau States, Central Nigeria. *British Journal of Ophthalmology*. 15(3):306-11. DOI:10.1136/bjo.2009.165282.

29. King, J. D., Teferi, T., Cromwell, E. A., Zerihun, M., Ngondi, J. M., Damte, M., Ayalew, F., Tadesse, Z., et al. 2014. Prevalence of Trachoma at Sub-District Level in Ethiopia: Determining when to stop Mass Azithromycin distribution. *PLoS Neglected Tropical Diseases*. 8 (3): e2732. DOI:10.1371/journal.pntd.0002732.

30. Kuper, H., Solomon, A. W, Buchan, J., Zondervan, M., Foster, A. & Mabey, D. 2003. A critical review of the SAFE strategy for the prevention of blinding trachoma. [Abstract]. *Lancet Infectious Diseases 3(6):372–381.* Available: https://www.ncbi.nlm.nih.gov/pubmed/12781509 [2017, May 15].

31. Last, A.R., Burr, S.E., Welss, H. A., Harding-Esch, E. M., Cassama, E., Nabicassa, Meno., Marbey, D.C., Holland, M. J. & Bailey, R. L. 2014. Risk factors for active trachoma and ocular chlamydia trachomatis infection in Treatment-Naive trachoma hyper-endemic communities of the Bijagos Archipelago, Guinea Bissau. *PloS Neglected Tropical Diseases*. 8(6): e2900. DOI: 10.1371/journal.pntd.0002900.

32. Lawan, A. 2002. Prevalence and causes of blindness and visual impairment in Dambatta Local Government Area of Kano state, Nigeria. *Nigeria Journal of Medicine*.11 (3):108-12. Available: https://www.ncbi.nlm.nih.gov/pubmed/12221951.

33. Malhotra, S., Vashist, P., Gupta, N., Kalaivani, M., Satpathy, G., Shah, A., Krishnan, S., & Azad, R. 2016. Prevalence of Trachoma in Car-Nicobar Island, India after three annual rounds of Mass Drug Administration with Azithromycin. *PLoS ONE*. 11(7): e0158625. DOI:10.1371/journal.pone.0158625.

34. Mariotti, S. P., Pascolini, D. & Rose-Nussbaumer, J. 2009. Trachoma: Global magnitude of a preventable cause of blindness. *British Journal of Ophthalmology*. 2009 (93): 563–568. DOI:10.1136/bjo.2008.148494.

35. Mathenge, W., Kuper, H., Limburg, H., Polack, S., Onyango, O., Nyaga, G. & Foster, A. 2007. Rapid assessment of avoidable blindness in Nakuru district, Kenya. [Abstract]. *Ophthalmology*. 114(3): 599-605. DOI: http://dx.doi.org/10.1016/j.ophtha.2006.06.057.

36. Mengistu, K., Shegaze, M., Woldemichael, K., Gesesew, H. & Markos, Y. 2016. Prevalence and factors associated with trachoma among children aged 1–9 years in Zala district, Gamo Gofa Zone, Southern Ethiopia. *Clinical Ophthalmology*. 2016 (10): 1663–1670. DOI: 10.2147/OPTH.S107619.

37. Mpyet, C., Ogoshi, C & Goyol, M. 2008. Prevalence of trachoma in Yobe State, North-Eastern Nigeria. *Ophthalmic Epidemiology*. 15(5): 303–307. DOI: 10.1080/09286580802237633.

38. Mpyet, C., Odugbo, P., Adenuga, O., Velle, L. & Nyonkyes, A. 2010. Prevalence and Causes of Blindness and Visual Impairment in Plateau State, Nigeria. *TAF Preventive Medicine Bulleting*. 9(5):401-406. Available: http://www.scopemed.org/?mno=1854 [2017, May 13].

39. Mpyet, C., Lass, B.D., Yahaya, H.B. & Solomon, A.W. 2012. Prevalence of and risk factors for Trachoma in Kano State, Nigeria. *PLoS One*. 7(7):1-6. DOI:10.1371/journal.pone.0040421.

40. Mpyet, C., Muhammad, N., Adamu, M.D., Muazu, H., Umar, M.M., Goyol, M. Yahaya, H. B. Onyebuchi, U. 2017. Prevalence of Trachoma in Kano State, Nigeria: Results of 44 Local Government Area-Level Surveys. *Ophthalmic Epidemiology*. 24(3): 195-203. Available: http://dx.doi.org/10.1080/09286586.2016.1265657 [2017, May 13].

41. Muhammad, N., Mansur, R., Dantani, A., Elhassan, E. & Isiyaku, S. 2011. Prevalence and causes of blindness and visual impairment in Sokoto State, Nigeria: Baseline data for Vision 2020: The right to sight eye care programme. *Middle East African Journal of Ophthalmology*. 18(2): 123. Available: http://www.meajo.org/ [2016, December 26].

42. Muhammad, N. & Adamu, M. D. 2014. Making a difference with Vision 2020: The Right to Sight? Lessons from two states of North Western Nigeria. *Nigerian Journal of Clinical Practice.* 17(6):723-8. DOI: 10.4103/1119-3077.144385.

43. Muhammad, N., Damina, M., Umar, M.M. & Isiyaku, S. 2015. Trachoma prevalence and risk factors in eight local government areas of Zamfara State. *Nigerian Journal of Ophthalmology*. 23(2):48 -53. DOI:10.4103/0189-9171.170989.

44. Muluneh, E. K., Zewotir, T. & Bekele, Z. 2016. Rural children active trachoma risk factors and their interactions. *Pan African Medical Journal. 2016. 24:128.* DOI:10.11604/pamj.2016.24.128.8790.

45. Ngondi, J., Onsarigo, A., Adamu, L., Matende, I., Baba, S., Reacher, M., Emerson, P. & Zingeser, J. 2005. The epidemiology of trachoma in Eastern Equatorial and Upper Nile States, southern Sudan. *Bulletin of the World Health Organization*. 83 (12):904- 912. Available: DOI: http://dx.doi.org/10.1590/S0042-96862005001200012 [2017, May 10].

46. Ngondi, J., Ole-Sempele, F., Onsarigo, A., Matende, I., Baba, S., Reacher, M., Matthews, F., Carol Brayne, C. et al. 2006. Prevalence and causes of blindness and Low Vision in Southern Sudan. *PLoS Medicine*. 3(12): e477. DOI: 10. 1371/journal.pmed.0030477.

47. Noa Noatina, B., Kagmeni, G., Mengouo, M. N., Moungui, H. C., Tarini, A., Zhang, Y. & Bella, A. L. F. 2013. Prevalence of Trachoma in the Far North Region of Cameroon: Results of a survey in 27 Health Districts. *PLoS Neglected Tropical Diseases*. 7(5): e2240. DOI:10.1371/journal.pntd.0002240.

48. Oye, J. E., Kuper, H., Dineen, B., Befidi-Mengue, R. & A Foster, A. Prevalence and causes of blindness and visual impairment in Muyuka: A rural health district in south west province, Cameroun. *British Journal of Ophthalmology*. 90(5): 538-542. DOI: 10.1136/bjo.2005.082271.

49. Pascolini, D. & Mariotti, S. P. 2011. Global estimates of visual impairment: 2010. *British Journal of Ophthalmology*. 96 (5):614–618. DOI: 10.1136/bjophthalmol-2011-300539.

50. Polack, S., Brooker, S., Kuper, H., Mariotti, S., Mabey, D. & Foster, A. 2005. Mapping the global distribution of trachoma. *Bulletin of the World Health Organization.*83 (12): 913-919. Available: http://www.who.int/bulletin/volumes/83/12/913.pdf [2016, July 9].

51. Rabiu, M. M. 2001. Cataract blindness and barriers to uptake of cataract surgery in a rural community of northern Nigeria. *British Journal of Ophthalmology*. 85(7): 776-780. Available: http://bjo.bmj.com/content/85/7/776 [2017, May 13].

52. Rabiu, M. M. & Abiose, A. 2001. Magnitude of trachoma and barriers to uptake of lid surgery in a rural community of Northern Nigeria. *Ophthalmic Epidemiology*. 8(2-3):181-790. Available: http://www.ph.ucla.edu/epi/rapidsurveys/ophthalmicepid8(2_3)_181_190_2001.pdf [2016, July 17].

53. Rabiu, M., Alhassan, M. B., Ejere, H. O. D, Evans, J. R. 2012. Environmental sanitary interventions for preventing active trachoma. *Cochrane Database of Systematic Reviews.* 2012 (2). Art. No.: CD004003. DOI: 10.1002/14651858.CD004003.pub4.

54. Ramadhani, A. M., Derrick, T., Macleod, D., Holland, M. J & Burton, M. J. 2016. The relationship between active trachoma and ocular *Chlamydia trachomatis* infection before and after Mass Antibiotic Treatment. *PLoS Neglected Tropical Diseases* 10 (10): e0005080. DOI:10.1371/journal.pntd.0005080.

55. Ramyil, A., Wade, P., Ogoshi, C., Goyol, M., Adenuga, O., Dami, N. & Mpyet, C. 2015. Prevalence of Trachoma in Jigawa State, Northwestern Nigeria. *Ophthalmic Epidemiology*. 22(3):184–189. DOI:10.3109/09286586.2015.1037399.

56. Resnikoff, S., Pascolini, D., Etya'ale, D., Kocur, I., Pararajasegaram, R., Pokharel, G. P. & Mariotti, S. P. 2002. Global data on Visual Impairment in the year. *Bulletin of the World Health Organization.* 82:844-851. Available: http://www.who.int/bulletin/volumes/82/11/en/844.pdf [2016, July 9].

57. Rog, M., Swenor B., Cajas-Monson, L. C., Mchiwe, W., Kiboko, S., Harran Mkocha, H., & West, S. 2011. A cross-sectional survey of water and clean faces in trachoma endemic communities in Tanzania. *Bio-Medical Central Public Health*. 11:495. Available: http://www.biomedcentral.com/1471-2458/11/495 [2017, May 10].

58. Schémann, J. F., Sacko, D., Banou, A., Bamani, S., Boré, B., Coulibaly, S & El Mouchtahide, A. M. 1998. Cartography of trachoma in Mali: results of a national survey. *Bulletin of the World Health Organisation*.76 (6):599-606. Available: http://europepmc.org/abstract/med/10191556 [2016, July 12].

59. Schémann, J. F., Sacko, D., Malvy, D., Momo, G., Traore, L., Bore, O., Coulibaly, S. & Banou, A. 2002. Risk factors for trachoma in Mali. *International Journal of Epidemiology*. 31(1):194-201. Available: DOI: https://doi.org/10.1093/ije/31.1.194. [2017, May 10].

60. Shiferaw, D. & Moges, H. 2013. Risk factors for active trachoma among children aged 1-9 years in Maksegnit town, Gondar Zuria District, Northwest Ethiopia. *Saudi Journal for Health Sciences.* 2(3): 202-206. Available: http://www.saudijhealthsci.org/aboutus.asp [2016, May 11].

61. Smith, L., Flueckiger, R. M., Hooper, P. J., Polack, S., Cromwell, E. A., Palmer, S. L., Emerson, P.M. & Mabey, D. C. W. 2013. The geographical distribution and burden of trachoma in Africa. *PLOS Neglected Tropical Diseases*. 7(8): e2359. Available: https://doi.org/10.1371/journal.pntd.0002359 [2017, May 12].

62. Solomon, A. W., Holland, M. J., Burton, M. J., West, S. K., Alexander, N. D., Aguirre, A., Massae, P. A. & Mkocha, H. 2003. Strategies for control of trachoma: observational

study with quantitative PCR. *Lancet.* 362(9379):198-204. DOI:10.1016/S0140-6736(03)13909-8.

63. Solomon, A. W., Pavluck, A. L., Courtright, P., Abo, A., Adamu, L., Alemayehu W., Alemu, M. Alexander N.D.E et al. 2015. The Global Trachoma Mapping Project: Methodology of a 34-Country Population-Based Study. *Ophthalmic Epidemiology*. 22(3): 214–225. DOI: 10.3109/09286586.2015.1037401.

64. Stocks, M. E., Ogden, S., Haddad, D., Addiss, D. G., McGuire, C. & Freeman, M.C. 2014. Effect of Water, Sanitation, and Hygiene on the prevention of Trachoma: A Systematic review and Meta-Analysis. *PLoS Medicine.* 11(2): e1001605. DOI:10.1371/journal.pmed.1001605.

65. Taylor, H. R., West, S. K., Mmbaga, B. B., Katala, S. J., Turner, V., Lynch, M., Muñoz, B. & Rapoza, P. A. 1989. Hygiene factors and increased risk of trachoma in central Tanzania [Abstract]. *Archives of Ophthalmology*. 107(12):1821-5. Available: https://www.ncbi.nlm.nih.gov/pubmed/2597076 [2017, May 10].

66. Tellis, B., Keeffe, J. E. & Taylor, H. R. 2006. Surveillance report for Active Trachoma. *National Surveillance and Reporting Unit, Annual Report*. 31 (4) 366-374. Available: http://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdi3104-pdf-cnt.htm/$file/cdi3104b.pdf [2016, July 10].

67. Thylefors, B., Dawson, C. R., Jones B. R., West, S. K. & Taylor, H. R. 1987. A simple system for the assessment of Trachoma and its complications. *Bulletin of the World Health Organization*. 65 (4): 477-483.

Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2491032/pdf/bullwho00075-0054.pdf [2016, July 10].

68. Thylefors, B., Négrel, A. D., Pararajasegaram, R. & Dadzie, K. Y.1995. Global data on blindness. *Bulletin of the World Health Organization*. 73 (1):115-21. Available: https://www.ncbi.nlm.nih.gov/pubmed/7704921 [2017, May 11].

69. Traverse, A., Strasser, S., Palmer, S. L. & Stauber, C. 2013. The added value of Water, Sanitation, and Hygiene interventions to Mass Drug Administration for reducing the prevalence of Trachoma: a Systematic Review. *Journal of Environmental and Public Health*. 2013(2013): 1-10. Available: DOI: http://dx.doi.org/10.1155/2013/682093 [2017, May 10].

70. West, S., Congdon, N. S. & Mele, L. 1991. Facial cleanliness and risk of trachoma in families. *Archives of Ophthalmology*. 109(6):855-7. Available: https://www.ncbi.nlm.nih.gov/pubmed/2043075 [2017, May 10].

71. West, S. K., Bailey, R., Munoz, B., Edwards, T., Mkocha, H., Gaydos, C., Lietman, T., Porco, T. et al. 2013. A randomized trial of two coverage targets for mass treatment with Azithromycin for trachoma. *Plos. Neglected Tropical Diseases*. 7(8): e2415. DOI: 10.1371/journal.pntd.0002415.

72. WHO/IAPB. 1999. VISSION 2020 "The right to sight". Available: https://www.iapb.org/vision- 2020 [2017, May 5].

73. World Health Organization (WHO). 2003. Report of the 2nd Global Scientific Meeting on Trachoma. Geneva, 25-27. Available:

http://www.who.int/blindness/2nd%20GLOBAL%20SCIENTIFIC%20MEETING.pdf. [2018, June 5].

74. World Health Organization (WHO). 2010. Report of the 3rd global scientific meeting on trachoma, Johns Hopkins University, Baltimore, MA. 19–20, July 2010. Geneva: *WHO Press.* 1-19. Available: http://www.who.int/blindness/publications/WORLDHEALTHORGANIZATIONGSMmtgreportFINALVERSION.pdf. [2017, MAY 15].

75. World Health Organization (WHO). 2012. Global WHO Alliance for the Elimination of Blinding Trachoma by 2020: Progress report on elimination of trachoma. *Weekly epidemiological record*. 87(17): 161–168. Available: http://www.who.int/wer [2017, May 11].

76. World Health Organization (WHO). 2013. Global Alliance for the Elimination of Blinding Trachoma by 2020: Progress report on elimination of trachoma. *Weekly Epidemiological Record*. 88 (24):241–256. Available: http://www.who.int/wer [2017, May 1].

77. World Health Organization (WHO). 2014. Key Trachoma Facts and Statistics. International Coalition for Trachoma Control. *Weekly Epidemiological Records.* Available: http://www.trachomacoalition.org/trachomastatistics [2016, July 11].

78. World Health Organization (WHO). Meeting Report: Technical consultation on trachoma surveillance. 2014. Decatur, USA. Geneva: *WHO.* Available: http://www.who.int/trachoma/resources/who_htm_ntd_2015.02/en/ [2017, September 4].

79. World Health Organization (WHO). Alliance for the Global Elimination of Trachoma by 2020. 2016. Eliminating Trachoma: Accelerating Towards 2020. *WHO Alliance for GET2020 Database*. Available: www.trachomacoalition.org/GET2020.

80. World Health Organization (WHO). 2017. Morocco eliminates trachoma – the leading infectious cause of blindness. Available: http://www.emro.who.int/media/news/morocco-eliminates-trachoma-the-leading-infectious-cause-of-blindness.html [2017, May 15].

81. Xue, W., Lu, L., Zhu, J., He, X., He, J., Zhao, R. & Zou, H. 2016. A Cross-Sectional Population-Based Survey of Trachoma among Migrant School-Aged children in Shanghai, China. *BioMed Research International*. 2016: 1-8. Available: http://dx.doi.org/10.1155/2016/8692685 [2017, May 11].

82. Yalew N. K., Mekonnen, M. G. & Jemaneh, A. A. 2012.Trachoma and its determinants in Mojo and Lume districts of Ethiopia. *Pan- African Medical Journal*.13 (1):1-5. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3587019/ [2016, July 11].

PART C: Journal "Ready" Manuscript

This manuscript conforms to the requirements, instructions and guidelines for authors provided by the Ophthalmic Epidemiology Journal. Some relevant tables are appended as stipulated in the journal instructions. Other guidelines such as spacing and referencing follow the recommendations of the publishers of the Ophthalmic Epidemiology Journal. Supplementary materials and figures are included in the appendixes in section D.

TITLE PAGE

Prevalence of Trachoma and Risk Factors for Disease in Benue State, Nigeria.

Caleb Mpyet[a,b,c], Selassie Tagoh[d], Sophie Boisson[e], Rebecca Willis[f], Nasiru Muhammad[g], Ana Bakhtiari[f], Mohammed D. Adamu[g], Alexandre L. Pavluck[f], Murtala M. Umar[h], Joel Alada[i], Sunday Isiyaku[b], William Adamani[b], Rebecca Jande[j], Nicholas Olobio[k], and Anthony W. Solomon[l,m,n], for the Global Trachoma Mapping Project*

[a]Department of Ophthalmology, University of Jos, Jos, Nigeria
[b]Sightsavers, Kaduna, Nigeria
[c]Kilimanjaro Centre for Community Ophthalmology International, Division of Ophthalmology, University of Cape Town, Cape Town, South Africa
[d]School of Public Health and Family Medicine, University of Cape Town, Cape Town, South Africa
[e]Department of Public Health, the Environment and Social Determinants of Health, World Health Organization, Geneva, Switzerland
[f]Task Force for Global Health, Decatur, GA, USA
[g]Ophthalmology Unit, Surgery Department, Usmanu Danfodiyo University, Sokoto, Nigeria
[h]National Eye Centre, Kaduna, Nigeria
[i]Department of Ophthalmology, Federal Medical Centre, Makurdi, Nigeria
[j]Ministry of Health, Benue State, Makurdi, Nigeria
[k]Federal Ministry of Health, Abuja, Nigeria
[l]Clinical Research Department, London School of Hygiene & Tropical Medicine, London, United Kingdom
[m]London Centre for Neglected Tropical Disease Research, London, United Kingdom
[n]Department of Control of Neglected Tropical Diseases, World Health Organization, Geneva, Switzerland

CONTACT

Caleb Mpyet

mpyetc@yahoo.com
Department of Ophthalmology, University of Jos, PMB 2076, Jos, Nigeria
* See Appendix
Published with license by Taylor & Francis

ABSTRACT

Purpose: To determine the prevalence of trachoma and the common environmental risk factors associated with the disease in each Local Government Area (LGA) of Benue state, Nigeria.

Methods: Two-stage cluster-sampling was used to conduct a series of 23 population-based prevalence surveys. LGAs were the evaluation units surveyed. In each LGA, 25 households were selected in each of 25 clusters, and individuals aged one year and above resident in those households were invited to be examined for trachoma. Data on access to water and sanitation were also collected at household level.

Results: A total of 91,888 people were examined from amongst 93,363 registered residents across the 23 LGAs. The LGA-level prevalence of trachomatous inflammation—follicular (TF) in 1–9-year-olds ranged from 0.3–5.3%. Two LGAs had TF prevalences of 5.0–9.9%. The LGA-level prevalence of trichiasis in ≥15-year-olds ranged from 0.0–0.35%. Access to improved drinking water sources ranged from 0% in Gwer West to 99% in Tarka, while access to improved sanitation ranged from 1% in Gwer West to 92% in Oturkpo. Adults ≥15 years were 8.94(95%CI: 2.79 – 29.64) times more likely to have Trichiasis compared to persons between 1-9 years of age

Conclusion: There is need for public health-level interventions against trachoma in three LGAs of Benue State.

Key words: trachoma, trichiasis, epidemiology, Nigeria, Benue State, Global Trachoma Mapping Project

INTRODUCTION

Trachoma is the world's number one cause of infectious blindness.[1] The disease, caused by repeated bouts of infection by the obligate intracellular eubacteria *Chlamydia trachomatis,*[2] which passes from person to person through contaminated hands, clothes and vectors such as the eye-seeking fly, *Musca sorbens*.[1] Trachoma normally begins in childhood as an inflammation of the conjunctiva but worsens with time, reinfection and eventually leads to scaring of the upper tarsal conjunctiva which by extension causes the eyelashes to turn-in and rub on the cornea until it becomes scared, cause corneal damage and irreversible blindness.[1] Trachoma has been eliminated from many developed countries several years ago, however it continues to be a public health problem in many African countries including Nigeria.[3, 4]

Recent reports by the World Health Organization (WHO) suggests that trachoma is endemic in 42 countries worldwide with about 200 million persons living in trachoma endemic areas and are at risk of trachoma infection, with about 50% of this number living in Ethiopia, Malawi and Nigeria alone.[1]

WHO has been at the forefront of the fight to eliminate trachoma as a public health problem by the year 2020 through its flagship initiative "Global Elimination of Trachoma" (GET2020) established in 1996.[35] It has therefore recommended the implementation of a comprehensive strategy which goes by the acronym "SAFE" (Surgery, Antibiotics, Facial cleanliness and Environmental change) strategy [5] based on the prevalence estimates of TF(Trachomatous Follicular) among children 1-9 years old and TT(Trachomatous trichiasis) among adults 15 years and above.[4]

WHO recommends use of the SAFE strategy until elimination threshold prevalences (trichiasis <0.2% in ≥15-year-olds and TF <5% in 1–9-year-olds) are reached in each formerly-endemic district.[4, 6]

From 2012–2016, members of the WHO Alliance for GET2020 made considerable progress in baseline mapping of suspected trachoma-endemic districts worldwide within the Global Trachoma Mapping Project.[1, 36] Its goal was to provide a complete picture of the global burden of trachoma, enabling all stakeholders to see where work was needed to achieve elimination as a public health problem.[37] Though many other states of Nigeria had previously been mapped for trachoma,[3] no population-based surveys had been undertaken in Benue State, despite the fact that SAFE interventions had been required in neighboring Nasarawa State, including in a number of bordering Local Government Areas (LGAs).[3]

The work described here was therefore conducted as part of the WHO Global Trachoma Mapping Project (GTMP) in 2014 to (a) the LGA level prevalence of trachoma (b) determine LGA-level prevalence of access to improved water and sanitation; and (c) estimate the likely number of doses of antibiotics and number of people to be managed for trichiasis in Benue state of Nigeria in order to reduce the prevalence estimates below the elimination threshold.

MATERIALS AND METHODS

Study design and setting

The planning and conduct of the GTMP survey in Benue state of Nigeria between April and September 2014, followed the standard GTMP procedures as described elsewhere.[8] Benue state is located in the north– central zone of Nigeria with a population of about 4.2 million and a land area of 34,059 square km. 50% of the population are females while 34% is between 0-9 years old. The population includes a diverse number of ethnic groups distributed in 23 different districts (LGAs).[9]

Sampling and procedure

As already described, [8] villages were used as clusters, of which 25 were selected from each of the 23 LGAs in Benue state using a 2-stage cluster random sampling approach and a probability proportional to the village population size technique. From each village 25 households were selected. Taking into consideration the need to report expected TF prevalence of 10% and a 95% confidence interval with absolute precision of 3%, a minimum of 384 children aged 1–9 years selected by simple random sampling would be required. This number was however adjusted by a design effect of 2.65 and was further inflated by a factor of 1.2 to account for non-response rate to arrive at a final minimum sample size of 1019 children aged 1-9 in the eligible sample population. Enough participants were selected with the hope of capturing enough adults 15 years and above in order to report on trichiasis prevalence.

Despite challenges about its accuracy, [10] the random walk technique was employed in selecting which households to examine. With the help of a resident, the center of a village was located and a direction was randomly selected by spinning a pen, all residents 1 year and above residing in households along this direction were selected and examined upon their consent, by GTMP-certified graders for signs of trachoma using standard WHO (World Health Organization) recommended simplified grading systems, [11] practices and equipments. Information on potential individual and household-level environmental risk factors for trachoma was obtained through household heads' responses to questions on a pre-validated WaSH (Water Sanitation and Hygiene) structured questionnaire of the WHO/UNICEF(United Nations Children's Emergency Fund) Joint Monitoring Programme [12] administered by the survey team through a structured interview session.

Data collected on each participant included age, gender, household characteristics, drinking water source, distance to drinking water, washing water source and distance to washing water, latrine

facility, condition and distance of latrine facility from household, water and soap availability in latrine facility. Even though information was obtained about all the grades of trachoma, for planning and epidemiological purposes, this study focuses on and reports only the prevalence of TF among children aged 1-9 years and trichiasis among persons ≥ 15 years as our primary outcome measures. Interrater variability was ensured by certified experienced trachoma graders.

Operational definitions

Five or more follicles, each at least 0.5mm in diameter, in the central part of the upper tarsal conjunctiva indicates TF, while trichiasis was the presence of at least one eyelash touching the eyeball or evidence of recent removal of in-turned eyelashes.[11] Visual inspection of household latrine and hand washing facilities was also carried out to obtain information on "improved" water source and sanitation conditions in each household. Similarly Information on availability of water, source, latrine facility and sanitation practices at latrine facility were obtained from participants in accordance with guidelines in the WaSH report[12] and the responses were coded accordingly as previously described.[8] Trachoma was not considered a public health problem if TF prevalence in children 1-9 years old falls below 5% and the prevalence of TT is <0.1%[13,27] However in LGAs where trichiasis prevalence was higher than the elimination threshold of <0.2% in persons ≥15 years, steps were taken to calculate the number of trichiasis surgeries needed to be conducted to reach this goal.

Data management and analysis

Data were checked and cleaned by an independent data manager, approved by the health ministry, then analyzed; outputs were again health-ministry approved.[8] The approved data were imported to Stata version 14.0 for analysis. In Stata further checks were done to ensure data was clean and free from outliers, inconsistencies, inaccuracies, missing values as well as satisfying underlying assumptions of the intended statistical tests. Summaries as well as univariate and multivariate

analysis were conducted to ascertain the presence, strength and direction of any statistical association between the independent and dependent variables reporting crude (COR) and adjusted odds ratios (AOR), 95% Confidence Intervals (CI) and p-values.

Cluster-level proportions of children with TF were adjusted for age in 1-year age bands, and proportions of adults with trichiasis were adjusted for gender and age in 5-year age bands; local 2006 census data[9] were used for this adjustment process. LGA-level prevalences were calculated as the means of adjusted cluster-level proportions. Confidence intervals (CIs) were determined by bootstrapping: sets of 25 adjusted cluster-level proportions were selected, with replacement, over 10,000 replications, then the 2.5^{th} and 97.5^{th} percentiles of the ordered means of those sets formed the lower and upper bounds of the CI.

Multi-variable logistic regression model was fitted using all the variables except the ones suspected of breaking the principles of multicollinearity. The final model was fitted using pre-determined variables adjusting for gender, age, clustering as well as other relevant variables. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The survey was approved by the Ethics Committee of the London School of Hygiene and Tropical Medicine (reference number: 6319) and the National Health Research Ethics Committee of Nigeria (reference: NHREC/01/01/2007) while the government of Benue state Ministry of health gave permission for the conduct and appropriate report of the study. Additionally, the study was approved by the University of Cape Town Institutional Review Board (IRB) (reference: IRB00001938). Written and/or verbal informed consent was appropriately obtained from subjects/ guardians. Examination, data collection and management procedures conformed to the guidelines and tenets of the Declaration of Helsinki[32]. All the data collected were stored on a purpose built

Open Data Kit -based Android Smartphone application (Links) [8, 14] encrypted during transport, and stored in a password-protected database in the cloud to ensure confidentiality, fidelity and accessibility.[8, 14] Subjects who presented with active trachoma (TF) were given antibiotics; [33] those who needed trichiasis surgery were referred to the nearest provider.[34]

RESULTS

Sociodemographic characteristics

A total of 93, 363 participants from Benue state were enumerated across the 23 LGAs; 91,888 participated and were examined. 1,146 were not present to be examined while 602 refused participation. Overall, 49.33% (46,194) of persons enumerated were males while over half of them 50.67% (47,442) were females. 97.81% and 98.44% of the enumerated males and females respectively were examined with their consent. The age of participants ranged from 1 year to 100 years with an average age of 18.28 ±17.88. Age and sex distribution of the participants is shown in (Table 4).

Access to water and sanitation

More than half of all participants (57%) lived in households without a latrine facility, in which adult residents either defecated in the bush or in the open near the household. At LGA-level, the proportion of households with access to improved sanitation ranged from 1.38% in Gwer West to 92.16% in Oturkpo. In only two of 23 LGAs did ≥80% of households have access to improved sanitation facilities, while only one (Tarka) of 23 LGAs had ≥80% of households with access to an improved water source (Table 8: Appendix E).

Table 4: Age and Sex distribution of survey participants, Global Trachoma Mapping Project, Benue state, Nigeria, April –September 2014.

Age (years)	Males		Females			
	Number	%	Number	%	Total	% of Total
1-10	24,660	51.93	22,823	48.07	47,483	50.71
11-20	8,219	49.28	8,458	50.72	16,677	17.81
21-30	3,386	33.81	6,629	66.19	10,015	10.70
31-40	3,061	40.35	4,525	59.65	7,586	8.10
41-50	2,756	52.55	2,488	47.44	5,244	5.60
51- 60	2,089	60.57	1,360	39.43	3,449	3.68
61-70	1,251	61.29	790	38.71	2,041	2.18
71-80	584	66.90	289	33.10	873	0.93
80+	188	70.15	80	29.85	268	0.29
Total	46,194	49.33	47,442	50.67	93,636	100

Prevalence of trachoma among children 1-9 years old and adults ≥15 years

Overall (unadjusted) prevalence of TF among children 1-9 years old was 2.00% (95% CI: 1.20 – 2.98). TF prevalence was higher among females 1.44% (95% CI: 1.33 – 1.56) compared to males 1.16% (95% CI: 1.06 – 1.28). There was a statistically significant difference between TF prevalence among the two genders ($p<0.001$). At the LGA level, the average prevalence of TF among persons 1-9 years of age ranged from 0.3% to 5.3% (Table 6: Appendix E).

A total of 38,802 persons 15 years and above were examined. There were 42 adults with trichiasis, giving an overall (unadjusted) prevalence of trichiasis in examined ≥15-year-olds of 0.11%.

Prevalence of trichiasis was higher among females 0.05% (95% CI: 0.03 – 0.07) compared to males 0.03 %(95% CI: 0.02 – 0.05) this was however not statistically significant ($p=0.13$). LGA level trichiasis prevalence ranged between 0.00% in 15 LGAs to 0.35% (0.12–0.50) in Okpokwu (Table 7: Appendix E). Two LGAs had TF prevalence among children 1-9 years old between 5%-9.9%. Over 90% of the LGAs (21) had TF prevalence of <5% (Table 6: Appendix E). Over 90%%

(21) LGAs had trichiasis prevalence of less than 2 per 1000 (<0.2%) among adults (Table 4). From the results, it is estimated that the Benue state has a trichiasis backlog of 1,064. (Table 7: Appendix E). In the two LGAs with prevalence estimates of ≥0.2%, the estimated number of individuals needed to be managed to reduce the prevalence to less than the elimination threshold, ignoring incident disease and mortality in those with trichiasis, is 173.

Household and environmental determinants of trachoma

Overall, age, gender, latrine access, distance to drinking or face washing water source, presence and access to latrine facility as well as hygienic practices at latrine facility were independently associated with a greater odds of having trachoma. Upon adjusting for all these variables through the multivariate logistic regression, only age, sex, distance to drinking water source, presence of latrine facility and latrine accessibility significantly influenced TF occurrence. Multivariable analysis has shown that children who have TF were 1.74 times (AOR: 1.74 95%CI: 1.53 – 1.99) as likely to be between the ages of 1-9 compared to those who don't have TF (Table 9: Appendix E). Similarly Residents who have TF were 1.22 times (AOR: 1.22: 95%CI: 1.08 – 1. 37) as likely to have difficulty accessing latrine facility compared to those who do not have TF and finally households with high prevalence of TF were 1.72 times (AOR: 1.72(95% CI: 1.09 – 2.70) as likely to travel distances more than 30 minutes to get drinking water compared to those who do not have TF (Table 9) Age was a major risk factor for trichiasis among adults 15 years and above. Persons who have trichiasis have 9 times (AOR: 8.94; 95% CI: 2.70 – 29.64) the odds of being 15 years and above compared to persons who do not have trichiasis. Absence of latrine facility in household was associated with a greater odds of trichiasis 4.39, (AOR: 4.39; 95%CI: 1.00 – 19.18). (Table 10: Appendix E).

DISCUSSION

Trachoma remains endemic in many parts of Nigeria [3, 4, 15] despite significant efforts put into "SAFE" strategy implementation programmes to eliminate the condition as a public health problem. The overall prevalence of trachoma (TF) among children 1-9 years old was 2% while trichiasis among persons 15 years and above was 0.11% in this study. Generally, the results show that trachoma was of lower prevalence in this state compared to other regions in Nigeria [3, 4, 18, 25] and in the African sub-region[16] despite inadequate coverage of water and sanitation facilities. (Table 8).TF prevalence of 2% observed in this study is lower compared to recent reports of 3.4% in Kano state.[4, 25] At the LGA level, the results of TF prevalence in this study were similar to that of earlier studies. [18]

The relatively low prevalence of trachoma in Benue state compared to other parts of Nigeria may be attributed to difference in endemicity between the northern and north-central parts of the country as well as time of the study. This survey was conducted at a time when a lot of efforts have already been made to control trachoma in the states of Nasarawa and Plateau following a similar mapping project, [3] thereby preventing possible spread of the disease through migration of persons into Benue state from these highly endemic neighboring states. Despite the generally low prevalence levels, trachoma was a public health problem in Benue state of Nigeria per WHO guidelines.[6] According to these guidelines trachoma is a public health problem in three (Gwer East, Okpokwu and Ukum) LGAs. Two LGAs (Gwer East and Okpokwu) require public health-level implementation of the S component of the SAFE strategy and two LGAs (Gwer East and Ukum) also had TF prevalences suggesting a need for the A, F and E components of SAFE. Similarly community interventions including the A, F and E components of the SAFE strategy may be continued in the remaining 21 LGAs with TF levels below 5% and trichiasis levels below 0.2% in order to sustain the low levels of trachoma estimates recorded in these LGAs. WHO

guidelines show that districts with TF estimates ranging from ≥5% to 9.9 % would need at least one round of mass antibiotics treatment and those with TF estimates ranging from ≥10 to 20.9% would need at least three rounds of mass antibiotics treatment[6]. Gwer East and Okpokwu LGAs will need one round each of mass antibiotics administration.

Trichiasis levels in two LGAs (Gwer East and Okpokwu) were also found to be more than the 0.2% threshold stipulated by WHO. This implies that trichiasis surgeries need to be conducted in these LGAs. However the observed trichiasis prevalence only translates to an easily manageable number of 173 cases needing surgery in these 2 LGAs to reduce the prevalence to less than the elimination threshold, ignoring incident disease and mortality. Both of the latter LGAs (Gwer East and Ukum) had TF prevalence estimates just above the 5% elimination threshold, with 95%CI lower bounds from 3.0–4.0%, and it is eminently possible that these estimates are simply statistical outliers, rather than representations of ongoing *C. trachomatis* transmission that should trigger public health concern. However, hard thresholds for elimination must be (and have been) defined, and implementation of interventions for neglected tropical disease elimination are justifiable in such cases on the basis of apparent very low risk, high community acceptability, and a range of benefits to communities beyond simply bringing about the end of the diseases in question.[28,29]

Many reports,[3,4,16] including a recent global review,[17] have shown gender inequality in trachoma infection, this study reports a similar trend with females being more susceptible to both TF and trichiasis compared to males. The disproportionate association of trichiasis to women compared to men has been attributed to women's role of taking care of the mostly TF susceptible children, leading to repeated exposure of women to trachoma infections.[19] Females must therefore be of prime interest in any future trachoma control programme in this state. The predominance of TF among children of lower age-groups (1-9) and trichiasis among adults has also been confirmed in

this study just as reported by previous studies. [3, 16, 20, 21, 22] Children within this age group have inadequate capacity to take care of themselves and to observe good sanitation practices and are most likely to be involved in close contact activity which can promote easy transmission of trachoma infection among them. Persons with TF in this study were 1.74 times as likely to be below 9 years of age while the odds of trichiasis was 8.9 times among adults over 15 years old.

The potential risk factors for trachoma identified in this study included age, female gender, difficulty in access to drinking water, absence of improved latrine facility and difficulty in access to latrine facility. The odds of trachoma was 1.72 times more among households who travel thirty minutes or more to get drinking water compared to those who get their drinking water from a closer source. Similarly families who do not have latrine facility in their yard or close by had a higher odds of having trachoma compared to those who have latrine facilities in their household. These findings were in line with investigations conducted by other researchers.[21, 22, 25]

The prevalence of TF was highest in Gwer East (5.3%) and Ukum (5.2%). Expectedly in Ukum, less than half (45.44%) of the households had access to improved water source, only 6.31% could easily access the water source available and only 12.32% had access to latrine facility (improved sanitation). The lack of these facilities could have contributed to the high level of TF in these LGAs. Access to water and latrine facility were equally low in Gwer East (Table 5). In contrast Apa recorded the lowest TF prevalence (0.3%) estimate even though the LGA lacked access to improved drinking water sources (0.93%) and latrine facilities (18.99%). The low level of TF in this LGA despite these challenges can be attributed to the short distance their residents have to travel to get water from the few improved sources available. Nearly all (100%) of households in Apa have easy access to water (<1km from household). This finding is worth noting as it buttresses the importance of households having “easy” access to water for personal and environmental

hygiene practices. This finding does however not in any way diminish the value of providing adequate improved sources of water and sanitation facilities for trachoma endemic communities as these interventions have been widely reported to enhance effective control of the disease.[21,26] Overall 13 LGAs had coverage of improved water source less than a national average water coverage of 56%, coverage of latrine facility in 14 LGAs was less than a national average of 27%.[23] Inaccessibility to latrine facility was associated with a higher odds of trachoma in this study (AOR: 1.22 95% CI: 1.08 – 1. 37), a finding that is consistent with previous reports.[21] Inaccessibility to latrine can lead to exposure of household residents to human faeces which are a major breeding ground for trachoma vectors *Musca sorbens.* One would have thought that inaccessibility to improved latrine facility may be associated with higher risk for trichiasis. This study however found otherwise. This finding is at variance with other studies, however this may be the effect of an unmeasured confounding variable or the fact that access to latrine facility alone is inadequate in preventing trachoma but rather a concerted effort of education, health promotion and transfer of basic techniques of hygienic practices. [24] Clearly trachoma prevalence was low in Benue State despite inadequate access to water and sanitation (Table 8). Though recent work[30, 31] has begun to explore levels of community WASH coverage that might associate with lower risk of active trachoma, it does not necessarily follow that particular coverage levels are necessary or sufficient for active trachoma to be eliminated. Regardless, water and sanitation are human rights, and extension of these services to all residents of Benue should be vigorously pursued

Excluding new incident cases that may have occurred years after the conduct of this study, about 173 trichiasis surgeries are needed in order to eliminate trachoma as a public health problem in Benue state. The LGA level prevalence estimates provide a guide for programme organizers to target communities that are highly endemic and urgently need these services.

The study is limited by the arbitrary methods used to estimate some of the outcomes. Outcomes like source of drinking and face washing water, distance to water source and distance to latrine facility were based on household heads' response to questionnaires. Additionally, observed trachoma cases could not be confirmed by advanced laboratory tests, this can lead to a case of over- exaggerated trachoma prevalence by other differential diagnosis which can obscure the true magnitude of the problem of trachoma in Benue state. Relatively low numbers of adults were examined in several LGAs (771 in Tarka, 997 in Guma; in both of these LGAs no examined adults had trichiasis) and the lack of data on the presence or absence of trachomatous conjunctival scar in eyes diagnosed as having trichiasis. However, the very low prevalences of trichiasis observed almost uniformly across the state would support an assertion that trachoma is close to being eliminated in this setting.

Trachoma is a public health problem in some communities of Benue state, stakeholders must immediately start dialogues aimed at collaborative trachoma elimination through the implementation of WHO prescribed programmes.

DECLARATION OF INTEREST

None of the authors have any proprietary or conflict of interest with this submission. The authors alone are responsible for the writing and content of this article.

Funding

This study was principally funded by the Global Trachoma Mapping Project (GTMP) grant from the United Kingdom's Department for International Development (DFID; ARIES: 203145) to Sightsavers, which led a consortium of non-governmental organizations and academic institutions to support health ministries to complete baseline trachoma mapping worldwide. The GTMP was also funded by the United States Agency for International Development (USAID), through the

ENVISION project implemented by RTI International under cooperative agreement number AID-OAA-A-11-00048, and the END in Asia project implemented by FHI360 under cooperative agreement number OAA-A-10-00051. A committee established in March 2012 to examine issues surrounding completion of global trachoma mapping was initially funded by a grant from Pfizer to the International Trachoma Initiative. AWS was a Wellcome Trust Intermediate Clinical Fellow (098521) at the London School of Hygiene & Tropical Medicine, and is now, like SB, a staff member of the World Health Organization (WHO). The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated. None of the funders had any role in project design, in project implementation or analysis or interpretation of data, in the decisions on where, how or when to publish in the peer reviewed press, or in preparation of the manuscript.

Appendix

The Global Trachoma Mapping Project Investigators are: Agatha Aboe (1,11), Liknaw Adamu (4), Wondu Alemayehu (4,5), Menbere Alemu (4), Neal D. E. Alexander (9), Ana Bakhtiari (2,9), Berhanu Bero (4), Sarah Bovill (8), Simon J. Brooker (1,6), Simon Bush (7,8), Brian K. Chu (2,9), Paul Courtright (1,3,4,7,11), Michael Dejene (3), Paul M. Emerson (1,6,7), Rebecca M. Flueckiger (2), Allen Foster (1,7), Solomon Gadisa (4), Katherine Gass (6,9), Teshome Gebre (4), Zelalem Habtamu (4), Danny Haddad (1,6,7,8), Erik Harvey (1,6,10), Dominic Haslam (8), Khumbo Kalua (5), Amir B. Kello (4,5), Jonathan D. King (6,10,11), Richard Le Mesurier (4,7), Susan Lewallen (4,11), Thomas M. Lietman (10), Chad MacArthur (6,11), Colin Macleod (3,9), Silvio P. Mariotti (7,11), Anna Massey (8), Els Mathieu (6,11), Siobhain McCullagh (8), Addis Mekasha (4), Tom Millar (4,8), Caleb Mpyet (3,5), Beatriz Muñoz (6,9), Jeremiah Ngondi (1,3,6,11), Stephanie Ogden (6), Alex Pavluck (2,4,10), Joseph Pearce (10), Serge Resnikoff (1),

Virginia Sarah (4), Boubacar Sarr (5), Alemayehu Sisay (4), Jennifer L. Smith (11), Anthony W. Solomon (1,2,3,4,5,6,7,8,9,10,11), Jo Thomson (4); Sheila K. West (1,10,11), Rebecca Willis (2,9).

1. Advisory Committee, 2. Information Technology, Geographical Information Systems, and Data Processing, 3. Epidemiological Support, 4. Ethiopia Pilot Team, 5. Master Grader Trainers, 6. Methodologies Working Group, 7. Prioritisation Working Group, 8. Proposal Development, Finances and Logistics, 9. Statistics and Data Analysis, 10. Tools Working Group, 11. Training Working Group

REFERENCES

1. World Health Organization (WHO), Alliance for the Global Elimination of Trachoma by 2020. Eliminating Trachoma: Accelerating Towards 2020. *WHO Alliance for GET2020 Database.* 2016; 3-27.
2. Goldschmidt P, Zago VV, Vargas LD, et al. *Chlamydia Trachomatis* in the conjunctiva of children living in the three rural areas in Mexico. *Rev Panam Salud Publica*. 2007; 22(1):29-34.
3. King JD, Jip N, Jugu YS, et al. Mapping Trachoma in Nasarawa and Plateau States, Central Nigeria. *British Journal of Ophthalmology*. 2010; 15 (3):306-11.
4. Solomon AW, Zondervan M, Kuper H, Buchan JC, Mabey DCW, Foster A. Trachoma control: a guide for programme managers. Geneva: World Health Organization; 2006.
5. World Health Assembly. Global elimination of blinding trachoma. 51st World Health Assembly, Geneva. Resolution *World Health Assembly. 1998;* 51.11.
6. World Health Organization. Validation of elimination of trachoma as a public health problem (WHO/HTM/NTD/2016.8). *Geneva: World Health Organization; 2016.*

7. Mpyet C, Odugbo P, Adenuga O, et al. Prevalence and causes of blindness and visual impairment in Plateau State, Nigeria. *TAF Preventive Medicine Bulleting.* 2010; 9(5):401-406.
8. Solomon AW, Pavluck AL, Courtright P, et al. The Global Trachoma Mapping Project: Methodology of a 34-Country Population-Based Study. *Ophthalmic Epidemiology*. 2015; 22(3): 214–225.
9. National Population Commission. 2006. Population and Housing Census of the Federal Republic of Nigeria. Priority Tables. 2006:(1).
10. Grais RF, Rose AMC, Guthmann JP. Don't spin the pen: two alternative methods for second stage sampling in cluster surveys in urban zones. *Emerging Themes Epidemiology* 2007; 4:8.
11. Thylefors B, Dawson CR, Jones BR, et al. A simple system for the assessment of Trachoma and its complications. *Bulletin of the World Health Organization*. 1987; 65 (4): 477-483.
12. World Health Organization & United Nations Children's Emergency Fund (WHO/UNICEF). Core Questions on Drinking water and sanitation for household surveys. 2006; 1-25.
13. Kuper H, Solomon AW, Buchan J, et al. A critical review of the SAFE strategy for the prevention of blinding trachoma. [Abstract]. *Lancet Infectious Diseases* 2003; 3(6):372–381.
14. Pavluck A, Chu B, Flueckiger MR, et al. Electronic Data Capture Tools for Global Health Programs: evolution of LINKS, an Android-, web-based system. *PLoS Neglected Tropical Diseases.* 2014; 8(4): e2654.

15. Mpyet C, Ogoshi C, Goyol M. Prevalence of trachoma in Yobe State, North-Eastern Nigeria. *Ophthalmic Epidemiology*. 2008; 15(5): 303–307. (16)
16. Edwards T, Smith J, Sturrock HJW, et al. Prevalence of Trachoma in Unity State, South Sudan: Results from a Large-Scale Population-Based Survey and potential implications for further surveys. *PLoS Neglected Tropical Diseases.* 2012; 6(4): e1585.
17. Cromwell EA, Courtright P, King JD, The excess burden of trachomatous trichiasis in women: a systematic review and meta-analysis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 2009; 103 (10): 985- 992.
18. Muhammad N, Damina M, Umar MM, et al. Trachoma prevalence and risk factors in eight local government areas of Zamfara State. *Nigerian Journal of Ophthalmology.* 2015; 23(2):48 -53.
19. Mengistu K, Shegaze M, Woldemichael K, et al. Prevalence and factors associated with trachoma among children aged 1–9 years in Zala district, Gamo Gofa Zone, Southern Ethiopia. *Clinical Ophthalmology*. 2016 (10): 1663–1670.
20. Ketema K, Tiruneh M, Woldeyohannes D, et al. Prevalence of active trachoma and associated risk factors among children less than ten years in Baso Liben district, East Gojjam, Ethiopia. *Bio Medical Central, Public Health.* 2012 12:1105.
21. Last AR, Burr SE, Welss HA, et al. Risk factors for active trachoma and ocular chlamydia trachomatis infection in Treatment-Naive trachoma hyper-endemic communities of the Bijagos Archipelago, Guinea Bissau. *PloS Neglected Tropical Diseases*. 2014; 8(6): e2900.
22. Asres M, Endeshaw M, Yeshambaw M. Prevalence and risk factors of Active Trachoma among children in Gondar Zuria District North Gondar, Ethiopia. *Insight Medical Publishing Journals*. 2016; 1(5): 1-9.

23. National Population Commission. 2008 National Demographic and Health Survey: household drinking water tables. Abuja: *National Population Commission*. 2009.

24. Rabiu M, Alhassan MB, Ejere HOD, et al. Environmental sanitary interventions for preventing active trachoma. *Cochrane Database of Systematic Reviews*. 2012, Issue 2. Art. No.: CD004003.

25. Mpyet C, Lass, BD., Yahaya, H.B. & Solomon, A.W. 2012. Prevalence of and risk factors for Trachoma in Kano State, Nigeria. *PLoS One*. 7(7):1-6.

26. Traverse A, Strasser S, Palmer SL, et al. The added value of Water, Sanitation, and Hygiene interventions to Mass Drug Administration for reducing the prevalence of Trachoma: a Systematic Review. *Journal of Environmental and Public Health*. 2013 ;(2013): 1-10.

27. World Health Organization (WHO). 2003. Report of the 2nd Global Scientific Meeting on Trachoma. Geneva, 25-27. Available: http://www.who.int/blindness/2nd%20GLOBAL%20SCIENTIFIC%20MEETING.pdf. [2018, June 5].

28. Desmond N, Solomon AW, Massae PA, et al. Acceptability of azithromycin for the control of trachoma in Northern Tanzania. *Trans R Soc Trop Med Hyg* 2005; **99**(9): 656-63.

29. Marks M, Bottomley C, Tome H, et al. Mass drug administration of azithromycin for trachoma reduces the prevalence of genital Chlamydia trachomatis infection in the Solomon Islands. *Sex Transm Infect* 2016.

30. Oswald WE, Stewart AE, Kramer MR, et al. Active trachoma and community use of sanitation, Ethiopia. *Bulletin of the World Health Organization* 2017; **95**(4): 250-60.

31. Garn JV, Boisson S, Willis R, et al. Sanitation and water supply coverage thresholds associated with active trachoma: modeling cross-sectional data from 13 countries. *PLoS Negl Trop Dis* 2017.

32. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. Jama 2013; 310(20): 2191-4.

33. Evans JR, Solomon AW. Antibiotics for trachoma. *The Cochrane database of systematic reviews* 2011; **3**: CD001860.

34. Burton M, Habtamu E, Ho D, Gower EW. Interventions for trachoma trichiasis. *The Cochrane database of systematic reviews* 2015; **11**: CD004008.

35. World Health Organization. Planning for the global elimination of trachoma (GET): report of a WHO consultation, Geneva, Switzerland, 25 & 26 November 1996 (WHO/PBL/97.60). Geneva: World Health Organization; 1997.

36. Solomon AW, Kurylo E. The global trachoma mapping project. Community eye health / International Centre for Eye Health 2014; 27(85): 18.

37. Smith JL, Haddad D, Polack S, et al. Mapping the global distribution of trachoma: why an updated atlas is needed. PLoS Negl Trop Dis 2011; 5(6): e973.

PART D: APPENDICES

APPENDIX A: Informed Consent Forms

Participant Information Form

Participant Information Sheet: Global Trachoma Mapping Project

You are being invited to take part in a survey. Before you decide whether or not to take part it is important for you to understand why the survey is being done and what it will involve. Please take time to consider the following information carefully. Talk to others about the survey if you wish.

Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

1. What is the purpose of the survey?

Trachoma is an important cause of blindness in many countries, including Nigeria. There is an international goal to eliminate trachoma as a cause of blindness by the year 2020. The strategy that will be used to achieve this goal includes mass treatment with antibiotics, facial cleanliness and environmental changes. In order to decide where these interventions need to be conducted, we need to know in detail where trachoma is a problem, and in places where it is a problem, what proportion of the community suffers from the disease. We gain that knowledge by conducting surveys, in which we select a number of communities from each [district], and from the selected communities select a number of households in which to examine residents for the disease.

2. Why have I been chosen?

We are asking 25 communities from your Local Government Area (LGA) to participate in this survey. These communities have been chosen by chance selection. From each of those communities, we are asking residents of 25 households to participate. These households have been chosen by chance selection, so that each household in this community had an equal chance of being chosen. Your household is one of the chosen households in this community, and we would greatly appreciate it if you would consider taking part.

3. Do I have to take part?

No. It is up to you to decide whether or not to take part. If you do, you will be asked to give consent to participate. You are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of medical or ophthalmic care you receive. A copy of this information sheet will be given to the head of the community.

4. What will happen to me if I take part?

If you agree to take part, we will ask you some questions about water and sanitation for your household, ask to look at your latrine (if you have one), record information about the age and gender of the residents of the household, and examine everyone's eyes for signs of trachoma. Examination involves looking at the eye using a torch and magnifying glasses, including looking underneath the upper eyelid. All of these things are standard procedures: nothing experimental is being undertaken.

No blood or other samples will be taken.

No follow-up visits are planned, but the information that we collect may indicate that trachoma elimination activities are needed in this [district]. If this is the case, the Ministry of Health will make appropriate arrangements to begin interventions.

5. Are there any possible risks or benefits to me of taking part?

Having your eyes examined for trachoma is minimally uncomfortable but not painful, and will not affect your vision. The whole process, including asking questions and examination of all household residents, should take less than 15 minutes.

If we find trachoma or other medical problems, we will offer treatment or referral to a health clinic.

If we find that trachoma is a public health problem in the [district], the Ministry of Health will be able to launch a programme to eliminate the disease.

6. Will my taking part in the survey be kept confidential?

If you participate, some of the data collected for the study will be looked at by authorised persons from the Ministry of Health, the London School of Hygiene & Tropical Medicine, Sightsavers UK, and the International Trachoma Initiative. They may also be looked at by representatives of regulatory authorities to check that the survey is being carried out correctly. All will have a duty of confidentiality to you as a survey participant and nothing that could reveal your identity will be disclosed outside the project group.

7. What will happen to the results of the survey?

Results of the survey will be used by the Ministry of Health to determine whether or not a trachoma elimination programme is needed here. [District]- and national-level results will be published in the medical literature. You and your family will not be personally identified in any report or publication.

.

8. Who is organising and funding the survey?

The surveys are organised by [local partner] in collaboration with the London School of Hygiene & Tropical Medicine and Sightsavers UK. Money for the surveys has been provided by the UK's Department for International Development.

9. Who has reviewed the protocol for this survey?

This survey was given a favourable ethical opinion by the National Research Ethics Committee.

Thank you for taking the time to read this sheet.

Caleb Mpyet
Sightsavers
No 1 Golf Course Road
Kaduna, Nigeria
08033887970

Consent Forms

Consent form

Global Trachoma Mapping Project

Nigeria.

Name of participant: .....

Date: .....

Please tick the correct boxes

I have read the information sheet and understand what I am being asked to do	☐	Yes
	☐	No
My questions have been answered	☐	Yes
	☐	No
I agree to be examined	☐	Yes
	☐	No
I agree to anonymous results being used in reports or publications	☐	Yes
	☐	No
I agree to take part in this project	☐	Yes
	☐	No

Sign/thumbprint_____

APPENDIX B: Data collection tools

[GTMP] Trachoma baseline prevalence survey Date

(A) Household questionnaire Recorder

Section 1: Identifying information		
1	Country [write name or put code in boxes]	
2	Evaluation Unit [write name or put code in boxes]	
3	Cluster [write name or put code in boxes]	
4	Household [write name of household head or put code in boxes]	
Section 2: Household information and GPS		
G1	Latitude (N)	
G2	Longitude (E)	
G3	Elevation (metres)	
G4	Accuracy (metres)	
Section 3: Water, sanitation and hygiene questions		
W1	In the dry season, what is the main source of drinking water for members of your household?	01=Piped water into dwelling 02=Piped water to yard/plot 03=Public tap/standpipe 04=Tubewell/borehole 05=Protected dug well 06=Unprotected dug well 07=Protected spring 08=Unprotected spring 09=Rainwater collection 10=Water vendor 11=Surface water (e.g. river, dam, lake, canal) 99=Other (specify)
W2	How long does it take to go there, get water, and come back?	1=Water source in the yard 2=Less than 30 minutes 3=Between 30minutes and 1 hour 4=More than 1 hour

W3	In the dry season, what is the main source of water used by your household for washing faces?	01=Piped water into dwelling 02=Piped water to yard/plot 03=Public tap/standpipe 04=Tubewell/borehole 05=Protected dug well 06=Unprotected dug well 07=Protected spring 08=Unprotected spring 09=Rainwater collection 10=Water vendor 11=Surface water (e.g. river, dam, lake, canal) 99=Other (specify)
W4	If you collected water there to bring back to the house, how long would it take to go there, get water, and come back?	0=All face washing done at water source 1=Water source in the yard 2=Less than 30 minutes 3=Between 30minutes and 1 hour 4=More than 1 hour
S1	Where do you and other adults in the household usually defaecate?	1=Shared or public latrine 2=Private latrine 3=No structure, outside near the house 4=No structure, in the bush or field 9=Other
S2	Ask to see the latrine/toilet. *Observation:* What kind of toilet facility do the adults in the household use?	01=Flush/pour flush to piped sewer system 02=Flush/pour flush to septic tank 03=Flush/pour flush to pit latrine 04=Flush/pour flush to open drains 05=Flush/pour flush to unknown place 06=Ventilated improved pit latrine (VIP) 07=Pit latrine with slab 08=Pit latrine without slab/open pit 09=Composting toilet 10=Bucket 11=Hanging toilet/hanging latrine 12=No facilities or bush or field 99=Other (specify)
H1	*Observation*: Is there a handwashing facility within 15 meters of the latrine/toilet?	0=No 1=Yes 5=Not applicable (no latrine/toilet)
H2	*Observation:* At the time of the visit, is water available at the handwashing facility?	0=No 1=Yes

		5=Not applicable (no handwashing facility)
H3	*Observation:* At the time of the visit, is soap or ash available at the handwashing facility?	0=No 1=Yes 5=Not applicable (no handwashing facility)

(B) Census and examination findings

Country ☐☐☐ EU ☐☐☐☐☐ Cluster ☐☐ Household ☐☐

Recorder

List all household residents. Ask for consent to examine all 1-9 year-olds and all those aged ≥15 years. Mop-up should focus on 1-9 year-olds.

ID number		Name	Sex [1=M; 2=F]	Age (years)	Examined? [1=Yes (with consent); 2=Absent; 3=Refused; 4=Other]	Right Eye 0=Sign absent; 1=Sign present			Left Eye 0=Sign absent; 1=Sign present			Notes
						TT	TF	TI	TT	TF	TI	

APPENDIX C: Letter of approval from research ethics committees

Approval from NHREC of Nigeria

National Health Research Ethics Committee of Nigeria (NHREC)

Promoting Highest Ethical and Scientific Standards for Health Research in Nigeria

Federal Ministry of Health

NHREC Protocol Number NHREC/01/01/2007-16/04/2013

NHREC Approval Number NHREC/01/01/2007-19/05/2013

Date: 21st May, 2013

RE: GLOBAL TRACHOMA MAPPING PROJECT-NIGERIA

Health Research Ethics Committee (HREC) assigned number: NHREC/01/01/2007

Name of Principal Investigator: Prof. Caleb Mpyet

Address of Investigator: Jos University Teaching Hospital

Plateau State, Nigeria

Date of receipt of valid application: 16-04-2013

Date when final determination of research was made: 19-05-2013

Notice of Full Committee Review and Approval

This is to inform you that the research described in the submitted protocol, the consent forms, other participant information materials have been reviewed and granted full committee approval by the National Health Research Ethics Committee.

This approval dates remain as in the initial approval from 19/05/2013 to 18/05/2014. If there is delay in starting the research, please inform the HREC so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used inthis study must carry the HREC assigned number and duration of HREC approval of the study.* **If this is a multi-year research, endeavor to submit your annual report to the HREC early in order to obtain renewal of your approval and avoid disruption of your research.**

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the HREC.

No changes are permitted in the research without prior approval by the HREC except in circumstances outlined in the Code. The HREC reserves the right to conduct compliance visit your research site without previous notification.

Signed

Clement Adebamowo BMChB Hons (Jos), FWACS, FACS, DSc (Harvard)

Honorary Consultant Surgeon, Director, West African Center for Bioethics and

Chairman, National Health Research Ethics Committee of Nigeria (NHREC)

UCT ethics approval letter

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E53-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: sumayah.arlefdien@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

09 November 2016

HREC REF: 780/2016

Prof C Mpyet
Division of Ophthalmology
Room 26, H-53
OMB

Dear Prof Mpyet

PROJECT TITLE: PREVALENCE OF TRACHOMA AND RISK FACTORS FOR DISEASE IN BENUE STATE, NIGERIA (MPH-candidate-Dr S Tagoh)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 November 2017.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

We acknowledge that the student, Dr S Tagoh will also be involved in this study.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that institutional approval is required from Groote Schuur Hospital.
Formal approval from the HREC is subject to appropriate institutional approval being obtained from Groote Schuur Hospital.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

HREC 780/2016

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI),and Declaration of Helsinki (2013) guidelines.

The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC 780/2016

APPENDIX D: Instructions for authors

Instructions for authors

Thank you for choosing to submit your paper to us. These instructions will ensure we have everything required so your paper can move through peer review, production and publication smoothly. Please take the time to read them and follow the instructions as closely as possible. Should you have any queries, please visit our Author Services website or contact us at authorqueries@tandf.co.uk.

This journal uses Scholar One Manuscripts (previously Manuscript Central) to peer review manuscript submissions. Please read the guide for ScholarOne authors before making a submission. Complete guidelines for preparing and submitting your manuscript to this journal are provided below.

Publishing Ethics

The Editors and Taylor & Francis Group are committed to the highest academic, professional, legal, and ethical standards in publishing work in this journal. To this end, we have adopted a set of guidelines, to which all submitting authors are expected to adhere, to assure integrity and ethical publishing for authors, reviewers, and editors.

Taylor & Francis is a member of the Committee of Publications Ethics (COPE). COPE aims to provide a forum for publishers and editors of scientific journals to discuss issues relating to the integrity of their work, including conflicts of interest, falsification and fabrication of data, plagiarism, unethical experimentation, inadequate subject consent, and authorship disputes. For more information on COPE please visit http://publicationethics.org.

Instructions for Authors

All submissions should be submitted at http://mc.manuscriptcentral.com/nope

All submissions should be double spaced, with consecutively numbered pages. All abbreviations/acronyms must be defined at first use in the abstract, again at first use in the text and in each and every table or figure, regardless of seeming redundancy.

The following are the files need to make your online submission complete:

I. **MANUSCRIPT FILE**

1. **Cover page** –

a) list the title of your submission – no abbreviations or acronyms (acronyms may be considered if important for recognition of a prominent study, and in that case they should be used only after defining the acronym in the title)

b) supply a running head - a shortened version of title, not to exceed 50 characters. If the full title is 50 characters or less, they can be the same.

c) list all authors in publication order and their related affiliations,

d) indicate who is the corresponding author and the corresponding contact information (especially email),

e) financial support – list all financial support

f) list any proprietary interests or conflicts of interest for any and all authors related to this submission. "If none, please state: None of the following authors have any proprietary interests or conflicts of interest related to this submission:"; then list all the authors with no such interests. "None of the authors" suffices if no one has any such interests. Please err on the side of disclosure if it is unclear whether something is an interest or not, and please include relationships that may be perceived by others as a conflict of interest.

g) statement that this submission has not been published anywhere previously and that it is not

simultaneously being considered for any other publication. Note: if the paper previously has been reviewed and rejected by another journal, please indicate so, and please indicate what criticisms were given and what changes have been made in response (as if you were revising and resubmitting to the original journal). We are open to accepting such papers if they have merit, and there is no need to hide this information.

2. **Abstract** – start on new page – not to exceed 250 words, define all abbreviations or acronyms used at first use, formatted into the following four sections:

a) Purpose

b) Methods

c) Results

d) Conclusion

3. **Manuscript text** – start on a new page. The text should not exceed 4,000 words. Define all abbreviations and acronyms at first use (even if previously defined in abstract). The text should be divided into the following 5 sections:

a) Introduction—give the rationale for why this manuscript is important

b) Materials and Methods – should include a statement regarding adherence to the guidelines of the Declaration of Helsinki as well as giving the name of the Institutional Review Board which granted approval or which indicated approval was not needed. Any waivers granted, such as HIPAA waivers or waiver of consent, should be mentioned. Whether patients consented to participate in the study should be mentioned; if not, the reason why not should be mentioned (e.g., Institutional Review Board waiver of consent)

c) Results—summarize the key and supportive results in a clear, crisp, straightforward manner.

d) Discussion—discuss what the key findings are, how it fits in with existing knowledge on the subject, and if there alternative explanations of the observations such as bias or random error. Please include a strengths and limitations paragraph, as well as a concluding paragraph summarizing the main items of knowledge that the paper has provided and relevant applications.

e) References – Please follow the directions in Section 4 below.

4. **References** - cite in the text as superscript by reference number, consecutively as they appear in the text, starting with

I. Prepare a numbered reference list. Only published and accepted (in press) articles can be cited. Abstracts should be cited parenthetically within the text as should any personal communication or unpublished data. Submitted articles are not citable, and should be referenced as unpublished data. Examples:

Journal:

Mohney BG, Robertson DM, Schomberg PJ. Second nonocular tumors in survivors of heritable retinoblastoma and prior radiation therapy. *Am J Ophthalmol*. 1998; 126(2):269-277.

Book:

Raven JC, Court JH, Raven J. *Manual for Raven' Progressive Matrices and Vocabulary Scales*. London: H.K. Lewis & Co. Ltd., 1986.

II. **Tables and Figures**: Tables and figures should not be embedded in the text, but should be included as separate sheets or files. Each figure and table should be a separate file uploaded into the system. A short descriptive title should appear above each table with a clear legend and any footnotes suitably identified below. All units must be included. Figures should be completely labeled, taking into account necessary size reduction.

Figure captions should be typed, double-spaced, in a separate file. All non-electronic original figures should be clearly marked with the number, author's name, and top edge indicated. If you are contemplating submitting non-electronic material, please contact the editorial office to discuss whether this can be permitted, and to arrange how to do so. Non-electronic material should be used only if it is impossible to submit electronically, and if the material adds value to the manuscript.

III. **Illustrations**: Illustrations submitted (line drawings, halftones, photos, photomicrographs, etc.) should be clean originals or digital files. Digital files are recommended for highest quality reproduction and should follow these guidelines:

• 300 dpi or higher

• sized to fit on journal page

• EPS, TIFF, or PSD format only

• submitted as separate files, not embedded in text files

Color Reproduction: Color art will be reproduced in color in the online publication at no additional cost to the author. Color illustrations also will be considered for print publication; however, the author will be required to bear the full cost involved in color art reproduction for the print publication.

Please note that color reprints only can be ordered if print reproduction costs are paid. Print Rates: $900 for the first page of color; $450 per page for the next three pages of color. A custom quote will be provided for articles with more than four pages of color.

Art not supplied at a minimum of 300 dpi will not be considered for print.

IV. **Copyright Form**(s) – available upon article acceptance

It is a condition of publication that authors assign copyright or license the publication rights of the contents of their articles, including abstracts, to Taylor and Francis. This enables full copyright protection and dissemination of the article and the Journal, to the widest possible readership in electronic and print formats. A document to verify this will be sent upon acceptance for publication. This document should be signed by the corresponding author and returned to the publisher for archiving.

V. **Acknowledgements**: The journal will print acknowledgements if requested by authors, please do not confuse this with financial support. It is requested that these are kept to a minimum. If you wish to acknowledge those who reviewed, discussed, translated references, provided extensive statistical assistance, or provided essential research material, equipment, or other materials without which the study could not have been completed, written permission from the person being acknowledged is required. The corresponding author should indicate that such permission has been obtained in advance of submission in a cover letter.

OTHER GENERAL INFORMATION:

Expedited review generally can be organized for exceptionally high impact manuscripts by special arrangement with the Editor-in-Chief or his/her designee. Please contact the Editor-in-Chief directly at ophthalmic.epidemiology@gmail.com to request expedited review; please include a brief summary of the nature of the article, and your rationale as to why expedited review is justified.

Systematic review and meta-analysis projects should follow a research protocol that is developed and published or registered with Prospero, prior to the conduct of the review.

Reports of systematic review and meta-analysis should be prepared according to the PRISMA Statement (website http://www.prisma-statement.org/).

Reports of observational studies are strongly recommended to be prepared according to the STROBE Statement (website http://www.strobe-statement.org/index.php?id=strobe-home).

Reports of clinical trial primary results are strongly recommended to be prepared in accordance with CONSORT Guidelines.

Permissions: Authors are responsible for obtaining permission to reproduce copyrighted material from other sources and are required to sign an agreement for the transfer of copyright to the publisher. As an author you are required to secure permission if you want to reproduce any figure, table or extract text from any other source. This applies to direct reproduction as well as "derivative reproduction" (where you have created a new figure or table which derives substantially from a copyrighted source). It is the responsibility of the author to pay any fees associated with such permissions.

Page Proofs: All proofs must be corrected and returned to the publisher within 48 hours of receipt. Only correction of typographical errors is permitted.

Complimentary Access and Reprints: Authors for whom we receive a valid email address will be provided an opportunity to purchase reprints of individual articles, or copies of the complete print issue. These authors will also be given complimentary access to their final article on Taylor & Francis Online.

SUBMISSION PROCESS:

1. LOG IN AT: http://mc.manuscriptcentral.com/nope

2. REGISTER AS AUTHOR – be sure you are not already in the system

3. SELECT TYPE OF MANUSCRIPT

4. SUPPLY TITLE OF MANUSCRIPT

5. ABSTRACT: Copy and paste your abstract from your manuscript file

6. KEYWORDS: Supply minimum of 5 key words for your submission

7. AUTHORS: enter the names and information of all authors. Please verify the exact spelling carefully.

8. REVIEWERS: You can indicate the names of persons you prefer to or not to review your submission. Such suggestions are considered but choice of reviewers ultimately is at the discretion of the Editorial Board members involved in review of the article.

9. DETAILS AND COMMENTS: You must answer certain mandatory questions

Total number of figures in your submission (black and white as well as color)

Number of color figures

Number of tables

Number of words

Consent to pay for color figures (when applicable)

Confirm that the manuscript has been submitted for consideration of publication solely to this journal and is not published, in press, or submitted for potential publication elsewhere.

Confirm that all the research meets the ethical guidelines, including adherence to the legal requirements of the study country and that a statement is included in the manuscript regarding IRB approval (see instructions above).

Confirm any potential conflict of interests (see instructions above).

Confirm you are aware of copyright issues

10. UPLOAD FILES: manuscript: including cover page, abstract text and references, tables and each figure

11. REVIEW that these are the correct files in the correct order, etc.

12. SUBMIT

Open Access

Articles are eligible for Open Access. Electing this option allows the article to be made freely available online under a Creative Commons License. Authors of accepted papers will have the opportunity to purchase open access at proofs stage. Please note: This option is separate from Taylor and Francis's National Institutes of Health Funded Research Policy.

National Institutes of Health (NIH) Funded Research Policy

NIH policy: NIH-funded authors must ensure their manuscripts can and will be submitted to Pub Med Central (PMC), to appear on PMC no later than 12 months after final publication.

In consideration of the NIH Public and Open Access Policies, the Taylor and Francis journals group acknowledges that the broad and open dissemination of NIH -funded research results can benefit future scientific and medical research.

As part of our author services program, Taylor and Francis will assist authors in depositing to PubMed Central (PMC) author manuscripts reporting NIH funded research, on specific request by the author. Upon this request, Taylor and Francis will deliver to PMC the final peer-reviewed manuscript, which was accepted for publication and that reflects any author-agreed changes made in response to the peer review. We also will authorize the manuscript's public access posting 12

months (NIH) after initial publication in print or electronic form (whichever is sooner). Following the deposit, authors will receive further communications from the NIH Manuscript Submission System with respect to the submission.

Authors wishing to submit their funded work to PMC themselves are welcome to do so providing they follow the terms stated – submitting only the final peer-reviewed manuscript which was accepted for publication (this manuscript must not be altered by Publisher's copyediting and typesetting services) and specifying the 12 month (NIH) embargo period after final publication.

Please note that authors should not deposit post-print manuscripts directly to PMC or other third party sites for any systematic external distribution by a third party (e.g., to a listserv or database connected to a public access server). To do so is a copyright violation.

All authors must comply with our editorial polices.

Cross Check

Please note that *Ophthalmic Epidemiology* uses CrossCheck™ to screen papers for unoriginal material. By submitting your paper to the journal, you are agreeing to originality checks during the peer-review and production processes. Manuscripts may be rejected if sufficient unoriginal material is found to raise concerns about plagiarism.

APPENDIX E: Supplementary tables

Table 5: Socio demographic and household characteristics of participants Global Trachoma Mapping Project, Benue state, Nigeria, April –September 2014.

Factors	Frequency	Percentage
Age of Participants		
1-9	44,056	47.05%
≥15	38,045	40.63%
Gender		
Males	46,194	49.33%
Females	47,442	50.67%
Household Source of water for drinking and face washing		
Piped water into dwelling	11	0.01%
Piped water into yard/plot	10	0.01%
Public tap/standpipe	310	0.33%
Tube well/borehole	14,225	15.19%
Protected dug well	21,236	22.68%
Unprotected dug well	9,912	10.59%
Protected spring	2,440	2.61%
Unprotected spring	9,586	10.59%
Rain water collection	268	0.29%
Water vendor	1,929	2.61%
Surface water(river, dam, lake, canal)	33,639	35.93%
Others(stream, borehole and protected well, water vendor &borehole)	70	0.07%
Distance to drinking water source		
Water source in the yard	19,563	20.89%
Less than 30 minutes from HH	31,362	33.49%
Between 30 minutes and 1 hour from HH	25,149	26.86%
More than an hour from HH	17,562	18.76%
Distance to face washing water source		
Face washing done at water source	3,777	4.03%
Water source in yard of HH	19,508	20.83%
Less than 30 minutes from HH	28,565	30.51%
Between 30 minutes and 1 hour from HH	24,413	26.07%
More than an hour from HH	17,373	18.55%
Household latrine facility		
Shared latrine	23,104	24.67%
Private latrine	17,103	18.27%
No structure, outside near the household	4,734	5.06%
No structure, in the bush or field	47,905	51.16%

Others	790	0.84%
Types of latrines		
Flush/pour flash to piped sewer system	36	0.04%
Flush/pour flush to septic tank	4,797	5.12%
Flush/pour flush to pit latrine	2,813	3.00%
Flush/pour flush to open drains	14	0.01%
Flush/pour flush to unknown place	8	0.01%
Ventilated improved pit latrine VIP	1,062	1.13%
Pit latrine with slab	17,704	18.91%
Pit latrine without slab/open pit	14,542	15.53%
Composting toilet	16	0.02%
Hanging toilet/hanging latrine	34	0.04%
No facility/bush/field	52,483	56.05%
Others (buried/bush)	127	0.14%
Hand washing facility within 15 minutes of latrine/toilet		
Present	5,268	5.63%
Absent	1,192	1.27%
No latrine/toilet/not applicable	87,176	93.10%
Soap/ash for hand washing at facility		
Present	3,946	2.68%
Absent	2,507	4.21%
No latrine/toilet/not application	87,183	93.11%

Table 6: LGA level prevalence of TF and trachoma burden, Global Trachoma Mapping Project, Benue state, Nigeria, April – September 2014.

LGA	Total Population estimate for persons 0-9 years old	Number of persons 1-9 years old examined	Number of TF cases observed	TF Prevalence (%)(95% CI)[b]
Ado	65,725	3,449	120	3.0 (2.1–4.2)
Agatu	41,946	4,053	23	0.5 (0.3–0.7)
Apa	34,715	2,109	8	0.3 (0.1–0.5)
Buruku	72,919	1,309	17	1.8 (0.7–3.4)
Gboko	112,383	1,235	5	0.3 (0.1–0.7)
Guma	70,591	1,708	80	4.2 (3.2–5.4)
Gwer East	58,523	1,433	91	5.3 (3.3–7.7)
Gwer West	44,410	1,373	62	4.6 (2.9–6.6)
Katsina-Ala	77,848	1,172	28	1.9 (1.0–2.7)
Konshisha	78,592	1,972	17	0.8 (0.4–1.4)
Kwande	85,065	1,442	11	0.6 (0.3–0.9)
Logo	59,679	2,059	17	0.7 (0.3–0.9)
Makurdi	86,326	1,378	27	1.8 (0.7–2.8)
Obi	35,418	3,821	95	2.3 (1.5–3.2)
Ogbadibo	44,726	1042	41	3.5 (1.8–5.1)
Ohimini	24,698	3,072	23	0.8 (0.5–1.2)
Oju	56,060	1,189	21	1.5 (0.8–2.3)
Okpokwu	60,410	1,012	8	0.5 (0.1–0.8)
Oturkpo	84,744	1,462	9	0.7 (0.2–1.5)
Tarka	28,879	3,145	34	1.6 (0.8–2.7)
Ukum	76,373	1,111	66	5.2 (3.6–7.0)
Ushongo	66,589	1,701	24	1.1 (0.4–2.3)
Vandeikya	78,954	1,393	48	2.8 (1.5–4.7)
Total	1,445,573	43,640	875	

[b]Adjusted for age, in 1-year bands

Table 7: Local Government Area (LGA-level) estimates of trichiasis backlog, Global Trachoma Mapping Project, Benue state, Nigeria, April-September 2014.

LGA	Total Population estimate for persons ≥15 years	Number of persons ≥15 examined	Number of trichiasis observed	Trichiasis Prevalence (%)(95%CI)[a]	Estimated trichiasis backlog	Number of trichiasis surgeries needed to be conducted to eliminate trachoma
Ado	97,142	2,087	11	0.19 (0.07–0.34)	187	0
Agatu	60,493	1,572	0	0	0	0
Apa	51,001	1,426	0	0	0	0
Buruku	108,425	1,364	0	0	0	0
Gboko	202,010	1,750	0	0	0	0
Guma	101,355	997	1	0.01 (0.00–0.02)	6	0
Gwer East	90,299	1,709	5	0.23 (0.00–0.52)	210	29
Gwer West	63,901	1,175	0	0	0	0
Katsina-Ala	120,884	1,600	10	0.19 (0.03–0.43)	228	0
Konshisha	120,147	1,302	0	0	0	0
Kwande	133,246	1,265	0	0	0	0
Logo	89,816	2,938	0	0	0	0
Makurdi	176,405	1,879	0	0	0	0
Obi	52,081	1,883	0	0	0	0
Ogbadibo	70,791	1,657	1	0.01 (0.00–0.02)	5	0
Ohimini	37,847	2,644	1	0.03 (0.00–0.09)	11	0
Oju	92,435	1,481	0	0	0	0
Okpokwu	94,565	1,152	12	0.35 (0.12–0.50)	333	144
Oturkpo	148,700	1,322	0	0	0	0
Tarka	41,295	771	0	0	0	0
Ukum	115,173	1,341	0	0	0	0
Ushongo	101,497	1,545	1	0.08 (0.00–0.25)	84	0
Vandeikya	125,214	1,942	0	0	0	0
Total	2,294,722	36,802	42		1,064	173

[a]Adjusted for gender and age, in 5-year bands

Table 8: Household (HH) access to improved water and latrine facility by LGA, Global Trachoma Mapping Project, Benue state, Nigeria, April-September 2014.

LGA	HH With access to improved drinking water source (%)	HH with easy access to drinking water source	HH with access to improved sanitation (latrine access)
Ado	20.49	46.79	31.38
Agatu	9.09	37.39	14.59
Apa	0.93	100.00	18.99
Buruku	69.57	80.37	17.25
Gboko	35.96	55.06	37.58
Guma	25.78	46.39	20.09
Gwer East	67.66	49.99	11.63
Gwer West	0.07	8.06	1.38
Katsina-Ala	62.56	74.85	51.21
Konshisha	57.32	67.57	5.22
Kwande	72.39	81.08	26.17
Logo	33.88	31.41	50.10
Makurdi	64.49	37.93	49.78
Obi	28.36	14.78	3.36
Ogbadibo	43.14	96.00	33.87
Ohimini	13.94	57.31	25.25
Oju	61.24	12.07	2.29
Okpokwu	3.13	59.20	80.43
Oturkpo	50.60	98.80	92.16
Tarka	98.79	70.87	45.53
Ukum	45.44	6.31	12.32
Ushongo	69.98	65.99	17.31
Vandeikya	57.26	98.94	16.09

Table 9: Univariate and multivariate logistic regression analysis of factors associated with Trachomatous Follicular (TF) among children 1-9 years Global Trachoma Mapping Project, Benue state, Nigeria, April–September 2014.

Variable	TF Presence		Univariate model	P-value	Multivariate model	P-value
Age	YES (%)	NO (%)	COR(95%CI)		AOR(95%CI)	
1-9	710(1.63)	42928(98.63)	1.77(1.55 – 2.02)	<0.001	1.74(1.53 – 1.99)	<0.001
≥15	340(0.92)	36457(99.08)	1		1	
Sex						
Females	596(1.44)	40,827(98.56)	1.21(1.06 – 1.36)	0.013	1.28(1.14 – 1.45)	<0.001
Males	454(1.16)	38,558(98.84)	1		1	
Source of drinking water						
Unsafe	669(1.40)	47,199(98.60)	1.20(1.06 – 1.46)	0.006	0.77(0.40 – 1.46)	0.421
Safe	380(1.17)	32,134(98.83)	1		1	
Time to haul drinking water						
≥30 min. walk	481(1.10)	43,313(98.90)	1.42(1.26 – 1.60)	<0.001	1.72(1.09 – 2.70)	0.019
≤30 min. walk	568(1.55)	36,020(98.45)	1		1	
Source of face washing water						
Unimproved	674(1,40)	47,372(98.60)	1.21(1.07 – 1.38)	0.003	1.36((0.71 – 2.59)	0.351
Improved	375(1.16)	31,961(98.84)	1		1	
Time to haul face-washing water						
≥30 min. walk	499(1.12)	44,049(98.88)	1.38(1.22 – 1.55)	<0.001	0.72(0.46 – 1.14)	0.160
≤30 min. walk	550(1.53)	35,284(98.47)	1		1	
Latrine facility						
Absent	710((1.52)	45,891(98.48)	1.53(1.34 – 1.74)	<0.001	0.62(0.38 – 1.00	0.052
Present	339(1.00)	33,442(99.00)	1		1	
Latrine facility						
Unimproved	878(1.51)	57,367(98.49)	1.00(0.97 – 1.02)	0.770	1.00(0.96 – 1.03)	0.708
Improved	171(0.78)	21,847(99.22)	1		1	
Easy Accessibility of latrine facility						
NO	302(1.04)	28,629(98.96)	1.13(1.09 – 1.16)	<0.001	1.22(1.08 – 1. 37)	0.002
YES	32(0.59)	5,421(99.41)	1		1	
Water at facility						
Absent	4(0.41)	982(99.59)	1.19(1.10 – 1.28)	<0.001	0.74(0.44 – 1.25)	0.261
Present	28(0.63)	4,439(99.37)	1		1	
Soap at facility						
Absent	14(0.67)	2,072(99.33)	1.20(1.11 – 1.30)	<0.001	1.46(0.84 – 2.53)	0.176
Present	18(0.54)	3,343(99.46)	1		1	

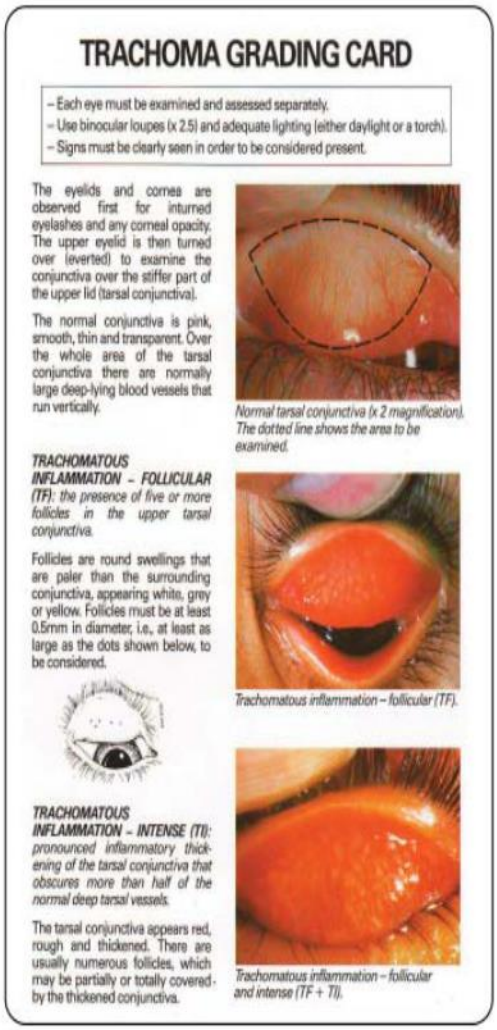
COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval. Environmental risk factors were categorized (Improved, unimproved, water source ≥/≤30 min. walk) according to the WHO/UNICEF Joint Monitoring Program (JMP) for Water Supply and Sanitation's "Sanitation Ladder" from the 2008 JMP Report (http://www.wssinfo.org/fileadmin/user_upload/resources/1251794333-JMP_08_en.pdf). All risk factors for both TF and trichiasis were recoded to binary variables to make for easy analysis and interpretation.

Table 10: Univariate and multivariate logistic regression analysis of factors associated with trichiasis among adults ≥ 15 years old Global Trachoma Mapping Project, Benue state, Nigeria, April –September 2014.

Variable	Trichiasis Presence		Univariate model	P-value	Multivariate model	P-value
Age	YES (%)	NO (%)	COR(95%CI)		AOR	
≥15	26(0.07)	36,771(99.93)	10.28(3.11 - 33.98)	<0.001	8.94(2.70 – 29.64)	<0.001
1-9	3(0.01)	43,635	1		1	
Sex						
Females	19(0.05)	41,404(99.95)	1.79(0.83 – 3.85)	0.136	1.60(0.74 – 3.44)	0.232
Males	10(0.03)	39,002(99.97)	1		1	
Source of drinking water						
Unsafe	22(0.05)	47,846(99.95)	1.00(0.92 – 1.11)	0.842	1.01(0.93 – 1.10)	0.840
Safe	7(0.02)	32,507(99.98)	1		1	
Time to haul drinking water						
≤30 min. walk	13(0.03)	43,834(99.97)	1.47(0.71 – 3.07)	0.298	2.12(0.98 – 4.58)	0.057
≥30 min. walk	16(0.04)	36,572(99.96)	1		1	
Source of face washing water						
Unimproved	22(0.05)	48,024(99.95)	1.01(0.92 – 1.11)	0.842	-	-
Improved	7(0.02)	32,329(99.98)	1			
Time to haul face-washing water						
≤30 min. walk	13(0.03)	44,588(99.97)	1.53(0.74 – 3.19)	0.253	-	-
≥30 min. walk	16(0.04)	35,818(99.96)	1			
Latrine Facility						
Absent	10(0.02)	46,598(99.98)	0.38(0.18 – 0.82)	0.014	4.39(1.00 – 19.18)	0.049
Present	19(0.06)	33,808(99.94)	1		1	
Latrine facility						
Unimproved	10(0.02)	58,242(99.98)	0.20(0.09 – 0.43)	<0.001	0.15(0.04 – 0.67)	0.012
Improved	19(0.09)	22,045(99.91)	1		1	
Easy Accessibility of latrine facility						
NO	19(0.07)	28,938(99.93)	0.76(0.63 – 0.91)	0.003	0.73(0.44 – 1.22)	0.231
YES	2(0.04)	5,471(99.96)	1		1	
Water at facility						
Absent	0	1,006(100.000	1.00(0.74 – 1.32)	0.940	0.71(0.13 – 3.85)	0.693
Present	2(0.04)	4,465(99.96)	1		1	
Soap at facility						
Absent	1(0.05)	2,105(99.95)	1.00(0.73 – 1.37)	0.988	1.83(0.29 – 11.58)	0.522
Present	1(0.03)	3,360(99.97)	1		1	

NB: COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval. Environmental risk factors were categorized (Improved, unimproved, water source ≥/≤30 min. walk) according to the WHO/UNICEF Joint Monitoring Program (JMP) for Water Supply and Sanitation's "Sanitation Ladder" from the 2008 JMP Report (http://www.wssinfo.org/fileadmin/user_upload/resources/1251794333-JMP_08_en.pdf). All risk factors for both TF and trichiasis were recoded to binary variables to make for easy analysis and interpretation. "Source of face washing water" and "Time to haul face washing water" were excluded from the multivariate analysis because of perceived collinearity with "Source of drinking water" and "Time to haul drinking water" respectively.

APPENDIX F: Figures



TRACHOMA GRADING CARD

– Each eye must be examined and assessed separately.
– Use binocular loupes (x 2.5) and adequate lighting (either daylight or a torch).
– Signs must be clearly seen in order to be considered present.

The eyelids and cornea are observed first for inturned eyelashes and any corneal opacity. The upper eyelid is then turned over (everted) to examine the conjunctiva over the stiffer part of the upper lid (tarsal conjunctiva).

The normal conjunctiva is pink, smooth, thin and transparent. Over the whole area of the tarsal conjunctiva there are normally large deep-lying blood vessels that run vertically.

Normal tarsal conjunctiva (x 2 magnification). The dotted line shows the area to be examined.

TRACHOMATOUS INFLAMMATION – FOLLICULAR (TF): *the presence of five or more follicles in the upper tarsal conjunctiva.*

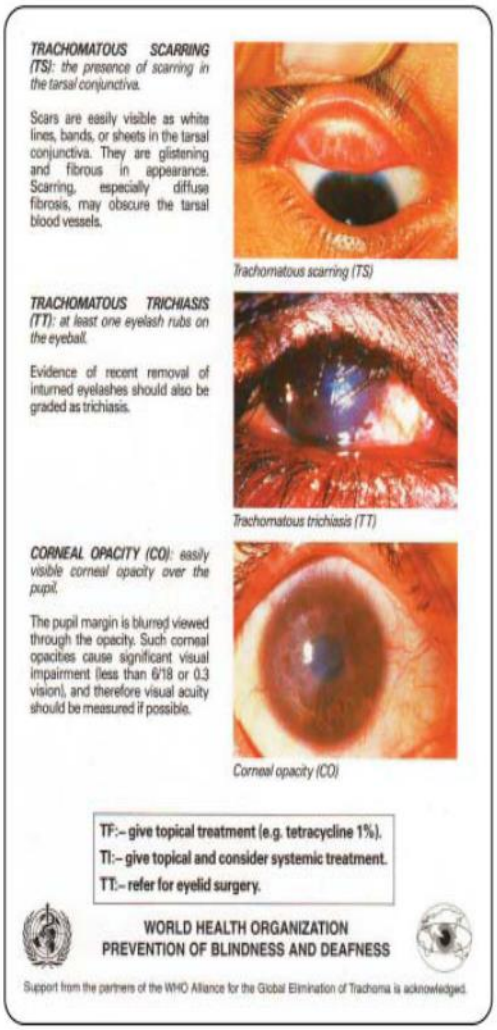
Follicles are round swellings that are paler than the surrounding conjunctiva, appearing white, grey or yellow. Follicles must be at least 0.5mm in diameter, i.e., at least as large as the dots shown below, to be considered.

Trachomatous inflammation – follicular (TF).

TRACHOMATOUS INFLAMMATION – INTENSE (TI): *pronounced inflammatory thickening of the tarsal conjunctiva that obscures more than half of the normal deep tarsal vessels.*

The tarsal conjunctiva appears red, rough and thickened. There are usually numerous follicles, which may be partially or totally covered by the thickened conjunctiva.

Trachomatous inflammation – follicular and intense (TF + TI).



TRACHOMATOUS SCARRING (TS): *the presence of scarring in the tarsal conjunctiva.*

Scars are easily visible as white lines, bands, or sheets in the tarsal conjunctiva. They are glistening and fibrous in appearance. Scarring, especially diffuse fibrosis, may obscure the tarsal blood vessels.

Trachomatous scarring (TS)

TRACHOMATOUS TRICHIASIS (TT): *at least one eyelash rubs on the eyeball.*

Evidence of recent removal of inturned eyelashes should also be graded as trichiasis.

Trachomatous trichiasis (TT)

CORNEAL OPACITY (CO): *easily visible corneal opacity over the pupil.*

The pupil margin is blurred viewed through the opacity. Such corneal opacities cause significant visual impairment (less than 6/18 or 0.3 vision), and therefore visual acuity should be measured if possible.

Corneal opacity (CO)

TF:– give topical treatment (e.g. tetracycline 1%).
TI:– give topical and consider systemic treatment.
TT:– refer for eyelid surgery.

WORLD HEALTH ORGANIZATION
PREVENTION OF BLINDNESS AND DEAFNESS

Support from the partners of the WHO Alliance for the Global Elimination of Trachoma is acknowledged.