Epidemiological assessment of a large geographical area with clustered trachoma: The Upper Eastern Kenya survey

Karimurio J[1], Rono H[2], Barasa E[3], Mukiri M[1], Gichangi M[3]

[1]Department of Ophthalmology, College of Health Sciences, University of Nairobi, Kenya
[2]Nothern Rift Valley Zonal Referral Eye unit, Kitale, Kenya
[3]Division of Ophthalmic Services, Ministry of Health, Kenya

Corresponding author: Dr. J. Karimurio. Email: jkarimurio@gmail.com

ABSTRACT

Objective: **To assess the prevalence and distribution of trachoma and dirty faces prior to implementation of the SAFE strategy (Surgery, Antibiotic treatment, Facial cleanliness and Environmental improvement) in the Upper Eastern Kenya region.**

Methods: **A pre-survey trachoma risk assessment was conducted followed by division of the region into three geographical areas (survey segments). The sample size was 800 children aged 1-9 years old and 600 adults aged ≥40 years per segment.**

Results: **A total of 2,400 children were examined. The prevalence of TF in the region was 9.2% (95%CI: 8.0%-10.4%) and Marsabit was the only segment with prevalence >10%. The prevalence of a dirty face in the region was 17.5% (95%CI: 16.0%-19.1%) and Masabit was the only segment with prevalence >20%. A child with a dirty face was more likely to have TF than one with a clean face. The Odd's ratios** were***:*** **Marsabit 12.1(95%CI: 8.1-18.1), Isiolo 7.5(95%CI: 4.4-12.8) and Moyale 1.9 (95%CI: 0.7-5.6). A total of 1,797 adults were examined and 54 (3.0%, 95%CI: 2.2%-3.8%) had TT. Women had higher prevalence of TT than men. Ten out of 13 persons with CO were from Moyale. The backlog of TT in the region was 2,369 people and TT surgical services were poor. Moyale had the lowest prevalence of TF but the highest prevalence of TT.**

Conclusion: **The survey methods used allowed differentiated interventions as follows: Marsabit needed full SAFE strategy; Moyale "S" component and Isiolo repeat sub-district surveys. A Knowledge Attitude and Practice (KAP) was needed to explain the distribution of trachoma in the region.**

Key words: Large area, Trachoma Prevalence, Risk scores, Surgical rate

INTRODUCTION

Trachoma is a neglected tropical disease and the leading infectious cause of blindness in the world[1]. In Kenya, the disease is mainly found in the arid areas in Rift Valley and Eastern regions among the marginalized nomadic communities with poor hygiene.

Children are the reservoir of active infection and blindness usually occurs in adults[2]. Recurrent infections in childhood result in conjunctival inflammation which leads to conjunctival scarring and in-turning of the eye lids (entropion) and eye lashes (trichiasis). The trichiatic eye lashes injure the cornea, leading to corneal scarring and visual loss[3]. The World Health Organization has classified these clinical signs into a simplified trachoma grading scheme used in surveys as follows[4]: TF = Trachomatous Follicular Inflammation, TI = intense Trachomatous inflammation, TS = Trachomatous Conjunctival Scarring, TT = Trachomatous Trichiasis and CO = Corneal Opacity due to trachoma.

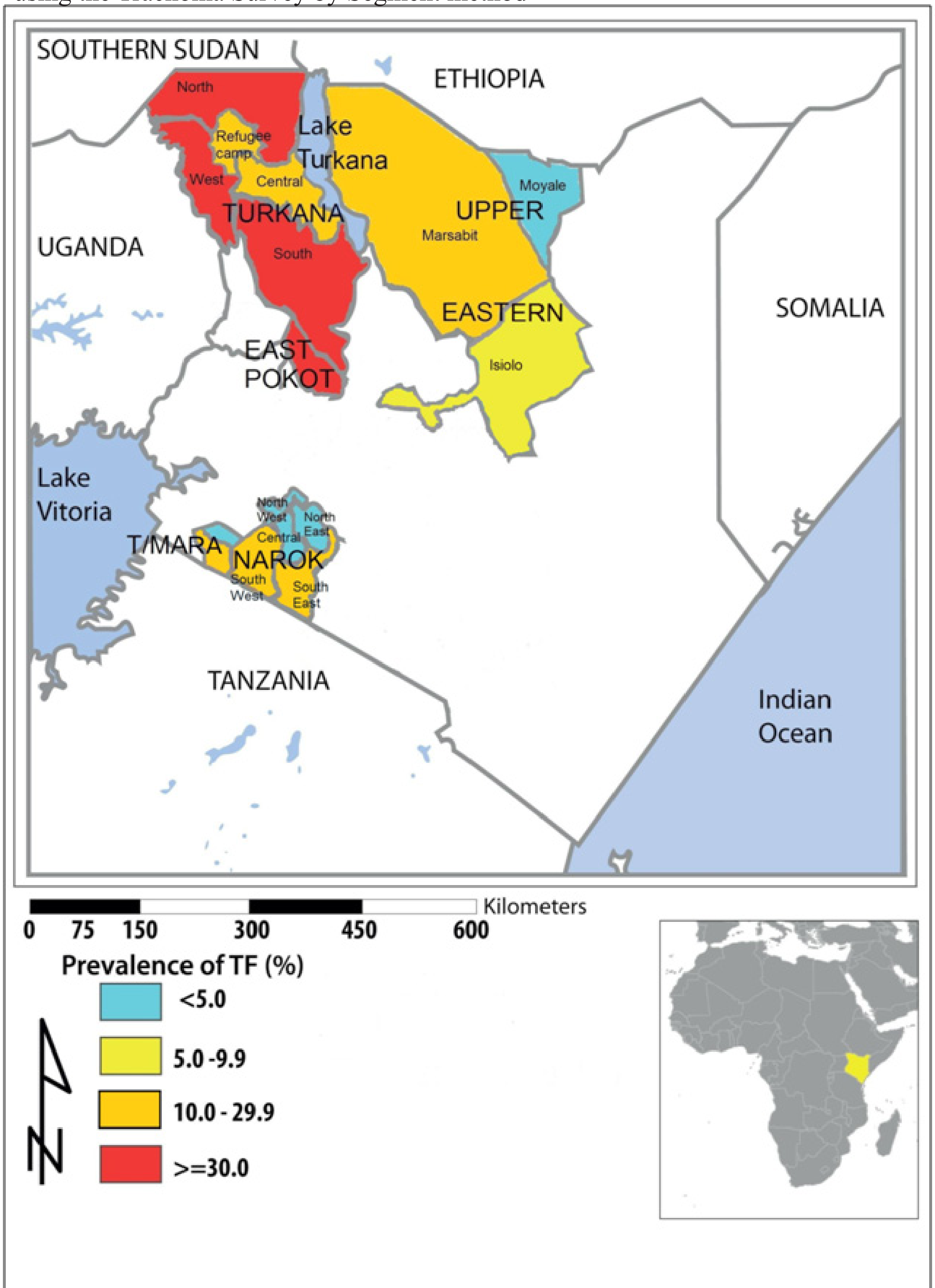
Prevalence of trachomatous Follicular Inflammation (TF) in children aged 1-9 years is the monitoring indicator for active trachoma while trachomatous trichiasis (TT) in adults ≥15 years is the indicator for the potentially blinding trachoma[5]. The World Health Organization (WHO) recommends that if the prevalence of TF is <5% at community level mass antibiotic treatment is not needed, 5% - <10% administer targeted mass treatment in the endemic villages and ≥10% treatment the whole population in the district[5]. The ultimate intervention goal for facial cleanliness is to ensure that 80% of the children 1-9 years in a community have clean faces[6].

The aim of this study was to assess the baseline prevalence and distribution of trachoma and dirty faces in the Upper Eastern Kenya region (Figure 1).

MATERIALS AND METHODS

A population based prevalence survey was conducted in May 2011 in Upper Eastern Kenya, a "hard-to-reach" region with poor health and economic indicators, surface area of 96,297 Km^2 and population of 434,460 people. The population density was 5 people per Km^2 and varied from 1 person per square kilometre in the Chalbi desert in Marsabit to 6,549 people per square kilometre in Moyale Township[7].

Figure 1: Kenya TF map showing Upper Eastern Kenya and other areas surveyed using the Trachoma Survey by Segment method



Adopted from the trachoma atlas (www.trachomaatlas.org) with permission from the International Trachoma Initiative (ITI)

The two methods used in this study were developed in Kenya in 2009 and published elsewhere[8,9]. In brief, the first method is the Trachoma Survey by Segment (TSS) to improve the efficiency of a trachoma survey to identify the specific trachoma-endemic areas in large administrative districts (>200,000 people). A pre-survey trachoma risk assessment is conducted to inform the division of the large area or district into geographical areas (segments) with 100,000 people each. This population size corresponds to the WHO recommended trachoma intervention unit (trachoma district)[10]. A simplified Trachoma Risk Assessment form is used to estimate the risk of finding trachoma in different parts in the study area. This information is collected from key informant interviews and review of project reports. Communities with similar risk scores are aggregated in a segment and after the study the non-endemic segments are excluded from mass treatment (segment knock-out). Five known trachoma risk factors are used as risk assessment parameters: evidence of trachoma (reports), main socioeconomic activity, availability of water sources, average duration of time taken to fetch water and poverty level. The five parameters are awarded equal weighting of 1 point (low) to 4 points (high risk) each. The scores are summed to derive the total scores of 5 - 10 points (low), 11 - 15 (medium) and 16 - 20 (high risk). Children aged 1-9 years old are included in TF survey while adults aged 40 years and older are included in TT survey.

The second is the "TT40" trachoma survey method to improve the efficiency of the TT surveys[9], where adults aged 40 years and older are recruited for TT surveys. A "TT40" trachoma survey requires a smaller sample than a standard survey where people aged 15 years and older (TT15 survey) are recruited.

Equation 1 is used to calculate the minimum samples, where: a= population size; b= expected prevalence; c = maximum sampling error tolerable; d = alpha risk (Z score = 1.96) and e= expected design effect.

Equation 1: Sample size calculation formula[10]

$$\text{Minimum sample size} = e\,\frac{d^2 b(1-b)}{c^2}$$

The parameters used to estimate the TF survey sample size for Upper Eastern Kenya were: assumed prevalence of TF in children 1-9 years old = 10% (the predictor variable), design effect= 2, confidence limit = 95% and maximum sampling error = 3%. Therefore, the minimum sample size for TF survey was 768 children per segment. In the actual survey 800 children were sampled in each segment. The design effect for this study was lower than the 4 used in standard surveys because the segmentation of the study area and selection of relatively small survey clusters of 40 children each were expected to reduced the random sampling error[11]. Previous surveys had high participation rates because of rigorous community mobilization and the same was expected in this study.

The parameters used for TT survey were: assumed prevalence of TT in people ≥40 years old = 10%, design effect = 1.5 (due to small clusters with 30 adults each), confidence limit = 95% (z score 1.96), maximum sampling error = 3%. Therefore the minimum sample TT survey was 576 adults aged >40 years per segment. In the actual survey 600 adults were sampled in each segment.

Twenty clusters with 40 children aged 1-9 years and 30 adults aged 40 years and older each were selected in a segment. In a cluster, a minimum of two villages was randomly selected. Each of the village was listed on a piece of paper and the pieces folded and mixed. One of the villagers was requested to pick two of the papers and read out the names of the selected villages. In a village, the random walk method was used to select households. The team started at the centre of the village and identified the direction of the first household by spinning an object (e.g. a bottle). After finishing with one household, they repeated the same process to indentify the next one. Children living in the selected households who satisfied the survey criteria were enumerated and examined until the sample size was achieved. Revisits were done where necessary.

The children were examined for active trachoma and dirty faces while adults were examined for TT (potentially blinding trachoma), trichiasis surgical scars and corneal opacities. A dirty face was defined as one with eye and/or nasal discharges[12].

A two day training workshop for enumerators was conducted in a trachoma endemic area. Field testing of data tools and standardizing the enumerators was done during the workshop. The WHO simplified trachoma grading scheme was used. Clinical examinations were done at the households by four experienced trachoma graders who were validated in preceding surveys in Turkana and Narok districts.

Data were entered by trained clerks and analysed using the Predictive Analytics Software (PASW version 18.0). Prevalence estimates were calculated for each of the surveyed segments. The data for all the three segments were pooled to create a master data set for the Upper Eastern Kenya region. Additionally, the graders sent daily telephone messages to the survey secretariat indicating the number of people examined and with trachoma. At the end of the study, the prevalence estimates calculated using the data entered by statistical clerks and from the telephone messages were compared. The prevalence calculated using the pooled data set was the mean prevalence for the region.

Endemicity of trachoma was classified according to the 2010 WHO guidelines which indicate the number of years mass treatment should be administered prior to an impact assessment survey as follows: if the prevalence of TF is <10% targeted treatment needed (no mass treatment), 10% to <30% mass treatment needed for 3 years and ≥30% mass treatment needed for 5 years both followed by repeat surveys to justify continuation or stoppage of treatment. The backlog of people with TT was estimated by multiplying the target population by prevalence of TT.

Cross-tabulations were done and the Pearson Chi-squared test used to test the association between categorical variables. A p value of <0.05 was considered statistically significant. Odds Ratio (OR) was calculated to assess the risk of a particular outcome if a certain factor was present.

To estimate the total backlog of TT, the backlog calculated in persons aged 40 years and older was multiplied by a correction factor of 1.1 and the TT surgical coverage was calculated using the *Equation 2* below[8]; where a = number of subjects with TT scars in both eyes; b = number of subjects with TT scar in one eye and TT in the other eye; and c = number of subjects with TT.

Equation 2: Estimation the TT surgical coverage for people

$$\text{TT surgical coverage (people)} = \frac{a + b}{a + b + c}$$

TT surgical coverage for eyes was calculated using the Equation 3[8]; where x = the number of eyes with TT surgical scars and y = number of eyes with TT.

Equation 3: Estimation the TT surgical coverage for eyes

$$\text{TT surgical coverage (eyes)} = \frac{x}{x + y}$$

RESULTS

TF prevalence survey: The trachoma risk scores and TF survey results for the three segments are shown in Figure1 and Table 1.

Out of the 2,400 children examined 1,311 boys 1,089 girls were examined and the male:female ratio was 1.2:1. The prevalence in boys was 9.7% (95% CI: 8.1%-11.3%) and in girls 8.6% (95% CI: 6.9%-10.3%), but the difference was not statistically significant (p value 0.37). The prevalence of a dirty face was higher in boys (18.3%, 95% CI: 16.2%-20.4%) than in girls (16.6%, 95% CI: 14.3% -18.9%) but the difference was not statistically significant (p value 0.27).

The Odd's ratios for a child with a dirty face having TF were: Marsabit 12.1(95% CI: 8.1-18.1), Isiolo 7.5(95% CI: 4.4-12.8) and Moyale 1.9 (95% CI: 0.7-5.6)

TT Survey: A total of 1,800 adults (600 per segment) aged 40 years and older were examined but three were removed from analysis because they were aged <40 years old. Of those included in the study 1,109 were women and 691 were men, meaning that women were over-represented (male:female ratio = 1:1.6). The distribution of TF and dirty faces by segment was as shown in Table 2.

Thirty seven persons with TT had it in one eye and 17 had it in both eyes. Only one person had recurrent TT in one eye. Prevalence of TT in women (3.6%, 95% CI: 2.5% - 4.7%) was almost double that in men (2.0, 95% CI: 0.9% - 3.1). Ten of the 13 persons with visually impairing CO were from Moyale.

Backlog of people with TT: The backlog of people with TT in Upper Eastern Kenya was as shown in Table 3.

TT surgical scars: In this study there were three persons with TT surgical scars in both eyes and one person with scar in one eye. One person with surgical scar was from Moyale, one from Isiolo and the rest were from Marsabit.

TT surgical coverage: The TT surgical coverage for people aged 40 years and older in the Upper Eastern Kenya region was 5.3% and it was calculated using the Equation 2. The TT surgical coverage for eyes was 9.0%. It was calculated using the Equation 3.

Table 1: TF survey results for Upper Eastern Kenya region (2011 survey report)

Survey segments	Total risk scores*	Children 1-9 years old				
		Examined	with TF	% with TF (95%CI)^	with dirty faces#	% With dirty face (95%CI)
Marsabit	18	800	113	14.1(11.6-16.6)	218	27.3(24.2-30.5)
Isiolo	17	800	71	8.9 (6.9-10.9)	95	11.9(9.6-14.2)
Moyale	17	800	37	4.6 (3.1-6.1)	107	13.4(11.0-15.8)
Upper Eastern	17	2,400	221	9.2(8.0-10.4)	420	17.5(16.0-19.1)

Table 2: TT survey results for Upper Eastern Kenya region (2011 survey report)

Survey segments	Adults aged 40 years and older				
	Examined	With TT	% with TT (95%CI)^	With CO	% With CO
Marsabit	598	10	1.7(0.6-2.8)	0	0.0
Isiolo	599	9	1.5(0.5-2.5)	1	0.2
Moyale	600	35	5.8(3.9-7.7)	10	2.0
Upper Eastern	1,797	54	3.0(2.2-3.8)	13	0.7

Table 3: Distribution of the TT backlog by survey segments

Survey segment	People aged 40 years and older			People aged 15 years and older*	
	Population^	Prevalence of TT (%)	Backlog of TT	Correction factor	Backlog of TT
Isiolo	24,022	1.8	432	1.1	475
Marsabit	18,252	1.7	310	1.1	341
Moyale	29,513	5.8	1,712	1.1	1,883
Upper Eastern	71,787	3.0	2,154	1.1	2,369

*15 years is the standard lower age limit for TT survey hence it represents total backlog ^2009 census

DISCUSSION

This study revealed that in the Upper Eastern Kenya region active trachoma was clustered in Marsabit while potentially blinding trachoma (TT) and visual impairment due to trachomatous CO were prevalent in Moyale. If the region was surveyed as single study area it would have qualified for TT surgical services but not mass antibiotic treatment because the mean prevalence of TF was <10%. The World Health Organisation recommends mass antibiotic treatment in communities with ≥10% prevalence of TF[5]. The TSS method[8] used in this study made it possible to identify the specific endemic areas in the region and administration of differentiated mass antibiotic treatment by segments.

Prior to this study, the Upper Eastern Kenya region did not have a trachoma control project. This implies that active trachoma may have spontaneously disappeared in Moyale for reasons which could not be verified using the results of this study. Similar phenomena have been reported in developed countries and they are attributed to social economic development; especially the developments which promote personal hygiene[2]. Furthermore, the high prevalence of TT was an indication that it was likely that the population in Moyale had severe active trachoma in the past. From the results of this study, it was not clear why Marsabit, which was the segment with the highest prevalence of TF, had lower prevalence of TT than Moyale, the segment with the lowest prevalence of TF.

A dirty face is the most important risk factor for active trachoma because it is believed to be the final common pathway by which environmental risk factors influence the risk of the disease[2]. The results of this study indicated that Marsabit had the highest prevalence of both TF and dirty face. Additionally, the Odds of a child with a dirty face were higher than for a child with a clean face.

Published literature indicate that women are at a higher risk of being blinded by trachoma than men and the prevalence of TT[13]. In this study the prevalence of TT in women was almost double the prevalence of TT in men.

Like it is reported in many trachoma-endemic countries[14], the TT surgical coverage in this study was too low, meaning the surgical services in Upper Eastern Kenya were inadequate, especially in Moyale where they were needed most. The Kenya National Trachoma Project reports indicated that the TT surgical coverage in the country was generally low.

The major limitation in this study was that the pre-survey trachoma risk scores for all the areas in the region were approximately equal hence they were not very useful in creation of the survey segments. The reason for this is that most of the communities in the Upper Eastern Kenya are marginalized, poor and live under harsh environmental conditions. These scores demonstrated what is known as "the ceiling effect".

In conclusion, the survey methods used in this study allowed differentiated implementation of the SAFE strategy in Upper Eastern Kenya as follows: Marsabit needed all the components of the SAFE strategy; Isiolo required repeat sub-district level survey to identify and treat the endemic villages and Moyale needed only the "S" component. A Knowledge Attitude and Practice (KAP) study was required to unveil the reasons behind the distribution of trachoma in the region.

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