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Prevalence of Trachoma in Kogi State, Nigeria: Results of four Local Government Area-Level Surveys from the Global Trachoma Mapping Project

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ABSTRACT

Purpose: To determine the prevalence of trachoma in four Local Government Areas (LGAs) of Kogi State, Nigeria.

Methods: In June 2014, we conducted population-based, cross-sectional surveys according to Global Trachoma Mapping Project (GTMP) protocols in selected LGAs of Kogi State. In each LGA, 25 clusters were selected with probability proportional to size. In each of these clusters, 25 households were enrolled for the survey. All residents of selected households aged ≥1 year were examined by GTMP-certified graders for trachomatous inflammation–follicular (TF) and trichiasis using the simplified trachoma grading scheme. Data on sources of household water and types of sanitation facilities were collected through questioning and direct observation.

Results: The age-adjusted TF prevalence in 1–9-year-olds ranged from 0.4% (95% CI 0.1–0.8%) in Bassa to 1.0% (95% CI 0.3–1.9%) in Omala. Across all four LGAs, only one case of trichiasis was found; this individual was in Omala, giving that LGA a trichiasis prevalence in individuals aged ≥15 years of 0.02% (95% CI 0.00–0.07%). Between 77 and 88% of households had access to water for hygiene purposes, while only 10–30% had access to improved sanitation facilities.

Conclusion: Trachoma is not a public health problem in any of the 4 LGAs surveyed. There is, however, the need to increase access to adequate water and sanitation services to contribute to the health and social and economic well-being of these communities.

Introduction

Trachoma is an infectious disease of the eye caused by particular strains[1,2] of the bacterium *Chlamydia trachomatis*. It is spread by direct contact with the ocular or nasal discharges of an infected person, by contact with shared clothing and towels carrying those discharges, or via eye-seeking flies (*Musca sorbens*[3]) which act as mechanical vectors. Blindness from trachoma occurs after repeated cycles of infection and resolution over years to decades,[4,5] approaching slowly and painfully.[6] It is the leading infectious cause of blindness worldwide.[7]

Since 1993,[8] the World Health Organization has recommended implementation of the SAFE (surgery, antibiotics, facial cleanliness, environmental improvement) strategy in populations where trachoma presents a threat to public health. In order to justify use of the SAFE strategy despite competing public health priorities and limited resources, district-level data on the prevalence of trachoma are needed.[9] To this end, from 2012 to 2016, the Global Trachoma Mapping Project (GTMP)[10] supported countries[11] to undertake population-based prevalence surveys in areas in which trachoma was suspected to be endemic.

Nigeria has a high trachoma burden.[12–26] Kogi State, located in central Nigeria, has a population of 3.3 million people[27] and had not previously been formally surveyed for the disease. To its north, Kogi borders currently or previously trachoma-endemic districts (Local Government

Areas, LGAs) of Nasarawa[16] and Niger[24] States. The aim of this series of surveys was to determine the LGA-level prevalence of key signs of trachoma in selected northern LGAs of Kogi State bordering trachoma-endemic (or previously endemic) LGAs, and to generate data on household-level access to water and sanitation.[28] These data are needed to guide trachoma elimination efforts at national-, state- and LGA-levels, as required.

Methods

We undertook a population-based prevalence survey in each of four LGAs in Kogi State, as part of the GTMP.

Sample size

For each LGA, we calculated that selecting 25 households in each of 25 clusters would allow 1019 children aged 1–9 years to be examined. This sample size would be sufficient to allow an expected 10% prevalence of trachomatous inflammation–follicular (TF) to be estimated with absolute precision of 3%, assuming a design effect of 2.65 and inflating by a factor of 1.2 to adjust for non-response.[20–26,29]

Team training

Each field team included a trachoma grader and a data recorder, who were recruited by the local Ministry of Health, were trained and certified according to GTMP protocols, as described in detail elsewhere.[29] Grader trainees were required to pass slide- and field-based tests of diagnostic accuracy and recorder trainees were required to pass an electronic examination on the accuracy of their data capture.

Household selection

In each surveyed LGA, we initially selected 25 villages using a systematic, probability-proportional-to-village-size methodology.[30] In selected villages, we chose 25 households using the random walk method, as practiced in other Nigerian States that undertook trachoma mapping with GTMP support.[20–25]

Data collection

At each selected household, global positioning system coordinates were recorded. Data on water and sanitation access were collected through interviews with household members and assessment of household sanitation facilities, where such facilities were present. All household residents aged ≥1 year were eligible to be included in the survey. Consenting individuals were examined by the grader for TF, trachomatous inflammation–intense (TI), and trichiasis, using the criteria set out in the WHO simplified grading scheme,[31] a 2.5× magnifying loupe and sunlight illumination. All data were recorded using LINKS software[29,32] running on Android smartphones, and uploaded to a secure Cloud-based server once the phones were within range of a suitable network.[29]

Ethical considerations

We adhered to the tenets of the Declaration of Helsinki.[33] Adults gave informed verbal consent for their own participation. Verbal consent for participation of those aged <15 years was provided by a parent or guardian. All consent was documented electronically by the recorder. Individuals with active trachoma were given two tubes of 1% tetracycline eye ointment and they (or a care-giver) were instructed on its application. Individuals with trichiasis were referred for surgery by a certified provider. The protocol was approved by the ethics committee of the London School of Hygiene & Tropical Medicine (reference 6319) and the National Health Research Ethics Committee of Nigeria (NHREC/01/01/2007).

Data analysis

Cluster-level proportions of children with TF were adjusted for age in 1-year age bands, and cluster-level proportions of ≥15-year-olds with trichiasis were adjusted for gender and age in 5-year age bands, using data from the 2006 census.[27] Confidence intervals (CIs) were calculated from adjusted cluster-level proportions by bootstrapping, with replacement, over 10,000 replications.

Univariable and multivariable analyses for associations of TF in 1–9-year-olds were performed using R 3.3.3 (2017; R Foundation for Statistical Computing, Vienna, Austria). For these analyses, we pooled data across all four LGAs, and used a multi-level hierarchical model to account for clustering at village- and LGA-level.

Prior to conducting multivariable analyses, we used Mantel–Haenszel tests of association to examine collinearity between explanatory variables, but this was not an absolute exclusion criterion. Age and sex were included in the multivariable model *a priori*, and a stepwise inclusion approach was used, adding variables that were statistically significant in the univariable analyses (Wald test), and retaining them in the final model if they were found to be statistically significant (LRT).

Results

Fieldwork was undertaken in June 2014. For three of the four LGAs, fewer than 750 1–9-year-old children were examined during field team visits to 25 households in 25 villages, and so additional villages were selected, as shown in Table 1. In total, after recruitment of additional clusters, 3081 households were surveyed in 124 villages. There were 12,021 individuals resident in those households, of whom 6602 (55%) were female. Graders examined 11,404 (95%) residents; 326 (3%) were absent, and consent for examination was not given for 239 (2%, Table 1). Of individuals examined, 6336 (56%) were female. A total of 3884 children aged 1–9 years (1974 boys) were examined. In Omala, one 58-year-old woman had bilateral trichiasis, giving an age- and gender-adjusted prevalence of trichiasis in individuals aged ≥15 years for that LGA of 0.02% (95% CI 0.00–0.07%). No cases of trichiasis were seen in Bassa, Yagba East or Yagba West (Table 2). The age-adjusted TF prevalence in 1–9-year-olds ranged from 0.4% (95% CI 0.1–0.8%) in Bassa to 1.0% (95% CI 0.3–1.9%) in Omala (Table 2, Figure 1).

The proportion of households with access to an improved source of water for face-washing ranged from 30% in Bassa to 94% in Yagba West. Only 10% of households in Bassa LGA had an improved latrine compared to 33% in Yagba West. In all four LGAs, a majority of households had a source of water for face-washing within a 30 minute round trip (Table 3).

Associations of TF

We categorized age in 3-year intervals, and this grouping was shown to fit our final model better than using 1-year intervals (LRT, p = 0.0008) or 4-year intervals (LRT, p = 0.001).

There was a clear difference in the prevalence of TF among children by age group, with higher disease prevalence in children between the ages of 4–6 years (Figure 2).
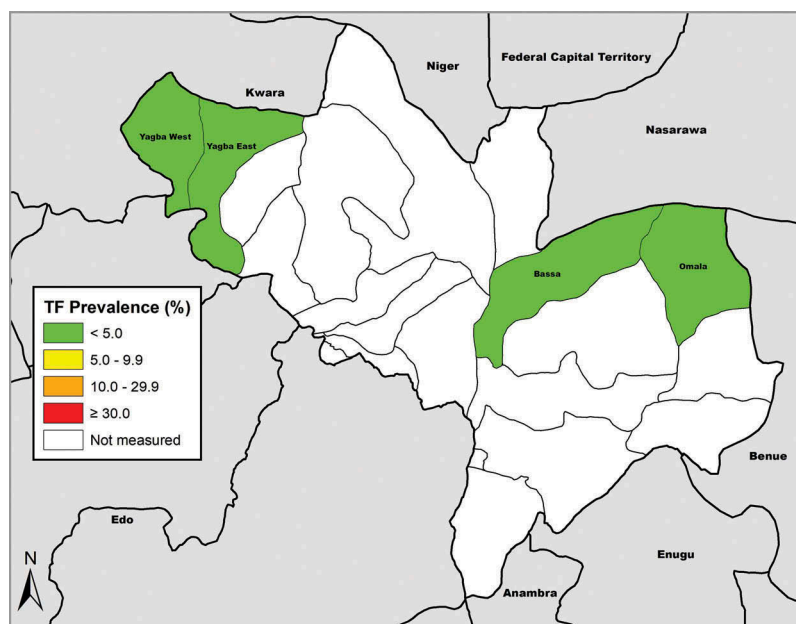
Results of the univariable analysis for associations of TF in children aged 1–9 years are shown in Table 4. Children living in households reporting open defaecation did not have significantly different odds of TF to those with access to a latrine facility. As a sensitivity analysis, we also compared the odds of TF for children living in households with access to improved sanitation versus those in households with unimproved sanitation (access to an unimproved latrine or use of open defaecation); the difference was not significant (p = 0.3). There was a similar lack of association of TF with access to private versus public or shared latrine.

Table 1. Number of 1–9-year-olds and number of ≥15-year-olds resident, examined, absent and refused, by Local Government Area (LGA), Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

	First 25 villages per LGA (original sample)								All villages							
	Number of 1–9-year-olds		Number of ≥15-year-olds		Number of villages added	Total number of villages included		Number of 1–9-year-olds				Number of ≥15-year-olds			
LGA	Resident	Examined	Resident	Examined				Resident	Examined	Absent	Refused	Resident	Examined	Absent	Refused
Bassa	728	704	1525	1443	2	27		805	781	0	23	1639	1557	62	19
Omala	1003	981	1422	1376	0	25		1003	981	5	17	1422	1376	33	12
Yagba East	552	534	1499	1393	12	37		1025	998	6	20	2052	1929	93	29
Yagba West	570	539	1333	1128	10	35		1162	1124	6	32	1744	1519	104	77
Totals						124		3995	3884	17	92	6857	6381	292	137

Table 2. Prevalence of trachomatous inflammation–follicular (TF) in 1–9-year-olds and prevalence of trichiasis in ≥15-year-olds, by Local Government Area, Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

Local Government Area	Number of 1–9-year-olds with TF	Age-adjusted TF prevalence in 1–9-year-olds (%) [95% CI]	Number of ≥15-year-olds with trichiasis	Age- and gender-adjusted trichiasis prevalence in ≥15-year-olds (%) [95% CI]
Bassa	13	0.4 (0.1–0.8)	0	0.00
Omala	22	1.0 (0.3–1.9)	1	0.02 (0.00–0.07)
Yagba East	25	0.9 (0.0–2.6)	0	0.00
Yagba West	23	0.4 (0.0–1.0)	0	0.00

Figure 1. Prevalence of trachomatous inflammation-follicular (TF) in 1–9-year-old children, Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

Table 3. Household-level access to water and sanitation, by Local Government Area (LGA), Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

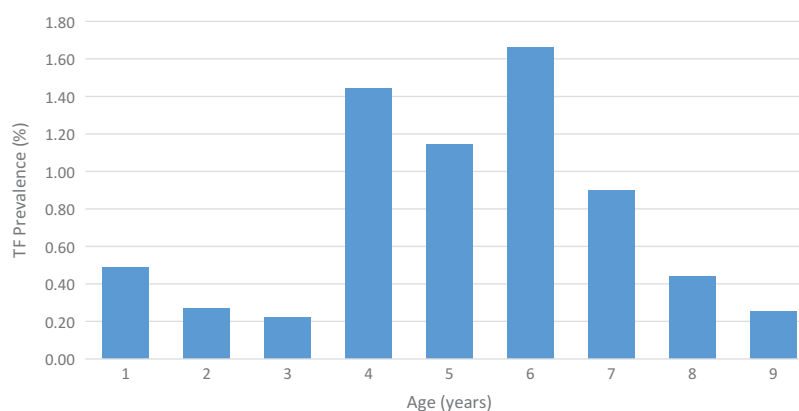| LGA	Number of households surveyed	Improved washing water source, n (%)	Washing water source <1km, n (%)	Improved sanitation facility, n (%)
Bassa	663	202 (30)	502 (76)	66 (10)
Omala	614	338 (55)	471 (77)	164 (27)
Yagba East	936	762 (81)	787 (84)	230 (25)
Yagba West	868	817 (94)	761 (88)	285 (33)

Figure 2. Prevalence of trachomatous inflammation–follicular (TF) among 1–9-year-olds, by age, Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

Table 4. Univariable analysis of associations of trachomatous inflammation–follicular in 1–9-year-olds, Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

Variable		Univariable OR[a] (95% CI)[b]	P-value[c]
Age, years	1–3	0.49 (0.12–1.99)	0.3
	4–6	2.57 (1.06–6.21)	0.04
	7–9	1	−
Children aged 1–9 years in household, n	1–3	1	−
	≥4	2.35 (1.06–5.17)	0.03
Gender	Male	1	−
	Female	1.06 (0.51–2.18)	0.9
Open defecation (no facilities, bush, or field)	Yes	4.53 (0.46–44.71)	0.2
	No	1	−
Surface water used as drinking source	Yes	3.43 (0.83–14.22)	0.09
	No	1	−
Surface water used for face-washing	Yes	3.14 (0.83–11.82)	0.09
	No	1	−
Time to main source of drinking water, minutes	<30	1	−
	≥30	2.41 (0.67–8.67)	0.2
Time to main source of water used for face-washing, minutes	<30	1	−
	≥30	1.93 (0.51–7.28)	0.3
Altitude, metres above sea level	<250	1	−
	≥250	1.46 (0.51–4.20)	0.5

[a]Univariable random effects regression accounting for clustering at village- and LGA-level.
[b]Wald's 95% confidence interval.
[c]Wald's test.
OR, odds ratio; CI, confidence interval.

Table 5. Multivariable analysis of risk factors related to trachomatous inflammation–follicular in 1–9-year-olds, Global Trachoma Mapping Project, Kogi State, Nigeria, June 2014.

Variable		Multivariable OR[a] (95% CI)[b]	P-value[c]
Age, years			0.004
	1–3	0.49 (0.12–1.98)	−
	4–6	2.59 (1.07–6.26)	−
	7–9	1	−
Children aged 1–9 years in household, n			0.03
	1–3	1	−
	≥4	2.39 (1.08–5.30)	−

[a]Multivariable random effects regression accounting for clustering at village- and LGA-level. Multivariable ORs are adjusted for sex, age and number of children aged 1–9 years in household.
[b]Wald's 95% confidence interval.
[c]Likelihood ratio test of inclusion/exclusion of variable in final model.
OR, odds ratio; CI, confidence interval.

Results of the multivariable analysis are shown in Table 5. Compared to children aged 7–9 years, children aged 4–6 years had 2.6 (95% CI 1.1–6.3) times greater odds of having TF. Children living in households with four or more children had 2.4 (95% CI 1.1–5.3) times greater odds of having TF than children in households with fewer than four children.

Discussion

Trachoma is not a public health problem in these Kogi State LGAs. The TF prevalence in 1–9-year-olds was well below 5% in each LGA surveyed, and the prevalence of trichiasis in individuals aged ≥15 years was <0.2% in each LGA, indicating that none of the components of the SAFE strategy need be deployed at public health level for the purposes of trachoma elimination.[34] Data from Nigeria's 2007 National Blindness and Visual Impairment Survey[35] indicate that risk of trichiasis and corneal opacity is concentrated towards the country's north,[18] and we take the present set of results as confirmation that trachoma mapping south of the LGAs surveyed here is not indicated. Trachoma elimination efforts should be directed to the north of Nigeria, where trachoma has been shown to be of public health importance.[18–25]

Although a majority of households in each of these LGAs had access to a source of water for face-washing within a 30 minute round trip of the household, less than one-third of households in each LGA had access to an improved sanitation facility. It could therefore be hypothesized that despite low sanitation coverage, relatively good access to water may have facilitated maintenance of clean faces, contributing to low levels of active disease.[36,37] However, in our analyses, neither access to water nor access to latrines was significantly associated with the presence of TF in children in these LGAs. Characteristics independently associated with TF were being aged 4–6 years, and living in a household with four or more children. Children aged 4–6 years may be less likely to practice facial hygiene than children aged 7–9 years. Children in households with more children may have more frequent or more sustained contact with other children than those living in households with fewer children. However, the importance of the associations that we observed here may be questionable, given the very low prevalence of active trachoma in this population.[38]

Our work had some limitations. First, the random walk was used in GTMP sub-projects in northern Nigeria because of local insecurity and our consequent

desire to use a household-sampling strategy that was familiar to local residents.[20–25] We used it in Kogi State by extension, even though we know it to be epidemiologically sub-optimal.[39–41] Second, in three of the four LGAs, we added extra clusters mid-survey, due to lighter-than-expected recruitment of examinees in the first 25 selected villages. We recognize that adding clusters to a set of previously-chosen, systematically sampled clusters compromises the principle of equal-probability sampling. It is somewhat reassuring to note that prevalence estimates were below WHO-defined thresholds[34] for elimination as a public health problem whether generated with or without the additional clusters. Third, our surveys were under-powered for precisely estimating the LGA-level prevalence of trichiasis, but the fact that only one individual with trichiasis was found amongst 6381 adults examined across four LGAs reinforces the impression that end-stage trachoma is rare here. Fourth, we did not examine eyes with trichiasis for conjunctival scar. Recognition of the importance of doing so arose in late 2015,[42] after these surveys were complete, but again, only one trichiasis case was seen, so the lack of conjunctival scarring data is perhaps inconsequential when assessing the public health relevance of the Kogi findings.

All four LGAs meet the elimination target for TF (prevalence <5% in 1–9-year-olds) and trichiasis (prevalence <0.2% in ≥15-year-olds). However, in order to achieve the United Nations Sustainable Development Goals for water and sanitation, safeguard health, improve quality of life, and fulfil the human right to water and sanitation, there is a need to improve access to adequate water and sanitation services in these LGAs.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the writing and content of this article.

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Appendix

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