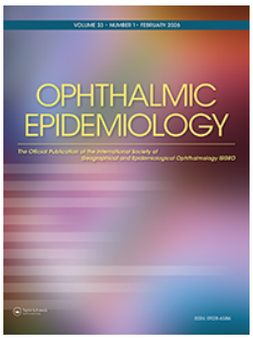

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ORIGINAL ARTICLE

Age-Specific Prevalence of Trachoma in Remote Australian Communities

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ABSTRACT

Purpose: Trachoma is endemic in Australia, affecting remote Indigenous communities in northern, central and western Australia. The World Health Organization (WHO) defines a key requirement of elimination as a public health problem being the prevalence of active trachoma (characterised as trachomatis inflammation – follicular) below 5% in children aged 1–9 years. In Australia, screening is based in school settings and focuses on children aged 5–9 years. There is international evidence that active trachoma may be more common in children under five, meaning true Australian prevalence may be under-estimated.

Methods: In 2018, jurisdictions screened children aged 1–4 years in 64 at-risk communities in addition to usual screening of children aged 5–9 years. Active trachoma was assessed by trained graders according to WHO simplified grading criteria. Logistic regression using a mixed effect model was used to compare age groups.

Results: In total, 2907 children were screened for trachoma, with observed active trachoma prevalence 7.2% and 6.9% in children aged 5–9 years and 1–4 years, respectively. No evidence of association between age group and trachoma prevalence was found overall [OR = 1.29 (95% CI: 0.93–1.79)] and when analyses were restricted by geographic location or to communities meeting screening coverage thresholds.

Conclusion: There was no evidence of higher active trachoma prevalence in children aged 1–4 years. These findings support the use of prevalence in children aged 5–9 years in assessing one of the key indicators of elimination of trachoma as a public health problem in the Australian context.

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Australia; epidemiological surveillance; follicular trachoma; prevalence; screening

Introduction

Trachoma is the leading infectious cause of preventable blindness worldwide, with an estimated total global burden of 1.5 million cases of severe advanced disease as of April 2024.[1] Caused by several serovars of the bacteria *Chlamydia trachomatis*, repeated infection leads to inflammation and scarring of the upper eyelid, which can cause the eyelashes to turn inwards (trichiasis), and scratch the corneal surface, leading to vision loss and blindness.[2] Trachoma is linked to poor living conditions, including overcrowding and inadequate access to water and sanitation facilities.[3,4] Children under 10 years are believed to be the main community reservoirs of infection in endemic settings.[5]

Australia remains the only high-income country with endemic trachoma. The disease is primarily found in remote and very remote Indigenous communities in the central, western, and northern parts of the country, corresponding to the jurisdictions of the Northern Territory, South Australia, and Western Australia (Figure 1). Australia initiated the National Trachoma Management Program in 2006 and has adopted the WHO's package of interventions for trachoma control known as the SAFE strategy, comprising: surgery to correct trichiasis, antibiotics to reduce the prevalence of *C. trachomatis*, facial cleanliness and environmental improvements to interrupt transmission.[6]

Australia is part of the World Health Organization (WHO)'s Alliance for the Global Elimination of Trachoma initiative, which has set a global target for the elimination of trachoma as a public health problem by 2030.[7] A key requirement for elimination of

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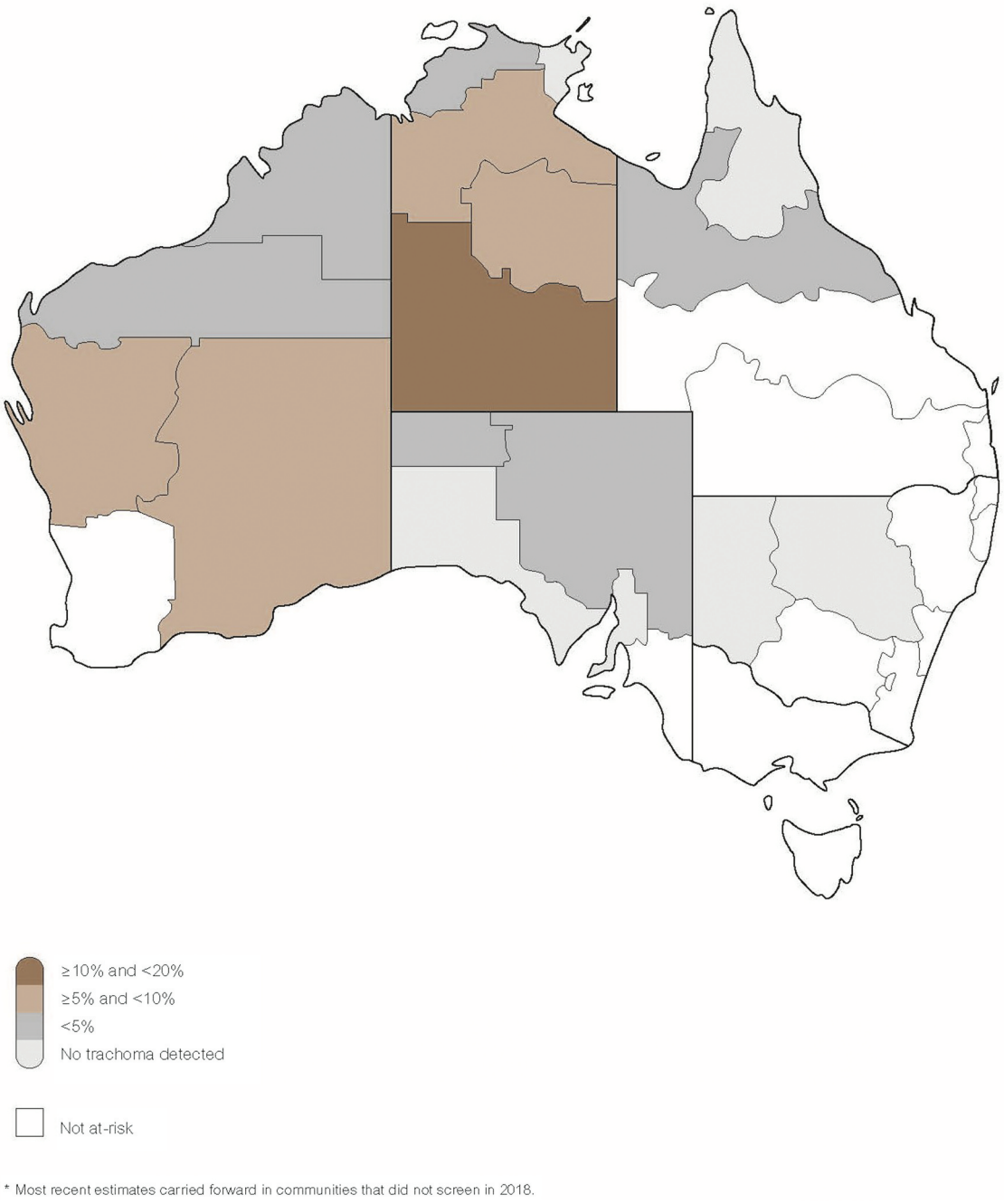

Figure 1. Overall trachoma prevalence in children aged 5–9 years in all at-risk communities by region, Australia, 2018.

trachoma as a public health problem is that the prevalence of active trachoma, defined as clinically diagnosed trachomatous inflammation – follicular (TF), is maintained below 5% in children aged 1–9 years in each formerly endemic district or evaluation unit.[8,9] Australia's evaluation unit for trachoma control is the state/territory jurisdiction.

Under Australian trachoma control guidelines, trachoma screening for the purpose of public health decision-making, including assessing progress towards eliminating trachoma as a public health problem, is based on children aged 5–9.[10] This narrower age group was chosen because of ready accessibility through schools, the greater feasibility of eye examination in older children, and the assumption that prevalence in children aged 5–9 would be similar to prevalence in children aged 1–4 years. Younger children have been screened opportunistically, but coverage has not consistently been as high as among those aged 5–9 years.[11]

International results are mixed regarding the relative prevalence of trachoma in younger versus older age groups, with studies variously reporting higher prevalence, lower prevalence, as well as regional variation.[12–14] The reasons for these differences are not clear. Immune responses to infection with *C. trachomatis* may be greater in older children and lead to lower disease duration and prevalence.[15] Age may also be a proxy for increased performance of hygiene behaviours, including via access to health promotion in schools.[12,16] Conversely, schools offer opportunities for greater social contact and potential for disease spread.[17] It has also been suggested that settings with lower prevalence and transmission intensity may delay age of first exposure, shifting burden to older children.[13]

This uncertainty raises the possibility that Australian estimates based on prevalence in children aged 5–9 years may underestimate the true prevalence in children aged 1–9 years. To address this, in 2018 enhanced screening was undertaken in Australian jurisdictions with endemic trachoma among children aged 1–4 years in at-risk communities and compared to the prevalence among children aged 5–9 years. A secondary aim of the study was to explore the association between age group and facial cleanliness.

Methods

Study population

The study population is children aged 1–9 years in remote and very remote Indigenous communities classified by jurisdictional health departments as at risk of trachoma and scheduled to be screened in 2018 in the Northern Territory, South Australia, or Western Australia. In accordance with Australian guidelines for the public health management of trachoma, a community was defined as a specific geographic location where people reside and there is at least one school.[10] Communities were classified as 'at risk' of trachoma by state/territory health departments if, at least once within the past 5 years, prevalence of Trachomatous inflammation–follicular and/or Trachomatous inflammation–intense was 5% or more in children aged 5–9 years screened.

Screening procedures

Due to the specific population who experience trachoma as a public health problem, Australia's approach to screening differs from other countries. Targeted active screening is undertaken only in communities classified as at risk of trachoma. The screening frequency for communities at risk of trachoma is specified according to the prevalence and degree of clustering of active trachoma cases. For instance, screening is typically conducted annually, although guidelines also provide jurisdictions the option to undertake biannual (two-yearly) screening in communities with low trachoma prevalence that would otherwise benefit little from annual screening. Australian guidelines have set a target of minimum 85% of resident children aged 5–9 years in communities screened per occasion.[10]

Public health and clinical staff responsible for routine trachoma control activities conducted enhanced screening among children aged 1–4 years throughout 2018 in the Northern Territory and South Australia, and during August–September in Western Australia. Teams explained the purpose of the enhanced screening to community residents. Lists of children aged 1–4 years in each community were provided by local healthcare services to teams. Children in this age group were recruited in pre-school, daycare centres, at playgroups, as well as in the home, following consent by parents or caregivers. Standard school-based screening of children aged 5–9 years continued as per routine procedures, with written permission provided in advance from parents or caregivers.

Clinical assessment

Diagnosis of active trachoma is by visual inspection by trained personnel, and defined as the presence of five or more follicles (white spots) ≥0.5 mm in diameter (TF) and/or inflammatory thickening of the upper tarsal conjunctiva obscuring more than half of the normal deep vessels (TI) in accordance with WHO simplified grading criteria.[18] Visual inspection was aided by the use of 2.5× binocular magnifying loupes.

Facial cleanliness

During screening, children are also examined for clean faces. Facial cleanliness is defined as the absence of nasal and ocular discharge, with children recorded as either with or without clean faces.

Data reporting

Jurisdictional health departments provide community-aggregated screening data for children aged 5–9 years annually to the National Trachoma Surveillance and Reporting Unit as part of routine surveillance. In 2018, the additional aggregated data collected from children aged 1–4 years was submitted as part of this process. The aggregated data submitted to the NTSRU records estimated resident populations, children screened for active trachoma,

children assessed with signs of clinical disease, children and household/community contacts requiring and receiving antibiotic treatment, and children screened for and presenting with clean faces. Data is provided by age group (1–4 years, 5–9 years, 10–14 years, 15+ years). Information about the antibiotic treatment of household/community contacts is also provided.

Statistical analysis

Observed active trachoma prevalence was calculated as the proportion of children in each age group screened with TF and/or TI, with Wilson's test used to estimate confidence intervals. A mixed-effect logistic regression model was used to estimate the association between active trachoma prevalence and age group (1–4 years vs 5–9 years), with community as a random effect. The significance level was set at 0.05. Where case numbers permitted, analysis was restricted by jurisdiction. Separate analyses were conducted for the association between facial cleanliness and age group. StataCorp (Stata 16) and Microsoft Excel (version 2402) were used for analysis.

Screening coverage was calculated as the proportion of resident children (derived using census data, updated annually by screening teams using school and/or health clinic enrolment lists and local advice on movement into and out of communities) in the target age group who were examined by assessors. Due to variable screening coverage, we conducted a secondary analysis which included only communities with comparable levels of coverage in the two age groups. The expected ratio of underlying population numbers in the two age groups was approximately 5:4.[19] Thus, we defined screening thresholds as being met in a community if the number of children aged 1–4 years screened was at least 64% (i.e. 80% of 80%) of the number of children screened aged 5–9 years. Communities that did and did not achieve this level of coverage were compared using Pearson chi-square test for categorical data, in terms of jurisdiction, size, screening coverage, and trachoma prevalence by age group.

Ethics statement

The collection, analysis, and reporting of Australia's jurisdictional trachoma surveillance data is approved by UNSW Sydney Human Research Ethics Committee (Committee B), number: HC200882.

Results

In 2018, 71 at-risk communities in the Northern Territory, South Australia, and Western Australia were screened for trachoma, with 64 (90%) also conducting enhanced screening among children aged 1–4 years. Just over half the communities that screened both age groups were in the Northern Territory (33/64, 52%), followed by Western Australia (25/64, 39%) (Table 1). Most communities were small, with 39% recording fewer than 30 resident children under the age of 10 years (Supplementary Table S1).

Across the 64 communities, 2907 children aged 1–9 years were screened for trachoma. Screening rates were higher among children aged 5–9 (88%), than for children aged 1–4 years (65%). A total of 206 cases of active trachoma were identified in children screened. Overall, observed active trachoma prevalence was 7.2% (95% CI: 6.1%–8.4%) in children aged 5–9 years and 6.9% (95% CI: 5.5%–8.7%) children aged 1–4 years. After controlling for community, there was no evidence of an association between age group and active trachoma prevalence, with the estimated odds ratio (OR) of 1.29 (95% CI: 0.93–1.79). When analyses were restricted by jurisdiction, there was no evidence of a higher odds of trachoma prevalence in the younger age group for either the Northern Territory (OR = 1.28, 95% CI: 0.82–2.00) or Western Australia (OR = 1.28, 95% CI: 0.78–2.11). The odds of having clean faces were three-fold higher for children in the older age group (OR = 3.31, 95% CI: 2.75–3.98) (Supplementary Table S2).

Analyses were restricted for the 20 communities in which the number of children aged 1–4 years screened was at least 64% of the number of children aged 5–9 years screened (Table 2). In these communities, 1169 children aged 1–9 years were screened, and 82 cases of active trachoma were reported. Observed active trachoma prevalence was 7.9% (95% CI: 6.1%–10.3%) for children aged 5–9 years and 5.9% (95% CI: 4.2%–8.2%) for children aged 1–4 years in communities meeting screening coverage thresholds. Again, no association was found between age group and active trachoma prevalence among all communities meeting screening thresholds (OR = 1.40, 95% CI: 0.85–2.29). We did not find evidence of an association between communities that did and did not achieve screening coverage and jurisdiction, community size, and trachoma prevalence by age group (Supplementary Table S1).

Discussion

WHO definition of elimination of trachoma as a public health problem includes the requirement for active

Table 1. Trachoma screening and prevalence by jurisdiction in communities conducting enhanced screening in 1–4 year olds, 2018.

	Northern Territory		South Australia		Western Australia		Total	
Communities	33		6		25		64	
Age groups	*1–4 years*	*5–9 years*	*1–4 years*	*5–9 years*	*1–4 years*	*5–9 years*	*1–4 years*	*5–9 years*
Resident Indigenous children	790	1,210	302	452	355	584	1,447	2,246
Examined for active trachoma (*n* [%[a]])	408 *(51.6)*	1,031 *(85.2)*	199 *(65.9)*	393 *(86.9)*	335 *(94.4)*	541 *(92.6)*	942 *(65.1)*	1,965 *(87.5)*
With active trachoma[b] (n)	34	82	1	3	30	56	65	141
% (95% CI)	*8.3 (6.0–11.4)*	*8.0 (6.5–9.8)*	*0.5 (0.1–2.8)*	*0.8 (0.3–2.2)*	*9.0 (6.3–12.5)*	*10.4 (8.1–13.2)*	*6.9 (5.5–8.7)*	*7.2 (6.1–8.4)*
Odds Ratio[c] (95% CI)	**1.28 (0.82–2.00)**		–		**1.28 (0.78–2.11)**		**1.29 (0.93–1.79)**	

[a]As a proportion of resident children.
[b]As a proportion of those examined for trachoma, unadjusted. Active trachoma is defined as the presence of trachomatous inflammation – follicular (TF) and/or trachomatous inflammation – intense (TI).
[c]Odds ratio not calculated for South Australia due to low trachoma prevalence.

Table 2. Trachoma screening and prevalence by jurisdiction (communities meeting screening coverage in children aged 1–4 years), 2018.

	Northern Territory		South Australia		Western Australia		Total	
Communities	7		2		11		20	
Age groups	*1–4 years*	*5–9 years*	*1–4 years*	*5–9 years*	*1–4 years*	*5–9 years*	*1–4 years*	*5–9 years*
Resident Indigenous children	227	237	274	252	167	212	668	701
Examined for active trachoma *[n (%[a])]*	176 *(77.5)*	221 *(93.2)*	190 *(69.3)*	235 *(93.3)*	161 *(96.4)*	186 *(87.7)*	527 *(78.9)*	642 *(91.6)*
With active trachoma[b] (n)	13	30	1	1	17	20	31	51
% (95% CI)	*7.4 (3.9–11.5)*	*13.6 (9.7–18.7)*	*0.5 (0.1–2.9)*	*0.4 (0.1–2.4)*	*10.6 (6.7–16.3)*	*10.8 (7.1–16.0)*	*5.9 (4.2–8.2)*	*7.9 (6.1–10.3)*
Odds Ratio[c] (95% CI)	**1.98 (1.00–3.93)**		–		**0.92 (0.43–1.97)**		**1.40 (0.85–2.29)**	

[a]As a proportion of resident children.
[b]As a proportion of those examined for trachoma, unadjusted. Active trachoma is defined as the presence of trachomatous inflammation–follicular (TF) and/or trachomatous inflammation–intense (TI).
[c]Odds ratio not calculated for South Australia due to low trachoma prevalence.

trachoma prevalence (TF) to be maintained below 5% in children aged 1–9 years.[8,9] The purpose of this study was to compare active trachoma prevalence between children aged 1–4 years and 5–9 years to determine if prevalence derived from the older age group underestimates prevalence for all children aged 1–9 years. Trachoma surveillance in Australia has concentrated on screening children aged 5–9 years for active trachoma in schools due to accessibility and to improve screening coverage. Our findings show no evidence of higher odds of trachoma prevalence in children aged 1–4 years versus children aged 5–9 years. This was consistent across jurisdictions (with sufficient data for comparison) and when analyses were restricted to communities meeting screening coverage thresholds in the younger age group. These findings provide support for the use of prevalence in children aged 5–9 years as the criteria for assessing one of the key indicators of elimination of trachoma as a public health problem in the Australian context.

There are several limitations to our study. According to existing research ethics and data sharing agreements, jurisdictional trachoma program data are aggregated by local health departments before being sent to the National Trachoma Surveillance and Research Unit. As such, it was not possible to explore (and statistically control for) factors that may have influenced relationships between age and active trachoma prevalence. Screening rates among children aged 1–4 years were generally lower than among those aged 5–9 years, which may have reduced power to detect differences in prevalence, particularly in the subgroup analyses. In addition, as a high income country, Australia's approach to trachoma control has features that differ from other countries with endemic trachoma. Specifically, guidelines allow for annual screening of designated at-risk communities. This, in turn, influences decisions about how widely antibiotic treatment (provided to all persons ≥3 kg) should be targeted in communities found to have active trachoma, that is, whether treatment is distributed to all community members or (if cases are clustered in a family unit) to household contacts only. The impact of this approach on age-group prevalences may differ from the conventional approach of annual mass drug administration at the district level according to population-based prevalence surveys.[20,21]

The WHO simplified grading scheme for trachoma has been widely adopted for trachoma endemic regions, including Australia.[18] There is recognition that clinical diagnosis of TF as a marker of ocular trachoma may lead to over-

estimation of disease due to weaker correlation between the presence of follicles and *C. trachomatis* infection in low prevalence settings.[22,23] PCR-based surveillance data has only been available from communities in one jurisdiction in Australia at the time of publication, and the very low levels of *C. trachomatis* in surveyed populations limit age-based comparisons.[24,25] Australia is currently planning future biomarker surveillance studies to inform ongoing management efforts. However, at the time of writing, prevalence according to the simplified grading scheme remains the approach officially endorsed by WHO for programmatic decision-making and as the basis of elimination thresholds.[8,9]

Facial cleanliness rates were significantly higher in children aged 5–9 years (Supplementary Table S2). This is not unexpected as facial hygiene promotion programs in Australia have largely been school-based. However, we cannot rule out the potential for measurement error, as the operational definition of facial cleanliness relies on observer judgement.[10] It is also possible that school age children were encouraged to wash their faces before being screened.

Conclusion

Our study provides evidence that national trachoma screening guidelines for Australia that focus on children aged 5–9 years are likely to provide estimates of prevalence that can be generalised to children aged 1–9 years in communities at risk of trachoma. Current prevalence data available for this age group can therefore be used to assess Australia's progress to meeting globally agreed elimination targets.

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Author contributions

CRediT: **Clare E. F. Dyer:** Writing – original draft, Writing – review & editing; **Alison Jaworski:** Data curation, Formal analysis, Writing – review & editing; **Carleigh S. Cowling:** Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Writing – review & editing; **Gordana C. Popovic:** Data curation, Formal analysis, Methodology, Writing – review & editing; **Donna B. Mak:** Conceptualization, Investigation, Methodology, Writing – review & editing; **Carlos Hernandez:** Conceptualization, Investigation, Methodology, Writing – review & editing; **Clare Huppatz:** Conceptualization, Investigation, Methodology, Writing – review & editing; **Paula Wines:** Conceptualization, Investigation, Methodology, Writing – review & editing; **Susana Vaz Nery:** Methodology, Supervision, Writing – review & editing; **John M. Kaldor:** Conceptualization, Funding acquisition, Methodology, Supervision, Writing – review & editing.

Disclosure statement

No potential conflict of interest was reported by the author (s).

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Data availability statement

Due to the ethical restrictions surrounding this research, supporting data is not available.

Data sharing statement

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