

Macniven Rona (Orcid ID: 0000-0002-2967-7977)

Indigenous ear health symptoms

Examining relationships between parent-reported factors and recurring ear symptoms among Aboriginal and Torres Strait Islander Children

Running title: Indigenous ear health symptoms

Fina Constantinides ¹ fconstantinides@gmail.com, Neil Orr ¹ neil.orr@mq.edu.au 0000-0002-5146-2278, Kai Nash ¹ kai.nash@mq.edu.au 0000-0001-7208-9698, John Robert Evans ² jrevans@swinburne.edu.au 0000-0003-1566-4507, Catherine M McMahon ¹ cath.mcmahon@mq.edu.au 0000-0001-7312-6593, Hasantha Gunasekera ^{3,4} hasantha.gunasekera@health.nsw.gov.au 0000-0003-4900-1277, Samantha Harkus ⁵ Samantha.Harkus@nal.gov.au 0000-0003-4067-3632, Liesa Clague ⁶ liesa.clague@nd.edu.au 0000-0002-9072-3135, Cara Cross ¹ cara.cross@mq.edu.au, Luke Halvorsen ¹ luke.halvorsen@mq.edu.au 0000-0001-6346-0264, Noeleen Lumby ¹ noeleen.lumby@mq.edu.au, Harvey Coates ⁷ harvey.coates@uwa.edu.au 0000-0003-2399-3183, Rona Macniven ^{1,8} r.macniven@unsw.edu.au 0000-0002-2967-7977

1. Macquarie University Hearing, Department of Linguistics, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, NSW, Australia

2. Moondani Toombadool Centre, Swinburne University of Technology, Melbourne, VIC, Australia

3. Faculty of Medicine and Health, University of Sydney, Sydney, NSW, Australia

4. The Children's Hospital at Westmead, Sydney, NSW, Australia

5. National Acoustic Laboratories, Sydney, NSW, Australia

6. School of Nursing and Midwifery, University of Notre Dame, Sydney, NSW, Australia

7. School of Medicine, The University of Western Australia, Perth, WA, Australia

8. School of Population Health, UNSW Sydney, Sydney, NSW, Australia

Funding

None

Acknowledgements

We would like to acknowledge the contributions of the participating families in the Longitudinal Study of Indigenous Children.

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process which may lead to differences between this version and the [Version of Record](#). Please cite this article as doi: [10.1002/hpja.719](https://doi.org/10.1002/hpja.719)

Indigenous ear health symptoms

Conflict of interest

The authors declare no conflict of interest.

Ethics

The Longitudinal Study of Indigenous Children has approval from the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) Ethics Committee. Additionally, state and territory and/or regional ethics clearance and support have been obtained for all Footprints in Time sites through state and territory HRECs or their equivalents.

Keywords

Health Services, Indigenous; Child; Public Health; Cohort Studies

Abstract

Issue addressed: Aboriginal and Torres Strait Islander child ear health is complex and multiple. We examined relationships between parent-reported sociodemographic, child health, health service access factors, and ear symptoms among Aboriginal and Torres Strait Islander children aged 3-7 years.

Methods: The Longitudinal Study of Indigenous Children is a large child cohort study with annual parent-reported data collection. Generalised linear mixed model analyses examined Wave 1 (1309 children 0-5 years; 2008) predictors of being free of parent-reported ear symptoms in both Waves 2 and 3.

Results: One thousand and thirty 1030 (78.7%) had no reported ear symptoms in either Wave 2 or 3. In the fully adjusted model, children who had been hospitalised in the past year (aOR = 2.16; 95% CI 1.19-3.93) and those with no ear symptoms (aOR = 2.94; 95% CI, 1.59-5.46) at Wave 1 had higher odds of no ear symptoms in both the subsequent waves. There were also relationships between parent main source of income - government pension or allowance

Indigenous ear health symptoms

as well as parents who reported no history of their own ear symptoms and higher odds of no ear symptoms in Waves 2 and 3 after partial adjustment for sociodemographic factors.

Conclusion: These findings suggest relationships between different sociodemographic and health factors and parent-reported ear symptoms among Aboriginal and Torres Strait Islander children that warrant further investigation.

So what? Children with parent-reported ear symptoms during the early years need holistic support to prevent future ear symptoms that impact health, social and educational life trajectories.

Keywords: Health Services, Indigenous; Child; Public Health; Cohort Studies

Introduction

It is widely recognized that health inequalities are experienced by Aboriginal and Torres Strait Islander people in Australia. [1] Broad structural determinants such as racism, play a dominant role in such health outcomes, [2] including social determinants, the conditions where people learn, live, play and grow. [3] Cultural determinants that embody Aboriginal and Torres Strait Islander worldviews are a beneficial influence. [4] Strategies to improve health and reduce inequality must holistically address these determinants for there to be an improvement in Aboriginal and Torres Strait Islander health. [5, 6] In the Aboriginal community-controlled health service (ACCHS) model, medical management is holistic and based on cultural safety principles where language and spiritual practices are embedded into care. [7] ACCHSs, including Aboriginal Medical Services, recognise that health outcomes are determined by socioeconomic and political factors that influence living and working conditions, lifestyle factors and emotional wellbeing. [2]

Indigenous ear health symptoms

Ear health is a significant health issue among Aboriginal and Torres Strait Islander children, who experience some of the highest rates of otitis media, or middle ear infection, in the world. [8, 9] Although reported ear and hearing problems (0-14 years) decreased from 11% to 2001 to 7% in 2018 – 19, hearing loss is higher in remote (59%) than non-remote areas (39%). [10] Further, Aboriginal and Torres Strait Islander children are more likely to experience the effects of unmanaged ear health and associated hearing problems on speech, language and education. [8] The causes of otitis media are multiple and complex and it is a public health challenge. [11] However, an examination of the determinants of ear health among Aboriginal and Torres Strait Islander people found health service access to be one of the key predictors of poor ear health, in addition to social factors that influence child health including household overcrowding, passive smoking, low income, and poverty. [12]

Aboriginal and Torres Strait Islander children experience a higher incidence and more severe otitis media such as Chronic Suppurative Otitis Media and associated complications, and mild to moderate conductive hearing loss, particularly in remote areas. [13]

The Longitudinal Study of Australian Children (LSAC), a nationally representative cohort of children living in urban and regional areas in Australia, examined the social determinants of healthy ears and health service usage among Australian children with otitis media. [14] In two cross sectional analyses, at age 4-5 years and at age 10-11 years, 7.9% and 3.3% of Australian children were reported via parent questionnaires to have otitis media, respectively. Sociodemographic and child health factors associated with good ear health included breastfeeding, parental smoking less than once per day and fathers having completed year 10 or higher in their schooling. [14] Approximately 5% of the LSAC baseline sample are Aboriginal and Torres Strait Islander children who were less likely to have good ear health than other (non-Indigenous) Australian children in the sample. [14]

Indigenous ear health symptoms

Few studies have examined health service access and early childhood ear health. There are long waiting times for diagnosis and specialist treatment, including audiology and surgery, regardless of location. [15, 16] As well, there is a discrepancy in the burden of otitis media in Aboriginal and Torres Strait Islander communities and the provision of specialist services resulting in significant underservicing. [15]

The Longitudinal Study of Indigenous Children (LSIC) is a cohort study that is following 1671 Aboriginal and Torres Strait Islander children from 11 urban, regional and remote communities and was established in 2008 (Wave 1). [17] Parent-reported data from Wave 1 (aged 0 to 5 years) indicated that ear health symptoms were the most common health problem among Aboriginal and Torres Strait Islander children (experienced by 20% of children), [18] with a similar proportion experienced in Wave 6 [19] when the cohort was aged from 5 to 10 years suggesting that ear health symptoms are common and persistent.

Health service utilisation was examined in Wave 6 data collected in 2013, where 32% of children had accessed Aboriginal Medical Services in the previous year, a higher proportion than healthcare settings such as general practitioners (GP) and community health centres; 18% had accessed hospital care. [19] Despite Aboriginal and Torres Strait Islander children experiencing health care access challenges and the high rates of ear health problems being well known, the relationship between health service access and ear health have not previously been studied. Understanding this relationship is an important first step to help inform strategies to improve Aboriginal and Torres Strait Islander child ear health. The current study aims to use LSIC data to examine relationships between parent-reported sociodemographic, child health, health service access factors and ear symptoms.

Methods

Design

Indigenous ear health symptoms

We conducted a longitudinal analysis of LSIC from Wave 1 (2008; 0 – 5 years) to Wave 3 (2010; 2 – 7 years).

Participants

The study included 1309 child participants from Waves 1 – 3 where ear health data were available in both Waves 2 and 3, using parent proxy (for child data) and parent self-report data (parent data). At the beginning of the study in 2008/2009 parents provided informed consent for themselves and their children to participate in the study. Data were collected during face-to-face interviews with the principal parent (primary carer) annually by Indigenous Research Administration Officers (RAOs) in English or Aboriginal language. This parent (Parent 1) was identified as the adult family member who spends the most time with the child, mainly a parent (96%), usually the mother (93%) as well as grandparents (2.8%) and a small number of other extended family members or foster carers. [18] There are two cohorts in the LSIC study: the Birth cohort and the Kindergarten cohort. In 2008 (Wave 1), the Birth (B) cohort was aged between 6 and 18 months and the Kindergarten (K) cohort was aged between 3.5 and 5 years. Participants were deliberately recruited from 11 urban, regional and remote sites in all Australian states and the Northern Territory and a range of socio-economic and community locations where Aboriginal and Torres Strait Islander children live. [20] A detailed LSIC cohort profile paper describing community engagement and governance in all aspects, design, community and participant sampling, questionnaire development, piloting, data collection procedures, baseline, and early wave follow-up characteristics has been published. [17]

Measures

Outcome variable: parent-reported child ear symptoms was the outcome variable in the study. In the interviews, parents were asked about any health problems their child might have had,

Indigenous ear health symptoms

with response options (1) runny ears, (2) perforated ear drum, (3) total deafness, (4) deaf in one ear, (5) hearing loss/partially deaf, and (6) other ear problems. If parents asked, other descriptors for the term ‘runny ears’ were provided for clarification by the Indigenous RAOs including ‘Glue ear’; ‘Tropical ear’; ‘Chronic Suppurative Otitis Media’; ‘Ear infections’; ‘Middle ear infection’; ‘Fluid in ears’; and ‘may have needed grommets’. [8, 21] Children whose parent responded ‘Yes’ to any option for this question in both Waves 2 and 3 were classified as having recurring ear health symptoms [22].

Sociodemographic, child health, and health service variables were selected based on their previous associations or relationships with ear health as demonstrated in the literature, [12–15] drawn from Wave 1. The sociodemographic predictor variables in the study were age (0 – 1; 2 – 3; 4 – 5 years), sex (Male; Female), Parent 1 is partnered (Yes; No), main source of income - wages or salary, [6] (Yes; No), main source of income - government pension or allowance, [6] (Yes; No), socio-economic status as measured by the 2006 Decile of Relative Indigenous Socioeconomic Outcomes (IRISEO) measure. [23] This indicator was transformed into tertiles resulting in the following classifications: (Most advantaged (8–10); Mid-advantaged (4–7); Most disadvantaged (1–3)). [24] [25] We also included the Australian Statistical Geography Classification (ASGC) Remoteness Area 2006 categories (urban; regional and remote), [26] and home occupancy type (Government/community rental; Private rental; Owned – outright/mortgage).

There were five parent-reported health variables including whether Parent 1 (the respondent) had ever had ear symptoms that made it difficult for you to look after their child (Yes; No) and Parent 1’s current smoking status (Yes/Casually; No). We also included indicators about whether the study child had difficulty sleeping (Yes; No), whether the study child had ever been breastfed (Yes; No), and a Global Health for the study child through the one-item measure on self-rated health, [27] (Excellent; Very Good; Good; Fair/ Poor).

Indigenous ear health symptoms

There were 10 health service access variables in the study including whether the study child had been hospitalised in past year (Yes; No), whether the child had received home visits from health professionals (a list of five) and the number of visits they received (health professionals included nurse, midwife, social worker, Aboriginal health worker and GP. The variable was coded as 0 home visits and/or 1 or more. In addition, we included whether the child had seen health services in the past year (a list of four - Aboriginal Medical Services, Maternal and Child Health Centre, Other community health centre or clinic, Doctor surgery or clinic, which were each coded as Yes or No). A strengths-based approach was adopted in the analysis where we focused on the absence of reported ear health symptoms. [28]

Data Analysis

Firstly, the number and percentage of children with parent-reported ear symptoms across categories of sociodemographic, child health, and health access variables were examined using descriptive statistics. Chi squared tests were performed to determine whether the predictor variables from Wave 1 were associated with ear health symptoms in Waves 2 and 3.

Secondly, we used a generalised linear mixed model to examine relationships between the outcome variable and the Wave 1 covariables and predictor variables that were statistically significant ($p \leq 0.05$) in the chi-square tests. The variables included in the model were Parent 1 is partnered (reference group [ref]: Yes), Main Source of Income- Any Government pension/allowance (ref: Yes), Parent 1 smokes (ref: No), Parent 1 had ear symptoms (ref: Yes), Child has difficulty sleeping (ref: Yes), Child ever breastfed (ref: No), Home visits - Nurse (ref: 1 or more). The model was adjusted for each variable within the model and study sample site clustering according to Indigenous Area. [29] A series of four generalised linear mixed models examined relationships between each variable that was statistically significant in the unadjusted tests and the outcome variable, adjusting for potential mediating or

Indigenous ear health symptoms

confounding variables of Parent 1 had ear symptoms, Study child Wave 1 runny ears, Parent 1 is partnered, Main source of income Gov pension/allowance.

Two subsequent models were additionally adjusted for Parent 1 is partnered, Main source of income Gov pension/allowance. Adjusted odds ratios (ORs) and 95% confidence interval (CI) are reported in the results tables. For all statistical tests, $p \leq 0.05$ was used to indicate statistical significance. IBM SPSS Version 27 (IBM Corporation, Armonk, New York) was used for data analysis.

Ethical Approval

LSIC has approval from the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) Ethics Committee. State and territory and/or regional ethical approval has been obtained for all study sites through state and territory Human Research Ethics Committees or their equivalents. Approval to access the LSIC data was obtained from the Australian Department of Social Services.

Results

Parent-reported data on ear symptoms was available for 1309 children in both Waves 2 and 3 (Table 1). Fifty-four (4.1%) children were reported by parents to have ear symptoms in both waves and 225 (17.2%) children had reported ear symptoms in either Wave 2 or 3. 1030 (78.7%) children were reported to have no ear symptoms in either Wave 2 or 3.

Among children whose Parent 1 were partnered, 78% had no reported ear symptoms in Wave 2 and 3 compared to those whose Parent 1 was single (81%; $p = 0.03$). A higher proportion of children whose parent's main source of income was a government pension/allowance in Wave 1 reported no ear symptoms in Wave 2 and 3 (81%) compared to those with a different main source of income (75%; $p = 0.02$). Among children whose Parent 1 reported a history

Indigenous ear health symptoms

of ear symptoms themselves, 65% had no ear symptoms in Wave 2 and 3, compared to 79% of children whose parent reported no such history ($p < 0.01$). Among children with reported ear symptoms in Wave 1, 60% had no reported ear symptoms in Wave 2 and 3. Among children with no reported ear symptoms in Wave 1, a higher proportion (83%) had no reported ear symptoms in Wave 2 and 3 ($p < 0.01$). Among children whose Parent 1 currently smoked, 82% had no reported ear symptoms in Wave 2 and 3. Among children of non-smoking parents a lower proportion (76%) had no reported ear symptoms in Wave 2 and 3 ($p = 0.05$). A lower proportion of children with difficulty sleeping had no ear symptoms in Waves 2 and 3 (78%), compared to those with no difficulty sleeping (81%; $p = 0.01$). A lower proportion of children who were ever breastfed reported no ear symptoms in Wave 2 and 3 (77%) compared to children who were not breastfed (85%; $p = 0.02$). The proportion of children who had been hospitalised in the past year and did not have ear symptoms in Wave 2 and 3 was higher (80%) than those who had not been hospitalised (76%; $p < 0.01$). A lower proportion of children who had received one or more home visits from a nurse in the past year at Wave 1 had no ear symptoms in Wave 2 and 3 (76%) compared to those who had not had nurse home visits (79%; $p = 0.03$).

In the analysis adjusted for all significant variables and study site clustering (Table 2), children with reported ear symptoms in Wave 1 were more than twice as likely to have reported ear symptoms in Wave 2 and 3 (aOR = 2.91; 95% CI, 1.57- 5.40). Children who had been hospitalised in the past year at Wave 1 were also more than twice as likely to have no ear symptoms reported Wave 2 and 3 ([aOR] = 2.16; 95% CI, 1.19 - 3.94) or in Wave 2 and 3 ([aOR] = 2.42; 95% CI, 1.24- 4.73) compared with children who had not been hospitalised.

Table 3 presents the additional analysis of relationships between Wave 1 child health and health service access variables and ear symptoms in both Waves 2 and 3, adjusted each sociodemographic variable and study site clustering. Children whose Parent 1 were single

Indigenous ear health symptoms

were almost twice as likely to have no ear symptoms reported in Wave 2 and 3 compared to those whose Parent 1 was partnered after adjusting for Parent 1 ear symptoms only ([aOR] = 1.94; 95% CI, 1.06- 3.56). Children whose parent's main source of income was a government pension/allowance in Wave 1 were almost twice as likely to have no reported ear symptoms in Wave 2 and 3 after adjusting for Parent 1 ear symptoms ([aOR] = 1.95; 95% CI, 1.11 - 3.43) or Study child ear symptoms ([aOR] = 1.82; 95% CI, 1.04 - 3.19) compared to those with a different main source. Children whose Parent 1 reported no history of their own ear symptoms were almost four times as likely to have no reported ear symptoms in Wave 2 and 3 after adjusting for Parent 1 is partnered ([aOR] = 3.90; 95% CI, 1.43 - 10.62) or Main source of income – Government pension or allowance ([aOR] = 3.98; 95% CI, 1.45 - 10.86) compared to children whose parent reported a history of their own ear symptoms. Children with no difficulty sleeping in Wave 1 were more likely to not have ear symptoms in Waves 2 and 3 after adjusting for Parent 1 ear symptoms only ([aOR] = 1.84; 95% CI, 1.02- 3.34) compared to children with difficulty sleeping. Children who had received one or more home visits from a nurse in the past year at Wave 1 were over twice as likely to not have ear symptoms in Waves 2 and 3 after adjusting for Main source of income – Government pension or allowance than those who had not received a home visit from a nurse.

Discussion

This study presents new evidence of relationships between sociodemographic, child health, and health service factors and ear health among Aboriginal and Torres Strait Islander children. We found that children who had no history of ear symptoms and those who had been hospitalised in the past year, at age 0 – 5 years, had better ear health at age 2 - 7 years, using parent-reported data. We also found some evidence of better ear health among children whose responding parent was single, where their main source of income was a government pension/allowance, where the parent had no history of ear symptoms themselves, where the

Indigenous ear health symptoms

child had no difficulty sleeping or where the child received at least one home visit from a nurse at age 0 – 5 years but only in analyses adjusted for specific potential confounding factors. However, these effect sizes were small and these variables are subject to multiple complex inter-relationships.

The proportion of parent-reported ear symptoms in the present study of 4.1% in both Waves 2 and 3 and 17.2% in either Wave 2 or 3 is consistent with data from Wave 6, [19] and is broadly consistent with another study [30] and Aboriginal and Torres Strait Islander experiences. [9] This study adds value to prevalence estimates in identifying longitudinal predictors of the prevalence of parent-reported ear symptoms in this large, national sample of Aboriginal and Torres Strait Islander children. [17]

In the analyses partially adjusted for parent ear symptoms or child prior ear symptoms only, we found that children whose parent's main source of income was a government pension or allowance, [6] at Wave 1 were more likely to have better ear health in the two years subsequently. Income is a key socioeconomic indicator, [23] and the relationship between both income and socioeconomic status and ear health appears to be complex. A 2009 review of otitis media risk factors acknowledged great variability in the association between otitis media and low socioeconomic status. Limited access to health care may be a mediating factor. [13] A more recent scoping review of the determinants of otitis media found social and environmental factors such as overcrowded housing, poverty and limited access to services were otitis media risk factors [12] Forty five percent of Aboriginal and Torres Strait Islander people receive government cash pension or allowance as their main source of income, [10] that can be considered a proxy for low socioeconomic status. The direction of the finding in this analysis is a little surprising. It may indicate that LSIC families with this source of income are receiving access to health care through social welfare provisions such as

Indigenous ear health symptoms

an Australian Government Health Care Card. The Health Care Card reduces health care expenses such as prescription costs, [31] and may be contributing towards preventing the development, sustainability, or recurrence of ear symptoms. Regardless of source, having adequate income is a key pillar of good health, [3] and such income support type needs to be sufficiently resourced to cover costs of living, including those that relate to healthcare.

Previous studies have identified that remote areas have a higher prevalence of otitis media due to socioeconomic status, educational factors, and inaccessibility of services, with health service accessibility and provision affected by remoteness. [15] However, the present study did not find that remoteness or area-level socioeconomic status in Wave 1, measured through an Aboriginal and Torres Strait Islander specific index, [23] predicted parent-reported ear symptoms in Waves 2 and 3. While socioeconomic status and remoteness are intrinsically linked for Aboriginal and Torres Strait Islander people, [24] the ongoing effects of settler colonisation and social exclusion have led to complex health inequalities that cannot purely be explained by socioeconomic status. [32] Broader, historical and cultural determinants of health exist where Indigenous people still experience comparatively poorer health outcomes when socioeconomic status, educational factors and health behaviours are equal to other populations. [33] Through a cultural lens that not only addresses the health concern, but also underlying cultural determinants, [34] service access needs to be viewed not only in terms of availability, [35] but also in terms of cultural safety for Aboriginal and Torres Strait Islander people as well as the historical and sociopolitical context. [33] Services must address the biomedical, social and cultural determinants of health in order to improve health equity for all Australians. [2] Aboriginal and Torres Strait Islander peoples have always understood that health and wellbeing is intrinsically linked to a holistic approach to healthcare, knowledge of culture, connection to land and community, recognising the positive effects that cultural connection has to self-esteem, collective identity and resilience, and the subsequent benefit of

Indigenous ear health symptoms

these factors to health and wellbeing. [34] These values are fundamental to improving ear health.

There was a strong, yet somewhat unexpected, finding in the present study of a relationship between child hospitalisation, for any reason, and better ear health. This may indicate children who have been hospitalised had better access to care and is consistent with the finding of a relationships between home visits from a nurse and better ear health, after adjusting for income source. Healthcare access could include increased proximity to services, more culturally appropriate care, or private health insurance to support access however such variables are not available in LSIC. As access to health services is a known determinant of ear health, [12] it may be that hospitalisation within a supportive, reliable, coordinated and trusted health system, [35] can lead to better ear health outcomes. Although it is acknowledged that preventing hospitalisations through quality preventive, primary and community care is optimal, [36] and this is reflected in the benefits of timely nurse home visits during the early years. Further, LSIC has already identified that equitable access to health service facilities, including tertiary care, is pivotal for the detection and treatment of health conditions, [19] and we recommend strategies to strengthen access to health care services. .

The finding that children without ear symptoms in Wave 1 were more likely to be without ear symptoms subsequently in both Waves 2 and 3 is not surprising given known recurrence but further highlights the impact on future ear health. [8, 13, 37] We also found that children whose parents had a history of ear symptoms had higher odds of subsequent parent-reported ear symptoms, after adjusting for the potential sociodemographic confounding variables of parent relationship status and income source which may be explained by genetic predisposition. [11, 13] Some previous Australian, [13, 14, 38] and international, [39] studies have found that breastfeeding and smoke free homes predict better ear health but no

Indigenous ear health symptoms

associations were found in an epidemiological study in an urban location, [37] and this was not apparent in our analyses. We did find that children with no difficulty sleeping had better ear health after adjusting for parent ear symptoms but not other potentially confounding factors; this could be due to bidirectional relationships between sleep and ear symptoms. While a link between ear health and sleep has been found, [13] good sleep habits may contribute to future ear health.

Strengths and Limitations

The LSIC is a well-established dataset and has been used as a data source to explore a range of social, economic, welfare and health issues for Aboriginal and Torres Strait Islander children across a range of areas. The strengths of the dataset include high participant follow-up rates and the advantages afforded by data from a large cohort study. Although not a random sample, LSIC participant locations are generally representative of the population distribution of Aboriginal and Torres Strait Islander children. [17] LSIC uses parent reported data that has inherent limitations, including recall bias, desirability bias and the under-reporting of less severe infections, which may not be noticed by parents, particularly those with multiple life stressors. Differences between parent reported data and objectively measured data may due to lack of severity of infection or recall bias. [14] The LSIC questionnaire asks about any episodes occurring in the past year and so does not identify if a child has had multiple infections in one year or just a single episode. [14] However, middle ear infections are difficult for parents to determine, [40] and an analysis of missing data indicated that ear symptoms data were more commonly missing among low socioeconomic and remote families. This suggests that parent-reported data may have differed across socioeconomic and remoteness categories although there were over 200 responses in each IRESIO and ASGC category, allowing for their inclusion in the analysis, and there were no

Indigenous ear health symptoms

missing data differences by child age or sex groups. Nonetheless, the use of parent-report gives child ear health data obtained at a lower cost and participant time and burden than clinical measures in this large sample.

Conclusion

This analysis of data from LSIC found new evidence of relationships between sociodemographic, child health, and health service access predictors factors and parent-reported ear health among Aboriginal and Torres Strait Islander children aged 0 – 5 years. These were receiving a government pension or allowance, hospitalisation in the past year and having no prior ear symptoms, which were related to good ear health among children at age 2- 7 years. These findings contribute to the evidence base that can inform future culturally safe, holistic strategies to improve health equity such as ensuring Aboriginal and Torres Strait Islander families have adequate support and improving healthcare access.

References

1. Australian Institute of Health and Welfare, *Tracking progress against the Implementation Plan goals for the Aboriginal and Torres Strait Islander Health Plan 2013–2023*. 2021, AIHW: Canberra.
2. Pearson, O., et al., *Aboriginal community controlled health organisations address health equity through action on the social determinants of health of Aboriginal and Torres Strait Islander peoples in Australia*. BMC Public Health, 2020. **20**(1): p. 1859.
3. Marmot, M., *Social determinants and the health of Indigenous Australians*. Med J Aust, 2011. **194**(10): p. 512-3.
4. Verbunt, E., et al., *Cultural determinants of health for Aboriginal and Torres Strait Islander people – a narrative overview of reviews*. International Journal for Equity in Health, 2021. **20**(1): p. 181.
5. Bond, C.J. and D. Singh, *More than a refresh required for closing the gap of Indigenous health inequality*. Medical Journal of Australia, 2020. **212**(5): p. 198-199.e1.
6. Australian Institute of Health and Welfare, *Indigenous income and finance*. 2021, AIHW: Canberra.
7. Harfield, S.G., et al., *Characteristics of Indigenous primary health care service delivery models: a systematic scoping review*. Globalization and Health, 2018. **14**: p. 12.
8. O'Connor TE, P.C., Lannigan FJ., *Complications of otitis media in Indigenous and non-Indigenous children*. Med J Aust 2009. **191**(9 Suppl): p. S60.
9. Kong, K., *Indigenous people and ear disease*. Deafness & Education International, 2020. **22**(4): p. 251-254.
10. Australian Institute of Health and Welfare. *Aboriginal and Torres Strait Islander Health Performance Framework (HPF) Tier 1 - Health status and outcomes 1.15 Ear health*. 2023; Available from: <https://www.indigenoushpf.gov.au/measures/1-15-ear-health>.
11. Fraser, S., J.C. Post, and M.L. Casselbrant, *Impact of Genetic Background in Otitis Media Predisposition*, in *Otitis Media: State of the art concepts and treatment*, D. Preciado, Editor. 2015, Springer International Publishing: Cham. p. 17-22.
12. DeLacy, J., T. Dune, and J.J. Macdonald, *The social determinants of otitis media in Aboriginal children in Australia: are we addressing the primary causes? A systematic content review*. BMC Public Health, 2020. **20**(1): p. 492.
13. Kong K and Coates HL, *Natural history, definitions, risk factors and burden of otitis media*. Med J Aust 2009. **191**(9 Suppl): p. S39-43.
14. Yiengprugsawan, V. and A. Hogan, *Ear infection and its associated risk factors, comorbidity, and health service use in Australian children*. Int J Pediatr, 2013. **2013**: p. 963132.
15. Gunasekera H, M.P., Daniels J, Couzos S, Craig JC., *Otitis media in Aboriginal children: the discordance between burden of illness and access to services in rural/remote and urban Australia*. J Paediatr Child Health, 2009 **45**(7-8): p. 425-30.
16. Practitioners, N.A.C.C.H.O.a.T.R.A.C.o.G., *National guide to a preventive health assessment for Aboriginal and Torres Strait Islander people 3rd edn*. 2018, RACGP: East Melbourne, Vic.
17. Thurber, K.A., et al., *Cohort Profile: Footprints in Time, the Australian Longitudinal Study of Indigenous Children*. International journal of epidemiology, 2015. **44**(3): p. 789-800.
18. Department of Families, H., Community Services and Indigenous Affairs, , *Footprints in Time: The Longitudinal Study of Indigenous Children—Key Summary Report from Wave 1*. 2009, FaHCSIA: Canberra.
19. Lovett, R. and K.A. Thurber, *Health Conditions and Health Service Utilisation among Children in LSIC*, in *Indigenous Children Growing Up Strong: A Longitudinal Study of Aboriginal and Torres Strait Islander Families*, M. Walter, K.L. Martin, and G. Bodkin-Andrews, Editors. 2017, Palgrave Macmillan UK: London. p. 209-231.

Indigenous ear health symptoms

20. Dodson, M., B. Hunter, and M. McKay, *Footprints in time: the longitudinal study of indigenous children: a guide for the uninitiated*. Family Matters, 2012(91): p. 69-82.
21. Rosenfeld, R.M., et al., *Clinical Practice Guideline: Otitis Media with Effusion (Update)*. Otolaryngol Head Neck Surg, 2016. **154**(1 Suppl): p. S1-s41.
22. Morrow, A., et al., *Parent Perspectives of Ear Health and the Relationship with Children's Speech and Language in the Longitudinal Study of Indigenous Children*. Children, 2023. **10**(1): p. 165.
23. Biddle N, *Ranking Regions: Revisiting an Index of Relative Indigenous Socioeconomic Outcomes*. 2009, Centre for Aboriginal Economic Policy Research, Working Paper No. 50: Canberra.
24. Macniven, R., et al., *Footprints in Time: Physical Activity Levels and Sociodemographic and Movement-Related Associations Within the Longitudinal Study of Indigenous Children*. J Phys Act Health, 2021. **18**(3): p. 279-286.
25. Thurber, K.A., et al., *Early Life Predictors of Increased Body Mass Index among Indigenous Australian Children*. PLoS ONE, 2015. **10**(6): p. e0130039.
26. Wilson, R., et al., *Lifestyle clusters and academic achievement in Australian Indigenous children: Empirical findings and discussion of ecological levers for closing the gap*. SSM - Population Health, 2020. **10**: p. 100535.
27. Ware, J.E. and B. Gandek, *Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project*. Journal of Clinical Epidemiology, 1998. **51**(11): p. 903-912.
28. Thurber, K.A., et al., *Strengths-based approaches for quantitative data analysis: A case study using the Australian Longitudinal Study of Indigenous Children*. SSM - Population Health, 2020. **12**: p. 100637.
29. Australian Bureau of Statistics, *Australian Statistical Geography Standard (ASGS): Volume 2—Indigenous Structure, Catalogue No. 1270.0.55.002*. . 2016, Australian Bureau of Statistics: Canberra, Australia.
30. Morris, P.S., et al., *Otitis media in young Aboriginal children from remote communities in Northern and Central Australia: a cross-sectional survey*. BMC pediatrics, 2005. **5** (27).
31. Australian Government, A.I.o.H.a.W., *Australia's health 2018*. 2018, AIHW: Canberra.
32. Krieger, N., *Proximal, Distal, and the Politics of Causation: What's Level Got to Do With It?* American Journal of Public Health, 2008. **98**(2): p. 221-230.
33. Finlay, S.M., et al., *Chapter 2 Aboriginal and Torres Strait Islander connection to culture: building stronger individual and collective wellbeing*. MEDICAL JOURNAL OF AUSTRALIA, 2021. **214**: p. S12-S16.
34. Lowitja Institute, *We nurture our culture for our future, and our culture nurtures us: close the gap*. 2020, Lowitja Institute: Melbourne.
35. Nolan-Isles, D., et al., *Enablers and Barriers to Accessing Healthcare Services for Aboriginal People in New South Wales, Australia*. International Journal of Environmental Research and Public Health, 2021. **18**(6): p. 3014.
36. Quilty, S., et al., *Addressing Profound Disadvantages to Improve Indigenous Health and Reduce Hospitalisation: A Collaborative Community Program in Remote Northern Territory*. International Journal of Environmental Research and Public Health, 2019. **16**(22): p. 4306.
37. Spurling, G.K., et al., *Household number associated with middle ear disease at an urban Indigenous health service: a cross-sectional study*. Aust J Prim Health, 2014. **20**(3): p. 285-90.
38. Jacoby, P.A., et al., *The effect of passive smoking on the risk of otitis media in Aboriginal and non-Aboriginal children in the Kalgoorlie-Boulder region of Western Australia*. Medical Journal of Australia, 2008. **188**(10): p. 599-603.
39. Alho, O.P., Läärä, and H. Oja, *How should relative risk estimates for acute otitis media in children aged less than 2 years be perceived?* J Clin Epidemiol, 1996. **49**(1): p. 9-14.

Indigenous ear health symptoms

40. Lo, P.S., et al., *Parental suspicion of hearing loss in children with otitis media with effusion*. *Eur J Pediatr*, 2006. **165**(12): p. 851-7.

Accepted Article

Table 1. Ear symptoms reported across Waves 2 and 3 and relationships with sociodemographic, health related and health access variables in Wave 1 participants in the Longitudinal Study of Indigenous Children

	LSIC		Wave 2, 3 combined: child ear symptoms						<i>P</i> value
	Wave 1		Yes in 0 waves		Yes in 1 wave		Yes in 2 waves		
	N	%	N	%	n	%	n	%	
Total ^a	1309	n/a	1030	78.7	225	17.2	54	4.1	
<i>Wave 1 Sociodemographic variables</i>									
Age (years)									
0 – 1	601	48.5	469	78.0	103	17.1	29	4.8	0.24
2 – 3	169	13.7	134	79.3	26	15.4	9	5.3	
4 - 5	468	37.8	375	80.1	82	17.5	11	2.4	
Sex									
Male	662	50.6	510	77.0	122	18.4	30	4.5	0.33
Female	647	49.4	520	80.4	103	15.9	24	3.7	
P1 is partnered									
Yes	706	57.0	548	77.6	121	17.1	37	5.2	0.03
No	532	43.0	430	80.8	90	16.9	12	2.3	

Main Source of Income- Wages or salary									
Yes	522	42.9	401	76.8	99	19.0	22	4.2	0.28
No	695	57.1	560	80.6	109	15.7	26	3.7	
Main Source of Income- Government Pension or allowance									
Yes	840	69.0	677	80.6	138	16.4	25	3.0	0.02
No	377	31.0	284	75.3	70	18.6	23	6.1	
2006 Decile of Relative Indigenous Socioeconomic Outcomes (IRISEO)									
Most advantaged (8–10)	250	20.2	200	80.0	39	15.6	11	4.4	0.17
Mid-advantaged (4–7)	781	63.1	621	79.5	136	17.4	24	3.1	
Most disadvantaged (1–3)	207	16.7	157	75.8	36	17.4	14	6.8	
Australian Statistical Geography Classification (ASGC) Remoteness area 2006									
Urban	363	29.3	284	78.2	64	17.6	15	4.1	0.85
Regional	492	39.7	393	79.9	83	16.9	16	3.3	
Remote	383	30.9	301	78.6	64	16.7	18	4.7	
Home occupancy type									
Government/community rental	714	54.5	582	81.5	104	14.6	28	3.9	0.08
Private rental	258	19.7	197	76.4	51	19.8	10	3.9	

Owned – outright/mortgage	337	25.7	251	74.5	70	20.8	16	4.7	
<i>Wave 1 Health variables</i>									
Parent 1 has had ear symptoms									
Yes	40	3.3	26	65.0	9	22.5	5	12.5	<0.01
No	1183	96.7	939	79.4	201	17.0	43	3.6	
Study Child has had prior ear symptoms									
Yes	218	17.8	130	59.6	68	31.2	20	9.2	<0.01
No	1009	82.2	839	83.2	142	14.1	28	2.8	
Parent 1 currently smokes									
Yes/ Casually	667	53.9	545	81.7	99	14.8	23	3.4	0.05
No	570	46.1	433	76.0	111	19.5	26	4.6	
Study Child has difficulty sleeping									
Yes	305	25.1	225	78.3	62	20.3	18	5.9	0.01
No	910	74.9	739	81.2	142	15.6	29	3.2	
Study Child ever breastfed									
Yes	959	77.9	741	77.3	177	18.5	41	4.3	0.02
No	272	22.1	231	84.9	34	12.5	7	2.6	

Study Child Global Health									
Excellent	558	42.6	452	81.0	88	15.8	18	3.2	0.07
Very Good	382	29.2	303	79.3	66	17.3	13	3.4	
Good	257	19.6	192	74.7	52	20.2	13	5.1	
Fair/ Poor	112	8.6	83	74.1	19	17.0	10	8.9	
<i>Wave 1 Health service access variables</i>									
Study Child hospitalisation in past year									
Yes	260	21.1	774	79.8	168	17.3	28	2.9	<0.01
No	970	78.9	197	75.8	42	16.2	21	8.1	
Home visits ^c - Nurse									
0 home visits	1093	83.5	867	79.3	188	17.2	38	3.5	0.03
1 or more	216	16.5	163	75.5	37	17.1	16	7.4	
Home visits - midwife									
0 home visits	947	72.3	748	79.0	162	17.1	37	3.9	0.80
1 or more	362	27.7	282	77.9	63	17.4	17	4.7	
Home visits – social worker									
0 home visits	1218	93.0	959	78.7	210	17.2	49	4.0	0.79

1 or more	91	7.0	71	78.0	15	16.5	5	5.5	
Home visits – Aboriginal health worker									
0 home visits	1123	85.8	882	78.5	195	17.4	46	4.1	0.91
1 or more	186	14.2	148	79.6	30	16.1	8	4.3	
Home visits – general practitioner									
0 home visits	1220	93.2	964	79.0	207	17.0	49	4.0	0.53
1 or more	89	6.8	66	74.2	18	20.2	5	5.6	
Seen health professionals: Aboriginal Medical Service (AMS)									
Yes	436	35.4	329	75.5	88	20.2	19	4.4	0.07
No	797	64.6	645	80.9	122	15.3	30	3.8	
Seen health professionals: Maternal and Child Health Centre									
Yes	1067	86.5	126	75.9	32	19.3	8	4.8	0.56
No	166	13.5	848	79.5	178	16.7	41	3.8	
Seen health professionals: Other community health centre or clinic									
Yes	910	73.8	246	76.2	62	19.2	15	4.6	0.34
No	323	26.2	728	80.0	148	16.3	34	3.7	
Seen health professionals: Doctor surgery or clinic									

Yes	543	44.0	423	77.9	102	18.8	18	3.3	0.23
No	690	56.0	551	79.9	108	15.7	31	4.5	

^aLSIC wave 1 data where there were data from wave 2 and/or wave 3 as well

^b For over 95% of the sample, the responding parent (P1) was the child's mother

^c IF 6 – 18 MONTHS OLD (B COHORT): (Since (STUDY CHILD)'s birth)/ IF 3½ – 4½ YEARS (K COHORT): (Since this time last year)

Table 2. Multivariate adjusted Odds ratio (aOR) and their 95% Confidence Interval (CI) of children with reported ear symptoms in Wave 2 or/and 3, relative to in both waves (reference category), adjusted for each Wave 1 sociodemographic, child health and health service access variables *and study site clustering*

Wave 1 Variable	Parent reported symptoms in 1 Wave only (Wave 2 or 3)	Parent reported symptoms in 0 Waves (neither Wave 2 or 3)
	aOR (95% CI)	aOR (95% CI)
Parent 1 is partnered (ref: Yes)		
No	1.62 (0.79-3.35)	1.37 (0.70-2.69)
Main Source of Income- Any Government pension/ benefit/ allowance (ref: No)		
Yes	1.50 (0.76-2.98)	1.70 (0.91-3.18)
Parent 1 has had ear symptoms (ref: Yes)		
No	1.94 (0.55-6.78)	2.47 (0.79-7.74)
Study Child has had prior ear symptoms (ref: Yes)		

No	0.98 (0.50-1.90)	2.91 (1.57-5.40)
P1 smokes (ref: No)		
Yes	0.85 (0.45-1.59)	1.13 (0.63-2.01)
Child has difficulty sleeping (ref: Yes)		
No	1.03 (0.53-6.78)	1.33 (0.72-2.44)
Child ever breastfed (ref: No)		
Yes	0.92 (0.40-2.12)	1.33 (0.62-2.85)
Child hospitalised in past year (ref: No)		
Yes	2.42 (1.24-4.73)	2.16 (1.19-3.94)
Home visits - Nurse (ref: 1 or more)		
0 home visits	2.04 (0.89-4.66)	1.60 (0.77-3.31)

Table 3. Adjusted Odds ratio (aOR) and their 95% CI of children with reported ear symptoms in Wave 2 or 3, relative to in both waves, adjusted for Wave 1 potential mediating and confounding variables *and study site clustering*

Wave 1 variable	Model 1: Parent 1 is partnered aOR (95% CI)		Model 2: Main source of income Gov pension/allowance aOR (95% CI)		Model 3: Parent 1 ear symptoms aOR (95% CI)		Model 4: Study child ear symptoms aOR (95% CI)	
	1 wave	0 waves	1 wave	0 waves	1 wave	0 waves	1 wave	0 waves
Parent 1 is partnered (ref: Yes)								
No	-	-	1.61 (0.83-3.11)	1.68 (0.83-3.41)	1.86 (0.97-3.56)	1.94 (1.06-3.56)	1.78 (0.94-3.40)	1.81 (0.99-3.30)
Main Source of Income- Government Pension or allowance (ref: No)								
Yes	1.24 (0.64-2.41)	1.53 (0.84-2.80)	-	-	1.61 (0.87-2.99)	1.95 (1.11-3.43)	1.55 (0.84-2.85)	1.82 (1.04-3.19)
Parent 1 ear symptoms (ref yes)								
No	2.43 (0.78-7.57)	3.90 (1.43-10.62)	2.45 (0.79-7.65)	3.98 (1.45-10.86)	-	-	1.16 (0.61-2.19)	2.45 (0.87-6.87)
Study Child ear symptoms (ref: Yes)								
No	1.18 (0.63-2.20)	3.59 (2.01-6.42)	1.12 (0.60-2.11)	3.42 (1.89-6.17)	1.16 (0.61-2.19)	3.46 (1.91-6.29)	-	-
Parent 1 smokes (ref yes)								
No	0.85 (0.46-1.56)	1.20 (0.69-2.10)	0.89 (0.48-1.65)	1.20 (0.68-2.12)	0.97 (0.53-1.77)	1.35 (0.77-2.36)	0.96 (0.53-1.74)	1.30 (0.75-2.27)
SC difficulty sleeping (ref Yes)								
No	1.17 (0.62-2.23)	1.69 (0.93-3.04)	1.19 (0.62-2.26)	1.68 (0.93-3.05)	1.30 (0.68-2.47)	1.84 (1.02-3.34)	1.23 (0.65-2.34)	1.62 (0.90-2.93)
SC ever breastfed (ref no)								
Yes	0.84 (0.37-1.90)	1.39 (0.66-2.91)	0.98 (0.43-2.26)	1.59 (0.74-3.40)	0.91 (0.40-2.05)	1.47 (0.70-3.08)	0.91 (0.41-2.03)	1.38 (0.66-2.88)
SC hospitalisation previous year (ref no)								
Yes	2.50 (1.32-4.73)	2.44 (1.38-4.29)	2.51 (1.32-4.77)	2.46 (1.39-4.34)	2.45 (1.28-4.70)	2.34 (1.31-4.16)	2.32 (1.22-4.43)	2.09 (1.17-3.72)
Home visits from nurse (ref no)								
Yes	2.08 (0.94-4.57)	1.97 (0.99-3.93)	2.12 (0.96-4.66)	2.03 (1.01-4.05)	2.10 (0.95-4.65)	1.97 (0.98-3.95)	2.09 (0.95-4.59)	1.90 (0.95-3.80)