Dental Health Inequalities among Indigenous Populations: A Systematic Review and Meta-Analysis

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Abstract

The aim of this systematic review and meta-analysis was to document the disparity in dental caries experiences among indigenous and nonindigenous populations globally by measuring dental caries prevalence and severity. An electronic database (MEDLINE) was initially searched using relevant keywords. This was followed by use of the search string in the following electronic databases: Scopus, EBSCOhost, Cochrane, and Open Grey. Two independent reviewers conducted the study search and screening, quality assessment, and data extraction, which was facilitated using JBI SUMARI software. The primary outcome was the decayed missing filled teeth (DMFT) score and dental caries prevalence. Subgroup analysis was done by country of publication to identify causes of heterogeneity. Forest plots were used with the standardized mean difference (SMD) and publication bias was assessed using the Egger test with funnel plot construction. For the final review, 43 articles were selected and 34 were meta-analyzed. The pooled mean DMFT for both the permanent dentition (SMD = 0.26; 95% CI 0.13–0.39) and deciduous dentition (SMD = 0.67; 95% CI 0.47–0.87) was higher for the Indigenous population than for the general population. Indigenous populations experienced more decayed teeth (SMD = 0.44; 95% CI 0.25–0.62), a slightly higher number of missing teeth (SMD = 0.11 < 95% CI –0.05 to 0.26), and lesser filled teeth (SMD = –0.04; 95% CI –0.20 to 0.13) than their nonindigenous counterparts. The prevalence of dental caries (SMD = 0.27; 95% CI 0.13–0.41) was higher among indigenous people. Globally, indigenous populations have a higher caries prevalence and severity than nonindigenous populations. The factors which have led to such inequities need to be examined.

Introduction

Globally, there are approximately 476 million indigenous peoples in 90 countries, who represent diverse cultures, languages, and spirit [Stephens et al., 2006; Erni, 2008a; Sarfati et al., 2018]. In 2004, the United Nations (UN) defined indigenous peoples as all “people with a historical continuity with pre-invasion and pre-colonial
societies that developed on their territories, and who consider themselves distinct from other sectors of the societies now prevailing on those territories” [United Nations, 2007]. Self-identification and community acceptance is a recognized path to membership for indigenous peoples that preserves sovereignty [United Nations Department of Economic and Social Affairs, 1981]. Despite vast cultural and geographic differences, indigenous communities share commonalities regarding the fight to protect indigenous rights as a result of long-term colonization and disenfranchisement [Armitage, 1995]. The continuing impacts of colonial settlement, marginalization, and assimilation of indigenous peoples and their cultures are embodied by the vast health inequalities experienced by indigenous communities in comparison to nonindigenous populations [King et al., 2009]. Colonialism is an ongoing process of domination [Wolfe, 1999] that has “often swung (and still does) between the poles of elimination and coercive exploitation” [p. 163 in Glenn, 2015]. For Indigenous communities, displacement from traditional lands and resources has disrupted spiritual connections with both the land and one another, resulting in mass health inequalities [Stephens et al., 2006; Richmond and Ross, 2009; Per et al., 2016; Yin, 2016]. Though varying over time and place, indigenous peoples suffer higher infant, child, and adult mortality and suicide rates and a heavier burden of infectious diseases [Gracey and King, 2009].

Indigenous oral health disparities have been identified as persistent [Schuch et al., 2017], and in many countries inequalities appear to be increasing [Spencer and Do, 2016; Moffat et al., 2017]. Oral disease affects approximately half of the global population but up to 80% of global indigenous populations [Tiwari et al., 2018; Williams et al., 2019]. Indigenous adults have almost 3 times as much untreated tooth decay and twice as much periodontal disease, and they experience complete tooth loss 5 times as often as nonindigenous adults [Phipps et al., 2012; Council of Australian Governments, 2015]. Further, hospital admissions requiring general anesthetic for oral health conditions are more common among indigenous than nonindigenous peoples (especially among children) [de Silva et al., 2017a]. Estimates from a systematic review revealed that aboriginal and Torres Strait Islanders in Australia have a higher risk of dental caries than nonindigenous Australians, ranging from 46 to 93% compared to 28% among nonindigenous people; national surveys in Canada estimate that the rate of untreated dental caries is 35% among indigenous Canadians and 19% among nonindigenous Canadians, and in New Zealand it is 50% among Maori and 34% among non-Maori, respectively [Marmot, 2017]. Reasons for oral health inequalities include misalignment of health provisions with indigenous health needs as well as barriers in acceptable, appropriate and affordable access to health services [Spencer and Do, 2016]. Other determinants of social inequality, such as poverty, experienced by indigenous peoples are a direct reflection of the historical mistreatment of indigenous communities through government-enforced colonization and assimilation policies [Jamieson and Roberts-Thomson, 2006c]. The unique social determinants experienced by indigenous communities at a global level need to be taken into consideration when analyzing measures of all health, including oral health [Jamieson et al., 2016a].

Indigenous oral health outcomes are often masked in national datasets because indigenous peoples tend to represent a minority of the population [Sarfati et al., 2018]. A comparison of oral health measures between indigenous and nonindigenous populations could provide important information regarding these preventable health outcomes. Previous works have reviewed the prevalence of indigenous oral health measures, without comparison to a corresponding nonindigenous population [Martin-Iverson et al., 2000; Parker et al., 2010]. Some studies have only assessed differences specific to a nation [Christian and Blinkhorn, 2012; Alves Filho et al., 2014; de Silva et al., 2017b]. Therefore, this systematic review seeks to better understand oral health disparities, as measured by dental caries prevalence and severity, by assessing differences between indigenous populations and comparable nonindigenous populations. The objective of this systematic review was to synthesize existing research findings to evaluate dental caries prevalence and experience between indigenous and nonindigenous populations. The findings may help to generate an understanding of indigenous oral health disparities at a global level, which may then facilitate more targeted and culturally safe approaches to reducing these inequities.

**Methods**

This systematic review was conducted according to the Joanna Briggs Institute (JBI) methodology for systematic reviews of prevalence [Aromataris, 2020]. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines were followed for reporting of this systematic review [Moher et al., 2009]. This systematic review was conducted according to an a priori protocol and is registered on the international prospective register of systematic review (PROSPERO) with registration number CRD42020204311.
Research Question

The research question for this systematic review was outlined based on the PECO format. The articles that adhered to the following PECO question were selected: “Is the prevalence and severity of dental caries (O) higher among Indigenous (E) populations (P) compared to non-Indigenous populations (C)?”

Literature Search Strategy

A 3-step search strategy was employed for the literature search. A systematic electronic search was initially conducted in the MEDLINE database. The reviewers identified the text words contained in the title and abstract of the relevant articles and index terms to describe the articles. A search string was created using the keywords and synonyms combined with the boolean operators “AND” and “OR” covering the period from database inception to September 2020. In the second step, searches were conducted across Scopus, EBSCOhost (Dentistry and Oral Sciences), and the Cochrane database by using the search string. For unpublished data and for finding grey literature, Open Grey, national oral health survey reports, and government databases reporting on oral health were searched. In the third step a reference list was made for critical appraisal of all identified studies, and free hand searches were done to identify additional literature. The electronic search was not limited to any language.

The key words used in the electronic search were: “dental caries” and “indigenous population.” The following search string was used for MEDLINE: (Dental caries [MH] OR Caries [TW] OR Dental decay [TW] OR Tooth decay [tw] OR Carious [tw] OR Decayed teeth [tw]) AND (“first nation” OR “first nations” OR “Pacific islander” OR “Pacific islanders” OR “Torres Strait Islander” OR “Torres Strait Islanders” OR “aborigin*” OR “alaska*” OR “aleut*” OR “amerind*” OR “arctic OR “aymara” OR “bushmen” OR “chukchi OR “circumpolar OR “eskimo*” OR “greenland*” OR “hmong” OR “indian*” OR “indi- gen*” OR “inuit*” OR “inupiat” OR “Inuit” OR “Khanty” OR “maori*” OR “mapuche” OR “metis” OR “native*” OR “navaho*” OR “navajo*” OR “nenets” OR “quechua” OR “sami” OR “samoan*” OR “siberia*” OR “skol” OR “tribal OR tribe*” OR “xin*” OR “yup*” OR “yupik” OR “zuni OR “American continental ancestry group” OR “American continental ancestry group” OR “Asian continental ancestry group” OR “Health services, Indigenous” OR “Indigenous Health Services” OR “Oce- anic ancestry group” OR “arctic regions” OR “ethnic groups”). A search strategy for other database can be found in Appendix 1.

Inclusion Criteria

Participants and Context

We included papers that followed guidelines by the UN Declaration on the Rights of Indigenous Peoples Article 33 for identification of indigenous status. This includes self-identification as indigenous [Erni, 2008b]. We additionally included studies that determined indigenous status according to country-specific identity registration systems or by parent report.

This review included studies that assessed oral health outcomes of dental caries among indigenous populations and compared against nonindigenous populations. This review considered original studies performed in either community settings or hospitals. The selection of studies was not restricted to any sex, age, or geographic location.

Condition

As recommended by the World Health Organization, the decayed (d/D), missing (w/M), filled (f/F) teeth (dmft/DMFT) index score [Moradi et al., 2019] was used. This systematic review considered papers that reported either prevalence (% dmft/DMFT >0) or severity (mean dmft/DMFT) on either permanent or deciduous teeth.

Studies

All epidemiological, cross-sectional, cohort, and case-control studies with data on dental caries comparing indigenous and non-indigenous populations were considered for this review. If more than 1 study presented the findings for the same geographic area and oral health outcomes using the same dataset, we included the primary study.

Studies were included in this review if they met the following inclusion criteria: (1) an original study, (2) indigenous population reporting dental caries, (3) having comparison to a nonindigenous or general population.

The exclusion criteria included: (1) studies that were observational or descriptive without any comparison group; (2) papers that examined indigenous and nonindigenous persons but did not present the findings separately for each group; (3) studies defining dental caries by a self-check questionnaire alone, without any clinical examination; (4) experimental studies, such as randomized controlled clinical trials and quasi experimental studies, with the exception of baseline data, if it pertained to the research question and the data were obtained before the intervention; and (5) case reports, literature reviews including systematic reviews and scoping reviews, conference reports, letters, commentaries, opinion pieces, and editorials. Language, age, sex, and geography were not exclusion criteria for this review. For translation of articles in a language other than English, online tools such as Google Translate and Findreader were used.

Evaluation of the Selected Studies

Following the electronic search, all identified citations were collated and uploaded to EndNote X9 version 3.3 (Clarivate Analytics, Philadelphia, PA, USA) and duplicates were removed. Two investigators (S.N. and B.P.) evaluated both the abstract and the titles. In case of uncertainty, the full text was read and a joint decision was made. Potentially relevant studies were retrieved in full text and their citations were imported into the JBI System for the Unified Management Assessment and Review of Information (JBI SUMARI; Joanna Briggs Institute, Adelaide, SA, Australia). Full/text evaluation of the relevant articles was performed and articles that were not considered eligible were excluded from this study. The reasons for exclusion were recorded in JBI SUMARI. Any disagreements concerning the inclusion of a study were discussed between the 2 reviewers until a mutual decision was made or a third reviewer (L.M.J.) was consulted.

Assessment of Methodological Quality

After exclusion of the ineligible studies, all eligible full texts were critically appraised by 2 independent reviewers (S.N. and B.P.) using critical appraisal instruments for prevalence studies in JBI SUMARI. The same checklist was used for experimental studies to appraise how the baseline data was collected and analyzed, as that was the outcome of interest. Any disagreement was resolved by discussions or with the help of a third reviewer (L.M.J.). There were a total of 9 questions, to which the response was “yes,” “no,” “unclear.”

Data Extraction

A modified version of the data extraction tool for prevalence studies available in JBI SUMARI was used by the 2 independent
reviewers. In case of any missing information or additional data, the corresponding author was contacted through email but this did not yield any additional data. Any disagreement between the reviewers were resolved through discussion by a third reviewer (L.M.J.).

The data extraction form included the following details:
1. Study characteristics: last name of the first author, year of publication, country of study, study design, location of the study, sampling methods, sample size calculation, and data collection methods
2. Participant characteristics: number of study participants for indigenous and nonindigenous groups, age, definition of indigenous status, and description of the case and control populations
3. Outcome measure: the primary outcome was dental caries severity as measured by the mean DMFT/dmft score, and the prevalence of dental caries was measured as a percentage with SD; the secondary outcome was measurement of the mean DT, MT, and FT.

For the purpose of pooled data and meta-analysis, data extraction from either graphs or charts was done with a WebPlot-Digitizer tool (version 4.2; GNU Affero General Public License). For the purpose of data analysis, studies with 95% CI were converted to SD using the formula stated in the Cochrane Handbook, i.e., SD = \( \sqrt{N \times (\text{upper limit} - \text{lower limit})/3.92} \) [Higgins et al., 2019].

Data Synthesis
Papers, where possible, were pooled in a statistical meta-analysis using JBI SUMARI software. Papers that reported outcome values that deviated from the average outcome found in other studies were excluded. The outcomes of the papers included in the meta-analysis were as follows: the mean number of decayed teeth (DT), the mean number of filled teeth (FT), the mean number of missing teeth (MT), the mean DMFT score and the mean dmft score, and the prevalence of dental caries. Data were presented as means ± SD or 95% CI. Effect sizes were presented as standardized mean differences (SMD), and 95% CI were calculated for analysis [Takehashima et al., 2014]. Heterogeneity was assessed statistically using the standard \( \chi^2 \), Tau² and \( F^2 \) tests. Meta-analysis was performed using the random effects model with heterogeneity taken from an inverse variance model to estimate the pooled effect. Subgroup analyses were conducted for both DMFT and dmft scores by country of publication, performed on STATA version 15 (Stata Corp LLC, USA). Publication bias was assessed using the Egger test and visualized using funnel plots.
Table 1. Description of the included studies

| No. | Study, country | Study design | Location | Sampling method | Cases | Controls | Study participants | Age, years | Inference |
|-----|----------------|--------------|----------|-----------------|-------|----------|-------------------|------------|-----------|
| 1   | Arantes et al. [2021], Brazil (4 parts) | Cross-sectional | Mato Grosso do Sul Brazilian state | Stratified sampling for participants, random sampling for villages | Guarani, Kaiowá, Terena, and Kadiowé | Nonindigenous population | 606 | 1,124 | 1,179 | 12,354 | 5 | The mean DMFT was lower among indigenous people than among nonindigenous populations |
| 2   | Arrow [2016], Australia (2 parts) | Cross-sectional | West Australian School Dental Service | Systematic sampling | Aboriginal and Torres Strait Islander | Nonindigenous population | 268 | 6,047 | 8,023 | 100 | 5–10 | The aboriginal children had a higher drift score than the nonindigenous population |
| 3   | Brennan et al. [2007], Australia | Cross-sectional | All states and territories of Australia except Tasmania and the Australian Capital Territory | Random sampling | Indigenous | Nonindigenous population | 157 | 5,243 | 18–65+ | The indigenous population had a higher number of decayed teeth and a lower number of filled teeth |
| 4   | Davies et al. [1997], Australia (2 parts) | Cross-sectional | Community Dental Service in Northern Territory; a dental health program for school age children | N/A | Aboriginal children | Nonaboriginal children | 429 | 1,218 | 696 | 6 | The oral disease experience and the prevalence of untreated dental caries were higher among aboriginal children |
| 5   | de Muzio [1985], Argentina (2 parts) | Cross-sectional | Data from school children in a city in Argentina residing in urban and rural areas | N/A | Amerindians | Caucasians | 135 | 312 | 67 | 7 | The decayed tooth number was higher among Amerindians than among Caucasians |
| 6   | del Rio Gomez [1991], Mexico | Cross-sectional | Population was recruited from a school in a place named Guadalupe | Random sampling | Mazahua children | Mexican children | 100 | 100 | 12–14 | The prevalence of dental caries was higher in Mexico City than among the indigenous community; the Mazahua population had lower DMFT scores |
| 7   | Dogar et al. [2011], Australia | Cross-sectional | Rural and remote children from Western Australia | Convenience sample | Indigenous children | Nonindigenous children | 79 | 174 | 2–4 | The indigenous population had a higher prevalence of dental caries than the nonindigenous population |
| 8   | Drummond et al. [2015], Brazil | Cross-sectional | Data from the Nacional Oral Health Survey Brazil 2010 | Multistage random sampling | People of indigenous descent | White Brazilian population | 48 | 2,177 | 15–19 | No difference was present between the indigenous and nonindigenous populations in Brazil due to a small sample size |
| 9   | Endean et al. [2004], Australia (2 parts) | Cross-sectional | Pitiñantjatjarraand Yankunytjatjarra-speaking communities of the northwest of South Australia | N/A | Anangu adults | Nonindigenous Australians | 317 | 1,198 | 1,706 | 5–6 | Aboriginal children and adults experienced more dental caries than their national counterparts |
| 10  | Foster Page and Thomson [2011], New Zealand (2 parts) | Cohort | Taransk region of New Zealand | Random sample | Maori adolescents | Non-Maori adolescents | 342 | 226 | 88 | 29 | Maori people had a worse DMFT score than non-Maori people |
| 11  | Goswa et al. [2009], New Zealand | Cross-sectional | Children attending schools in Kaiapoi, Kaikōhe, Kāwakawa, Moerewa, and Dargaville | N/A | Maori children | Pakiha/other | 236 | 133 | 62 | 5–6 | The prevalence and severity of dental caries in Northland were very high in comparison to the rest of New Zealand |
| 12  | Grim et al. [1994], USA (2 parts) | Cross-sectional | Oklahoma population | Random sampling | Native American | Caucasian children | 457 | 367 | 456 | 332 | 5–6 | The prevalence and severity of dental caries in Native Americans students appeared to be higher than the values of their non-Indian counterparts |
| 13  | Ha [2014], Australia (2 parts) | Cross-sectional | Data for Queensland, South Australia, Western Australia, Tasmania, the Northern Territory, and the Australian Capital Territory were sourced from the Child Dental Health Survey | Random sampling | "Aboriginal," "Torres Strait Islander," "Aboriginal and Torres Strait Islander," or "South Sea Islander" | Nonindigenous population | 92,324 | 92,324 | 4,032 | 4,032 | 5–6 | Indigenous children were more likely to experience caries in both their deciduous and their permanent dentition and had higher levels of untreated decay than their nonindigenous counterparts |
| 14  | Haag et al. [2020], Australia | Cross-sectional | Data were from the Australian National Child Oral Health Study 2012–2014 | Random sampling | Aboriginal Australians | Non-aboriginal Australians | 485 | 13,059 | 5–10 | Indigenous children had a higher DMFT score than nonindigenous Australian children |
| No. | Study, country | Study design | Location | Sampling method | Cases | Controls | Study participants | Age, years | Inference |
|-----|----------------|-------------|----------|-----------------|-------|----------|-------------------|------------|-----------|
| 15  | Hallett and O'Rourke [2002], Australia | Cross-sectional | Children attending state preschools within the North Brisbane, Redcliffe, and Caboolture health districts | Preschool-based sampling method | Aboriginals/ Torres Strait Islander Caucasians children | 48 | 2,073 | 4-6 | Dental caries occurred more frequently in children from an aboriginal background than those from a Caucasian background |
| 16  | Jamieson et al. [2006a], Australia (4 parts) | Cross-sectional | Data were from the Child Dental Health Survey, national oral health data of children enrolled in the school dental service in each Australian state and territory; compilation of metropolitan areas | Random sampling | Indigenous metropolitan children Indigenous rural children Nonindigenous metropolitan children Nonindigenous rural children | 3,450 | 22,964, 85,662 | 4-10, 6-14, 6-14 | Indigenous children had more dental caries and worse dmft/DMFT scores than the nonindigenous children |
| 17  | Jamieson et al. [2006b], Australia (10 parts) | Cross-sectional | Data collected as part of the Child Dental Health Survey | Random sampling | Indigenous children Nonindigenous children | 565 | 961 | 4 | Findings suggested that indigenous status and SES have strong oral health outcome correlations but are not mutually exclusive (indigenous children had a worse dmft/DMFT score than nonindigenous children) |
| 18  | Jamieson et al. [2007a], Australia (2 parts) | Cross-sectional | Data from School Dental Services operated through SA dental services in Port Augusta and standard dental clinic in the SA mid-north region from 2001–2006 | Random sampling | Regional indigenous Regional nonindigenous | 1,169 (all ages) 6,488 (all ages) | <10 6+ | Indigenous regional children had a poor dmft score compared to regional nonindigenous children |
| 19  | Jamieson et al. [2007b], Australia (2 parts) | Cross-sectional | Data were obtained from the Child Dental Health Survey, a national oral health investigation of children enrolled in the School Dental Service (SDS) from New South Wales, South Australia, and the Northern Territory | Random sampling | Indigenous children Nonindigenous children | 10,517 (all ages) 317,525 (all ages) | 4-10 6-14 | The prevalence of dental caries and DMFT scores were higher among the indigenous population compared to the nonindigenous population |
| 20  | Jamieson et al. [2008a], Australia | Cross-sectional | Data used from Wave-3 Aboriginal Birth Cohort study, a cross sectional study conducted from 2006 to 2007 and the 2004–2006 National Survey of Adult Oral Health | Random sampling | Indigenous Nonindigenous | 442 | 202 | 16-20 | The mean number of decayed teeth was higher among ABC study participants than among NSAOH participants |
| 21  | Jamieson et al. [2010b], Australia (3 parts) | Cross-sectional | Data from Aboriginal Birth Cohort and Child Dental Health Survey and Northern Territory Level CDHS among 6- to 8-year-olds | Random sampling | Aboriginal birth cohort study Northern Territory CDHS | 143 145 119 | 6-8 11-13 18-20 | ABC study participants had a higher DMFT score than NT CDHS or NSAOH participants |
| 22  | Jamieson et al. [2016], Australia (3 parts) | Cross-sectional | Australian National Survey of Adult Oral Health 2004–2006 Canadian Health Measure Survey 2007–2009 New Zealand Oral Health Survey 2009 | Random sampling | Aboriginal and Torres Strait Islander Canada Native American Indian, Metis or Inuit Maseri Nonaboriginal | 64 304 386 5,299 3,611 3,089 | ≥18 | The indigenous person had more untreated dental caries and missing teeth and fewer teeth that had been restored |
| 23  | John et al. [2015], India | Cross-sectional | Tribal children were from Palamalai hills and Kolli hills; urban children were from Tiruchengode and Erode | N/A | Tribal children Urban children | 206 411 | 9–12 | Higher DMFT and df scores were found among tribal children than among urban children |

Table 1 (continued)
| No. | Study, country          | Study design                | Location                                                                 | Sampling method                                    | Cases | Controls | Study participants | Age, years | Inference                                                                 |
|-----|-------------------------|-----------------------------|--------------------------------------------------------------------------|----------------------------------------------------|-------|----------|--------------------|------------|---------------------------------------------------------------------------|
| 24  | Jones et al. [1992],    | Cross-sectional             | Children enrolled in Rural CAP Head Start and American Indian Program     | Convenience sample                                 | Native| Nonnative| 381                | 163        | 3–5 Native children had higher dmft scores than nonnative children       |
|     | America                 |                             | Branch Head Start programs from 20 communities in Alaska                |                                                    |       |           |                    |            |                                                                           |
| 25  | Kapellas [2014],        | Cross-sectional             | Darwin, Katherine, and correctional facility in Darwin and Alice Springs, | Convenience sample                                 | Indigenous Australian | National Survey | 312                | 4,967      | 20–55+ Untreated dental caries were prevalent among indigenous Australians compared to the general Australian population |
|     | Australia               |                             | Northern Territory                                                       |                                                    |       |           |                    |            |                                                                           |
| 26  | Kumar et al. [2013],    | Cross-sectional             | Urban region: various corporation schools of Chennai, the capital of Tamil Naidu state; tribal region: various government tribal schools in and around the Gudalur of Nilgiris district | Multistage stratified random sampling              | Tribal children | Urban children | 743                | 707        | 6–14 The prevalence of dental caries was higher in tribal children than in urban children |
|     | India                   |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 27  | Lallo et al. [2015],    | Cross-sectional             | Child Dental Health Survey                                               | Random sampling                                     | Aboriginal, Torres Strait Islander, Aboriginal and Torres Strait Islander, South sea Islander individuals were grouped as indigenous |          | 6,817               | 91,255        | 5–15 Indigenous children had worse dmft and DMFT scores than nonindigenous children |
|     | Australia               |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 28  | Lawrence et al. [2008], | Randomized controlled clinical trial | Sioux Lookout Zone, located in Northwest Ontario, and Thunder Bay District | Cluster sampling and convenience sampling          | First Nation nonaboriginal children            | 915    | 150              | 6 months to 5 years | First Nation children had a poor dmft score compared to nonaboriginal children |
|     | Canada                  |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 29  | Lawrence et al. [2009], | Cross-sectional             | Children entering junior kindergarten in the Thunder Bay District, Northwest Ontario, Canada | Cluster sampling                                   | Aboriginal | Nonaboriginal | 65                 | 58         | 3–3 | 3–5 (2003/2004) 3–5 (2004/2005) 3–5 (2005/2006) A significant difference was observed for the caries experience between aboriginal and nonaboriginal children |
|     | Canada (3 parts)        |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 30  | Medina et al. [2008],   | Cross-sectional             | Francisco de Orellana and Aguarico districts of the Orellana province in the north-eastern part of Ecuador | Purposive sampling                                 | Indigenous children | Nonindigenous children | 930               | 519        | 6–12 Indigenous children had lower DMFT scores than nonindigenous children |
|     | Ecuador                 |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 31  | Miranda et al. [2018],  | Cross-sectional             | National Oral Health (SB Brasil 2010) database                          | Stratified multistage sampling                      | Indigenous | Nonindigenous | 308               | 52         | 7,295 All ages | There were unequal differences in the state of tooth decay between the indigenous population and the national population |
|     | Brazil (2 parts)        |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 32  | Page and Thomson [2011],| Cross-sectional             | Taranaki, New Zealand                                                   | NA                                                  | Maori | Non-Maori | 29                 | 226        | 16 Maori people had a higher caries incidence than the non-Maori population |
|     | New Zealand             |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 33  | Phelan et al. [2009],   | Cross-sectional             | Metropolitan and non-metropolitan public, Catholic, and independent schools in New South Wales | Representative sampling                             | Aboriginal | Nonaboriginal | 458               | 6,991      | 5–12 The indigenous children of NSW had poor DMFT scores compared to the nonaboriginal children |
|     | Australia               |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 34  | Rao and Bharambe 1993,  | Cross-sectional             | Kasturba Rural Health Training Centre, situated 17 km from the Wardha District, India | Stratified cluster sample                           | Tribal children | Urban children | 230               | 123        | 5–14 Tribal children had a higher prevalence of dental caries compared to urban children |
|     | India                   |                             |                                                                          |                                                    |       |           |                    |            |                                                                           |
| 35  | Schamschula et al. [1980], Australia (2 parts) | Cross-sectional             | Orana and Far West Health Region of New South Wales                      | NA                                                  | Indigenous children | Nonindigenous children | 51                 | 77         | 6–8 10–11 Tooth defects were more severe in aborigines than in Caucasians | Table 1 (continued)
### Results

#### Study Selection

The study selection process is described in Figure 1 as per the PRISMA flow diagram format. The initial electronic database search resulted in 16,126 articles; after the removal of duplicates, 14,398 articles remained. For full-text assessment, 61 records were retrieved. Of these, 18 were excluded after full-text screening and the reasons for exclusion were noted (Appendix 2). One of the prominent reasons for exclusion was the use of secondary data-sets that had been used in multiple studies and only the data from the primary study was included. Another reason for exclusion was variations in measurement of dental caries prevalence for both the case and control groups. Therefore, a total of 43 articles [Schamschula et al., 1980; de Muñiz, 1985; del Rio Gomez, 1991; Jones et al., 1992; Rao and Bharambe, 1993; Grim et al., 1994; Davies et al., 2009; Jamieson et al., 2007a, b; Brennan et al., 2007; Lawrence et al., 2008; Medina et al., 2009; Gowda et al., 2009; Lawrence et al., 2009; Phelan et al., 2009; Jamieson et al., 2010a, b; Dogar et al., 2011; Foster Page and Murray Thomson, 2011; Page and Thomson, 2011; Singh et al., 2011; Kumar et al., 2013; Ha, 2014; Kapellas et al., 2014; Drummond et al., 2015; John et al., 2015; Laloo et al., 2015] were included in this review.

#### Table 1 (continued)

| No. | Study, country | Study design | Location | Sampling method | Cases | Controls | Study participants | Age, years | Inference |
|-----|----------------|--------------|----------|-----------------|-------|----------|--------------------|------------|-----------|
| 36  | Schroth et al. [2005], Canada (2 parts) | Cross-sectional | 4 communities in Manitoba, i.e., 2 urban communities and 2 first nation communities, comparison to northern communities | Convenience sample | Northern First Nation, Roseau First Nation | Thompson community, Winnipeg | 128 cases, 105 controls, 87 | 0-6 | The First Nation communities had a slightly worse dmft score than the disadvantaged urban populations |
| 37  | Schuch et al. [2017], Australia (3 parts) | Cross-sectional | National Oral Health (SB Brasil 2010) database | Stratified multistage cluster sampling | Indigenous | Nonindigenous | 144 cases, 17,254 controls, 510 | All ages 15+ adults | The indigenous population has a higher prevalence of dental caries than the nonindigenous population |
| 38  | Shen et al. [2015], China | Cross-sectional | Data from the Third National Oral Health Survey of China | Multistage stratified cluster sampling | Non-Han | Han children | 425 cases, 2,201 controls, 12 | 12 | The non-Han children had higher DMFT score than the Han children |
| 39  | Shi et al. [2018], Canada | Cross-sectional | Children in grades 1 and 2 attending school in the public or Catholic school system in the cities of Calgary and Edmonton, Alberta, Canada | Multistage probabilistic sampling | Indigenous children including First Nations, Metis, and Inuit | Children of all races | 95 cases, 5,600 controls, 5-8 | Indigenous children had more caries experience than children of all races |
| 40  | Simangwa et al. [2018], Tanzania | Cross-sectional | Maasai population areas of the Monduli and Longido districts in the Arusha region in the northern part of Tanzania attending public primary schools | Randomly selected using 1-stage cluster sampling | Maasai children | Non-Maasai children | 721 cases, 185 controls, 12-14 | 12-14 Maasai children had lower DMFT scores than non-Maasai children |
| 41  | Singh et al. [2011], India | Cross-sectional | Tribal children from 6 schools of the Udaps district | NA | Tribal children, Other government school children | 418 cases, 428 controls, 5 | The dmft score for the tribal school children was higher than that for the government school children |
| 42  | Slade et al. [2011], Australia | Cross-sectional | Australian National Survey of Adult Oral Health 2004–2006 | 3-stage stratified clustered sampling | Indigenous Australian | Nonindigenous Australians | 61 cases, 5,905 controls, 15-97 | The indigenous population had more caries experience than the nonindigenous population |
| 43  | Zeng et al. [2005], China | Cross-sectional | Guangxi Province, Southern China | Multistage sampling technique | Zhuang children | Han children | 470 cases, 487 controls, 3-5 | The Zhuang children had higher dmft scores than the Han children |

Caries Experience among Indigenous Populations
2015; Shen et al., 2015; Arrow, 2016; Jamieson et al., 2016a; Schuch et al., 2017; Miranda et al., 2018; Shi et al., 2018; Simangwa et al., 2018; Haag et al., 2020; Arantes et al., 2021] met the inclusion criteria and were included in this review for descriptive analysis. A total of 34 articles were included for meta-analysis [Schamschula et al., 1980; del Rio Gomez, 1991; Jones et al., 1992; Grim et al., 1994; Hallett and O’Rourke, 2002; Schroth et al., 2005; Zeng et al., 2005; Jamieson et al., 2006a, b; Australian Institute of Health and Welfare, 2007; Jamieson et al., 2007a, b; Brennan et al., 2007; Lawrence et al., 2008; Medina et al., 2008; Gowda et al., 2009; Lawrence et al., 2009; Jamieson et al., 2010a, b; Dogar et al., 2011; Foster Page and Murray Thomson, 2011; Singh et al., 2011; Kumar et al., 2013; Ha, 2014; Kapellas et al., 2014; John et al., 2015; Laloo et al., 2015; Shen et al., 2015; Arrow, 2016; Jamieson et al., 2016a; Schuch et al., 2017; Miranda et al., 2018; Haag et al., 2020; Arantes et al., 2021].

Methodological Quality

All of the included studies underwent critical appraisal (Appendix 3). No studies were excluded based solely on the assessment of methodological quality. Only 13 [Hallett and O’Rourke, 2002; Endean et al., 2004; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Lawrence et al., 2008; Kapellas et al., 2014; Arrow, 2016; Jamieson et al., 2016a; Miranda et al., 2018; Shi et al., 2018; Simangwa et al., 2018; Haag et al., 2020; Arantes et al., 2021] studies of 43 answered “yes” for each critical appraisal question, achieving a score of 9 out of 9. The lowest score was 5, observed in studies by Jamieson et al. [2007b] and Gowda et al. [2009] as these studies failed to mention the sampling frame, methods for sampling participants, and sample size calculation. Out of 43 studies, only 14 [Hallett and O’Rourke, 2002; Endean et al., 2004; Schroth et al., 2005; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Lawrence et al., 2008; John et al., 2015; Arrow, 2016; Jamieson et al., 2016a; Miranda et al., 2018; Shi et al., 2018; Simangwa et al., 2018; Haag et al., 2020; Arantes et al., 2021] reported methods for sample size calculation or whether the sample size was adequate for the population of interest. Most studies described the study setting and participants in detail (95.3%). In almost all of the included studies the data analysis was done appropriately (97.7%). The DMFT index was used as a standard and reliable tool to measure caries prevalence and severity in all of the included studies (100%). Statistical analysis was performed appropriately in all of the included studies, except for 9 studies that failed to report SD and CI for the mean value.

Characteristics of the Included Studies

The current systematic review included 43 articles for descriptive analysis, with the details outlined in Table 1. All of the included articles were cross-sectional studies, except for 1 study by Lawrence et al. [2008] which was a randomized controlled clinical trial in which the baseline data was considered for the purpose of analysis. The included studies were published between the 1985 and 2020 and all of the studies were in the English language.

Study Setting

Fourteen studies used secondary data from different national oral health surveys from Brazil [Drummond et al., 2015; Schuch et al., 2017; Miranda et al., 2018], Australia [Jamieson et al., 2006a, b; Brennan et al., 2007; Jamieson et al., 2007a, b, 2010a, b; Ha, 2014; Laloo et al., 2015; Jamieson et al., 2016a; Haag et al., 2020], and China [Shen et al., 2015] for comparisons. Australia had the highest number of published articles, with a total of 21 articles [Davies et al., 1997; Hallett and O’Rourke, 2002; Endean et al., 2004; Jamieson et al., 2006a, b; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Jamieson et al., 2007a, b; Phelan et al., 2009; Jamieson et al., 2010a, b; Dogar et al., 2011; Ha, 2014; Kapellas et al., 2014; Laloo et al., 2015; Arrow, 2016; Jamieson et al., 2016a; Schuch et al., 2017; Haag et al., 2020]. While 4 articles were published in India [Rao and Bharambe, 1993; Singh et al., 2011; Kumar et al., 2013; John et al., 2015] and Canada [Schroth et al., 2005; Lawrence et al., 2008, 2009; Shi et al., 2018], 3 articles were published in New Zealand [Gowda et al., 2009; Foster Page and Murray Thomson, 2011; Page and Thomson, 2011] and Brazil [Drummond et al., 2015; Miranda et al., 2018; Arantes et al., 2021], 2 articles were published each in the USA [Jones et al., 1992; Grim et al., 1994] and China [Takeshima et al., 2014; Shen et al., 2015], while Argentina [de Muñiz, 1985], Ecuador [Medina et al., 2008], Mexico [del Rio Gomez, 1991], and Tanzania [Simangwa et al., 2018] reported only 1 published report each. Sample size calculation was reported for 13 studies [Hallett and O’Rourke, 2002; Endean et al., 2004; Schroth et al., 2005; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Lawrence et al., 2008; Singh et al., 2011; John et al., 2015; Arrow, 2016; Simangwa et al., 2018; Haag et al., 2020; Arantes et al., 2021]. Except for 8 studies [Schamschula et al., 1980; de Muñiz, 1985; Davies et al., 1997; Gowda et al., 2009; Page and Thomson, 2011; Singh et al., 2011; John et al., 2015; Schuch et al., 2017], all authors reported methods for sampling. A random sampling method was used in 12 of the included studies [del Rio Gomez, 1991; Grim
et al., 1994; Jamieson et al., 2006a; Brennan et al., 2007; Jamieson et al., 2007a, 2010a; Foster Page and Murray Thomson, 2011; Kumar et al., 2013; Ha, 2014; Drummond et al., 2015; Laloo et al., 2015; Haag et al., 2020], and 12 studies used stratified multistage cluster sampling approaches [Rao and Bharambe, 1993; Zeng et al., 2005; Australian Institute of Health and Welfare, 2007; Lawrence et al., 2008, 2009; Jamieson et al., 2010b; Shen et al., 2015; Jamieson et al., 2016a; Schuch et al., 2017; Miranda et al., 2018; Simangwa et al., 2018; Arantes et al., 2021].

Fig. 2. Forest plot comparing mean DMFT scores in indigenous vs. nonindigenous populations.
## Participants
A total of 234,352 indigenous persons and 700,357 nonindigenous persons were included in this review. Indigenous status was identified through self-identification mostly and based on residence. The sample size ranged from 29 to 7,023 participants for indigenous groups, and for nonindigenous groups the sample size ranged from 226 to 85,662 participants. Ages ranged from 2 years to 55+ years.

## Meta-Analysis
For the purpose of analysis, the pooled score of dmft/DMFT for mean age was recorded. However, some studies reported dmft/DMFT scores separately according to deciduous and permanent dentitions, some authors separated scores according to different age groups, and some studies were split into parts according to comparisons between different populations.

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### Table: Indicators of Study Quality and Risk of Bias

| Study             | Indigenous | Mean | SD  | Total | Non-Indigenous | Mean | SD  | Total | Standard Mean Difference | Weight, IV, Random, 95% CI |
|-------------------|------------|------|-----|-------|----------------|------|-----|-------|--------------------------|---------------------------|
| Arantes 2020      | 3.2        | 3.13 | 606 | 3     | 5.13           | 1124 | 3.17%| 0.04 [0.05, 0.14]       |                           |
| Arrow 2016        | 2.54       | 2.79 | 268 | 1.37  | 2.38           | 6047 | 3.16%| 0.49 [0.37, 0.61]       |                           |
| Dogar 2011        | 3.4        | 3.71 | 79  | 0.8   | 1.09           | 174  | 3.01%| 1.00 [0.72, 1.28]       |                           |
| Gowda 2009        | 6.4        | 3.8  | 236 | 4.2   | 3.5            | 133  | 3.06%| 0.59 [0.38, 0.81]       |                           |
| Grim 1994         | 4.52       | 4.2  | 457 | 2.39  | 3.3            | 456  | 3.16%| 0.56 [0.43, 0.70]       |                           |
| Ha 2014           | 4.22       | 51.9 | 9232| 2.22  | 3.07           | 4032 | 3.20%| 0.04 [0.01, 0.07]       |                           |
| Hallett 2002      | 2.44       | 4.13 | 48  | 1.14  | 2.44           | 2073 | 3.00%| 0.52 [0.24, 0.81]       |                           |
| J. Baby John 2015 | 1.63       | 2.09 | 206 | 1.81  | 1.93           | 411  | 3.13%| 0.01 [0.16, 0.28]       |                           |
| Jamieson 2006a     | 2.27       | 2.3  | 3450| 1.3   | 1.04           | 23964| 3.20%| 0.51 [0.47, 0.54]       |                           |
| Jamieson 2006b     | 3.19       | 3.4  | 7023| 1.64  | 2.13           | 85662| 3.20%| 0.69 [0.66, 0.71]       |                           |
| Jamieson 2007b     | 3.15       | 1.85 | 365 | 1.01  | 1.1            | 961  | 3.15%| 0.77 [1.63, 1.91]       |                           |
| Jamieson 2007b     | 4.33       | 1.94 | 476 | 1.47  | 1.24           | 967  | 3.16%| 1.83 [1.70, 1.96]       |                           |
| Jamieson 2007b     | 4.1        | 1.79 | 426 | 1.76  | 1.43           | 981  | 3.16%| 1.51 [1.28, 1.64]       |                           |
| Jamieson 2006b     | 3.72       | 1.73 | 514 | 1.8   | 1.08           | 924  | 3.16%| 1.42 [1.30, 1.54]       |                           |
| Jamieson 2006b     | 3.17       | 1.02 | 556 | 1.89  | 1.14           | 890  | 3.17%| 1.17 [1.05, 1.28]       |                           |
| Jamieson 2006b     | 2.4        | 1.36 | 542 | 1.7   | 1              | 913  | 3.17%| 0.61 [0.50, 0.72]       |                           |
| Jamieson 2006b     | 1.75       | 1    | 534 | 1.22  | 0.9           | 880  | 3.17%| 0.56 [0.45, 0.67]       |                           |
| Jamieson 2007a     | 4.24       | 4.4  | 419 | 2.06  | 2.86           | 6848 | 3.19%| 0.69 [0.63, 0.76]       |                           |
| Jamieson 2007b     | 2.66       | 3.4  | 1057| 1.4   | 2.49           | 17525| 3.20%| 0.58 [0.56, 0.60]       |                           |
| Jamieson 2010b     | 3.4        | 3.68 | 145 | 2.35  | 3.44           | 4467 | 3.13%| 0.04 [0.13, 0.21]       |                           |
| Jones 1992         | 4.88       | 4.3  | 381 | 1.65  | 2.8           | 163  | 3.11%| 0.82 [0.63, 1.01]       |                           |
| Kumar 2013         | 1.48       | 2.23 | 743 | 2.79  | 2.55           | 707  | 3.17%| 0.55 [0.65, 0.44]       |                           |
| Laloo 2015         | 3.84       | 7.79 | 617 | 2.22  | 7.7           | 92525| 3.20%| 0.21 [0.19, 0.23]       |                           |
| Lawrence 2008      | 7.19       | 6.65 | 915 | 1.07  | 3.79           | 150  | 3.12%| 0.97 [0.79, 1.14]       |                           |
| Lawrence 2009      | 6.5        | 5.55 | 65  | 1.4   | 2.86           | 351  | 3.01%| 1.49 [1.21, 1.77]       |                           |
| Lawrence 2009      | 6.7        | 5.33 | 76  | 1.7   | 3.78           | 611  | 3.05%| 1.26 [1.01, 1.50]       |                           |
| Lawrence 2009      | 5.9        | 4.85 | 63  | 1.5   | 2.79           | 481  | 3.02%| 1.42 [1.14, 1.70]       |                           |
| Miranda 2018       | 4.02       | 4.01 | 52  | 2.41  | 3.35           | 7295 | 3.02%| 0.48 [0.21, 0.75]       |                           |
| Schreth 2005       | 4.5        | 4.9  | 128 | 4.3   | 5.2           | 105  | 3.04%| 0.04 [0.22, 0.30]       |                           |
| Schreth 2005       | 4.4        | 5.2  | 108 | 3.1   | 4.4           | 67   | 2.98%| 0.26 [0.04, 0.57]       |                           |
| Singh 2011         | 4.13       | 3.9  | 418 | 3.58  | 3.6            | 428  | 3.15%| 0.15 [0.01, 0.28]       |                           |
| Zeng 2005          | 3.36       | 3.99 | 470 | 2.66  | 3.31           | 487  | 3.16%| 0.19 [0.06, 0.32]       |                           |

**Total (95% CI)**: 130177 560172

Heterogeneity: $\tau^2=0.33$, $\chi^2=3777.39$, df=31 ($P=0$) $I^2=100$

Test for overall effect: $Z=6.49$ ($P=0$)

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**Fig. 3.** Forest plot comparing mean dmft scores among indigenous vs. nonindigenous children.
Caries Experience among Indigenous Populations

There were 24 studies included in the meta-analysis of DMFT scores [Schamschula et al., 1980; del Rio Gomez, 1991; Grim et al., 1994; Jamieson et al., 2006a, b; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Jamieson et al., 2007a, b; Medina et al., 2008; Gowda et al., 2009; Jamieson et al., 2010a, b; Foster Page and Murray Thomson, 2011; Kumar et al., 2013; Ha, 2014; Kapellas et al., 2014; John et al., 2015; Laloo et al., 2015; Shen et al., 2015; Arrow, 2016; Miranda et al., 2018; Haag et al., 2020; Arantes et al., 2021]. Some authors [Schamschula et al., 1980; Jamieson et al., 2006a, b, 2010a; Foster Page and Murray Thomson, 2011; Arantes et al., 2021] reported DMFT scores for different age groups and these were recorded separately. The meta-analysis for DMFT scores of permanent dentition showed that the indigenous population had a worse caries experience than the nonindigenous population (Fig. 2). The standardized mean difference was 0.26 (95% CI 0.13–0.39). The heterogeneity by I^2 statistics was high at 99.2%. All of the authors reported that indigenous populations had higher DMFT scores, with the exception of 4 studies [del Rio Gomez, 1991; Medina et al., 2008; Kapellas et al., 2014; Arantes et al., 2021], which reported better oral health among indigenous groups.

The Decayed (D) Teeth Score

The meta-analysis was performed for 13 studies [Grim et al., 1994; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Medina et al., 2008; Lawrence et al., 2009; Jamieson et al., 2010a, b; Kapellas et al., 2014; Arrow, 2016; Haag et al., 2020; Arantes et al., 2021]. The mean dmft score for the deciduous dentition was significantly higher (SMD = 0.26; 95% CI 0.13–0.39) among indigenous than nonindigenous children (Fig. 3). Generally, all of the authors reported an increase in dmft score, except for 1 study [Kumar et al., 2013] from India, where the nonindigenous children had a higher dmft score.

The Filled (F) Teeth Score

There were 10 studies included in the meta-analysis. [Grim et al., 1994; Australian Institute of Health and Welfare, 2007; Brennan et al., 2007; Medina et al., 2008; Lawrence et al., 2009; Jamieson et al., 2010a, b; Kapellas et al., 2014; Arrow, 2016; Haag et al., 2020; Arantes et al., 2021]. Overall, the mean number of filled teeth was slightly higher among the general population than among the indigenous population (online suppl. Fig. 3). The SMD was −0.04 (95% CI −0.20 to 0.13). Three studies [Grim et al., 1994; Lawrence et al., 2009; Haag et al., 2020] reported a higher number of filled teeth among the indigenous population.

Prevalence of Dental Caries

The prevalence of dental caries was reported by several authors, but for meta-analysis only papers that presented both the mean and the SD were included. The data from only 6 studies [Australian Institute of Health and Welfare, 2007; Jamieson et al., 2010a, b, 2016a; Schuch et al., 2017; Arantes et al., 2021] could be analyzed. The prevalence of dental caries was significantly higher for the indigenous population (SMD = 0.27; 95% CI 0.13–0.41) than for the general nonindigenous population (Fig. 4).
Subgroup Analysis

A subgroup analysis was performed based on the country of publication for both DMFT and dmft. The heterogeneity by \(I^2\) statistics was high at 97.4\% for DMFT and 99.2\% for dmft. It was hypothesized that country could be the reason for heterogeneity. However, subgroup meta-analysis of DMFT (\(I^2: 78.5–97.7\%\)) and dmft subgroups (\(I^2: 88.5–99.5\%\)) by country did not substantially impact heterogeneity.

For both DMFT and dmft the pooled SMD of 0.22 (95\% CI 0.21–0.23) and 0.48 (95\% CI 0.47–0.49) were consistent with the overall finding, with the indigenous group having significantly more caries than the nonindigenous group (online suppl. Fig. 4, 5).

Publication Bias

The funnel plot for all variables (mean DMFT, mean dmft, mean DT, mean MT, mean FT) was scattered and had no relevance for the findings (online suppl. Fig. 6–11). With such a large sample size, the impacts of publication bias are minimal.

Discussion

Our review is a compilation of all published evidence on inequalities in dental caries prevalence and severity between indigenous and nonindigenous populations worldwide. To the best of our knowledge, there is no existing systematic review or meta-analysis on dental caries inequalities experienced among indigenous populations when compared against nonindigenous populations at a global level. Our review demonstrates that the experience of dental caries is substantially higher among indigenous groups compared to nonindigenous groups, irrespective of age, gender, or country. The factors that contribute to these inequalities vary across continents, and they are mostly attributed to a combination of socioeconomic factors, colonization, globalization, migration, transgenerational loss of culture, and disconnection from the land [Christian and Blinkhorn, 2012]. Sociopolitical constructs such as racism also play a role.

Studies from Brazil [Arantes et al., 2021], Mexico [del Rio Gomez, 1991], Ecuador [Medina et al., 2008], and a study from Australia [Kapellas et al., 2014] reported a

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**Fig. 4.** Forest plot comparing the mean (%) prevalence of dental caries among indigenous vs. nonindigenous populations.
lower caries burden on the permanent dentition of indigenous people when compared against their nonindigenous counterparts. It has been observed that indigenous people maintaining traditional hunter-gatherer lifestyles have extremely low levels of caries [Neel et al., 1964; Niswander, 1967; Martin-Iverson et al., 1999]. There were reduced caries scores among Amazon indigenous groups as their diet consisted of cassava, bananas, fish, and game meat [Medina et al., 2008]. For many, the industrialization of food and agriculture has led to changes in diet, increased consumption of processed foods, and a subsequent dramatic increase in dental caries [Arantes et al., 2001]. Gradually, through implementation of oral health programs, an improvement in oral health conditions has been observed [Patel et al., 2017]. For example, 6 years after the introduction of fluorinated water in Western Australia, a reduction in DMFT scores among indigenous groups was noted [Kruger et al., 2010]. Significant improvements in caries scores have been observed for indigenous children after implementation of oral health prevention programs, such as: incorporation of fluoride varnish application, water consumption, and daily tooth cleaning [Lawrence et al., 2008; Slade et al., 2011; Tadakamadla et al., 2020].

Another significant finding was that the pooled SMD for dmft was higher among indigenous children. A high intake of nutrient-poor processed foods with a high sugar content could contribute to this [Martin-Iverson et al., 1999]. Additionally, children are dependent on others for their health needs, including oral hygiene therefore parent influence is a factor. Another possible reason could be that the enamel is thinner and the disease progresses at a faster rate [Christian and Blinkhorn, 2012]. This susceptibility combined with socioeconomic conditions and environment and health factors are among some of the risk factors. The high rates of dental caries among indigenous children relative to their nonindigenous counterparts are especially concerning, as dental caries in childhood is the strongest predictor of dental caries in adulthood [Jackson et al., 2006b; Christian and Blinkhorn, 2012].

The findings of this review have significant implications for oral health professionals and dental public health efforts. While public health programs, especially water fluoridation [Whelton et al., 2019], have been effective in reducing caries in many populations, the significant findings here illustrate that oral health disparities persist for indigenous populations on a global scale. Indigenous populations are a small percentage of larger populations in the countries where they reside, and often times indigenous oral health inequities can be masked in population level statistics. The studies included in this review successfully highlighted the reality of indigenous oral health in their respective countries; this reflects the necessity to embed similar comparative approaches in future research to generate a true representation of population oral health. Innovative, multidisciplinary, and community level approaches are needed for acceptance and successful uptake by indigenous peoples [Baghdadi, 2016; Durey et al., 2017]. Moving beyond traditional methods of dental public health programming to cocreate community/tailored and culturally relevant strategies that focus on holistic health rather than isolating oral health to the oral cavity are necessary to address these preventable inequities [Watt and Sheiham, 1999; Watt, 2007; Kral et al., 2011].

There are some limitations of our review. All of the studies were methodologically different, with variations in sampling method, power calculation, and geographical locations. Most articles did not describe sample size calculation, and the indigenous group was always smaller in number when compared to the general population. Authors either reported the DMFT index or the caries prevalence rate, very few authors included both, and SD estimates were not present for the meta-analysis. Our subgroup analysis suggested that some populations had higher levels of dental caries when compared to the rest of the sample. To identify all of the evidence, we included all types of literature (published and unpublished) but almost half (49%) of the evidence was from Australia.

There is a need for well-planned oral epidemiological studies that take into account sampling methodologies to include indigenous as well as nonindigenous groups at a nationally representative level for developing as well as developed countries. This is important for policy translation and for monitoring and surveillance. Governments, oral health providers, and policy makers need to acknowledge the high social costs of dental caries among indigenous groups and the historical and contemporary socio-cultural determinants that lead to this. Many countries have now endorsed specific oral health services, policies, and long-term funding for indigenous populations, both in the provision of dental care and in the training of culturally safe indigenous dental practitioners. Our findings support the recommendation of all oral health service providers and policy makers to be cognizant of the unacceptable inequities in dental caries experienced by indigenous groups, of the factors contributing to this disparity, and to committing to addressing these aspects in the future.
Conclusion

At a global level, dental caries prevalence and severity are higher among indigenous groups compared to non-indigenous groups. This is irrespective of age, sex, or country. Higher rates are particularly noted for untreated dental decay and missing teeth due to pathology. This review highlights the unacceptable inequities that have stemmed from colonial policies and have resulted in dental service provision models that favor nonindigenous groups over indigenous groups. Increased awareness, targeted preventive programs, and culturally safe oral health interventions at the government (including the UN and WHO) level are required.

Statement of Ethics

This was a systematic review and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

Appendix 1

Search Strategy

| Database   | Search string                                                                 |
|------------|-------------------------------------------------------------------------------|
| MEDLINE    | (Dental caries [MH] OR Caries [TW] OR Dental decay [TW] OR Tooth decay[tw] OR Carious[tw] OR Decayed teeth [tw]) AND (“first nation” OR “first nations” OR “pacific islander” OR “pacific islanders” OR “torres strait islander” OR “torres strait islanders” OR aborigin* OR alaska* OR aleut* OR amerind* OR arctic OR Aymara OR bushmen OR chukchi OR chukotka* OR circumpolar OR eskimo* OR greenland* OR hmong OR indian* OR indigen* OR inuit* OR inupiaq OR Inupiat OR khtory OR maori* OR mapuche OR metis OR native* OR Navaho* OR navajo* OR nenets OR quechua OR sami OR samoan OR siberia* OR skold OR tribal OR tribe* OR xingu* OR yupik OR yupik OR zuni OR “African continental ancestry group” OR “African continental ancestry group” OR “Asian continental ancestry group” OR “Health Services, Indigenous” OR “Indigenous Health Services” OR “Oceanic ancestry group” OR “arctic regions” OR “ethnic groups”) |
| Scopus     | (TITLE-ABS-KEY (“caries” OR “Dental decay” OR “Tooth decay” OR carious OR “Decayed teeth”) AND (TITLE-ABS-KEY (“first nation” OR “first nations” OR “pacific islander” OR “pacific islanders” OR “torres strait islander” OR “torres strait islanders” OR aborigin* OR alaska* OR aleut* OR amerind* OR arctic OR aymara OR bushmen OR chukchi OR chukotka* OR circumpolar) OR TITILE-ABS-KEY (eskimo* OR greenland* OR hmong OR indian* OR indigen* OR inuit* OR inupiaq OR inupiat OR khtory OR maori* OR mapuche OR metis OR native* OR navaho* OR navajo* OR nenets OR quechua OR sami OR samoan OR siberia* OR skold OR tribal OR tribe* OR xingu) OR TITILE-ABS-KEY (yupik OR yupik OR zuni OR “African continental ancestry group” OR “African continental ancestry group” OR “Asian continental ancestry group” OR “Health Services, Indigenous” OR “Indigenous Health Services” OR “Oceanic ancestry group” OR “arctic regions”) OR TITILE-ABS-KEY (“ethnic groups”)) |

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

Not applicable.

Author Contributions

S.N. and L.M.J. conceived the presented idea. S.N., L.M.J., and X.J. devised the methodology of this paper. S.N., B.P., and L.M.J. performed the search of the databases for eligible studies and full-text assessment. S.N. and B.P. performed the methodological assessment, data extraction, and data entry. K.K., D.G.H., X.J., and P.H.R.S. contributed to interpretation and analysis of the results. S.N., B.P., and L.M.J. wrote this paper. All of the authors discussed the results and edited this paper.
## Appendix 2

### Excluded Studies

Alsharif AT, Kruger E, Tennant M. Dental hospitalization trends in Western Australian children under the age of 15 years: A decade of population-based study. Int J Paediatr Dent. 2015;25(1):42. Reason for exclusion: only hospitalization records for dental caries among indigenous and nonindigenous populations.

Australian Research Centre for Population Oral Health. Oral health of aboriginal Australians. Aust Dent J. 2004;49(3):151–3. Reasons for exclusion: secondary data from previous studies; incomplete data; and not an original article.

Brustard M, Bongo A, Hansen K, Trovik T, Oscarson N, Jonsen B. Oral health in the indigenous Sami population in Norway: The dental health in the North study. Acta Odontol Scand. 2020 Mar;78(2):98–108. Reason for exclusion: does not give dmft scores.

Dasanayake AP, Caufield PW. Prevalence of dental caries in Sri Lankan aboriginal Veddha children. Int Dent J. 2002;52(6):444. Reason for exclusion: does not include a control population.

Ferro R, Besostri A, Meneghetti B, Olivieri A, Benacchio L, Tabacanti S, et al. Oral health inequalities in preschool children in North-Eastern Italy as reflected by caries prevalence. Eur J Paediatr Dent. 2007;8(1):18. Reason for exclusion: indigenous status is not used to describe the native people.

Ha D, Xiangqun J, Cecilia MG, Jason A, Do LG, Jamieson L. Social inequality in dental caries and changes over time among Indigenous and non-Indigenous Australian children. Aust NZ J Public Health. 2016 Dec;40(6):542–7. Reason for exclusion: secondary data analyzed; excluded as data were compared from different time periods and categorized into quartiles based on SES.

Hopcraft M, Chow W. Dental caries experience in aboriginal and Torres Strait Islanders in the Northern Peninsula Area, Queensland. Aust Dent J. 2007;52(4):304. Reason for exclusion: no separate data for nonindigenous populations were given and only a comparison with an Australian population was made.

Jamieson L. Dental caries trends among Indigenous and non-Indigenous children in Australia. Community Dent Health. 2002;24:238–46. Reason for exclusion: secondary data was used for analysis; time trends reported from 1989–2000.

Jayashantha P, Johnson NW. Oral health status of the Veddas-Sri Lankan indigenous people. J Health Care Poor and Underserved. 2016;27(1):147. Reason for exclusion: incomplete comparison data.

Ju X, Do L, Ha D, Jamieson L. Association of modifiable risk factors with dental caries among indigenous and nonindigenous children in Australia. JAMA Netw Open. 2019 May;2(5):e193466. Reason for exclusion: same secondary dataset used (The Australian National Child Oral Health Study 2012/14); the outcome variable considered was decayed surface instead of DMFT.

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**Database** | **Search string**
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Dentistry and Oral Sciences | (“(caries” OR “Dental decay” OR “Tooth decay” OR carious OR “Decayed teeth”) AND (“first nation” OR “first nations” OR “Pacific islander” OR “Pacific islanders” OR “tobacco street islander” OR “tobacco street islanders” OR aboriginal* OR alaska* OR aleut* OR amerind* OR arctic OR aymara OR bushmen OR chukchi OR chukotka* OR circumpolar OR eskimo* OR greenland* OR greenland OR hmgon OR indiana* OR indigen* OR inuit* OR inuit OR inuk OR inupiat OR inupiat OR khanty OR maori* OR mapuche OR metis OR native* OR navaho* OR navajo* OR nenets OR quechua OR sami OR sami OR samoan* OR siberia* OR skold OR tribal OR tribe* OR xingu) OR (yup’ik OR Yupik OR zuni) OR “African continental ancestry group” OR “Africa continental ancestry group” OR “African continental ancestry group” OR “Asian continental ancestry group” OR “Health Services, Indigenous” OR “Indigenous Health Services” OR “Oceanic ancestry group” OR “arctic regions”) OR “ethnic groups”

Open Grey | (“caries” OR “Dental decay” OR “Tooth decay” OR carious OR “Decayed teeth” AND “first nation” OR “first nations” OR “Pacific islander” OR “Pacific islanders” OR “tobacco street islander” OR “tobacco street islanders” OR aboriginal* OR alaska* OR aleut* OR amerind* OR arctic OR aymara OR bushmen OR chukchi OR chukotka* OR circumpolar OR eskimo* OR greenland* OR greenland OR hmgon OR indiana* OR indigen* OR inuit* OR inuit OR inupiat OR inupiat OR khanty OR maori* OR mapuche OR metis OR native* OR navaho* OR navajo* OR nenets OR quechua OR sami OR sami OR samoan* OR siberia* OR skold OR tribal OR tribe* OR xingu OR yup’ik OR Yupik OR zuni OR “African continental ancestry group” OR “African continental ancestry group” OR “Asian continental ancestry group” OR “Health Services, Indigenous” OR “Indigenous Health Services” OR “Oceanic ancestry group” OR “arctic regions” OR “ethnic groups”

Cochrane database | (“caries” OR “Dental decay” OR “Tooth decay” OR carious OR “Decayed teeth” AND “first nation” OR “first nations” OR “Pacific islander” OR “Pacific islanders” OR “tobacco street islander” OR “tobacco street islanders” OR aboriginal* OR alaska* OR aleut* OR amerind* OR arctic OR aymara OR bushmen OR chukchi OR chukotka* OR circumpolar OR eskimo* OR greenland* OR greenland OR hmgon OR indiana* OR indigen* OR inuit* OR inuit OR inupiat OR inupiat OR khanty OR maori* OR mapuche OR metis OR native* OR navaho* OR navajo* OR nenets OR quechua OR sami OR sami OR samoan* OR siberia* OR skold OR tribal OR tribe* OR xingu OR yup’ik OR Yupik OR zuni OR “African continental ancestry group” OR “African continental ancestry group” OR “Asian continental ancestry group” OR “Health Services, Indigenous” OR “Indigenous Health Services” OR “Oceanic ancestry group” OR “arctic regions” OR “ethnic groups”

- (Word variations have been searched)
Lalloo R, Jamieson LM, Ha D, Luzzi L. Inequalities in tooth decay in Australian children by neighbourhood characteristics and indigenous status. J Health Care Poor Underserved. 2016;27(1A):161-177. Reason for exclusion: same data set as Ha et al., 2014; data analyzed according to neighborhood characteristics.

Rush E. Secular trends 2013–2017 in overweight and visible dental decay in New Zealand preschool children: influence of ethnicity, deprivation and the Under-5-Energize nutrition and physical activity programme. J Dev Orig Health Dis. 2019 Jun;10(3):345-52. Reason for exclusion: does not use DMFT as a measure of decay.

Rush E. Under 5 Energize: Tracking progress of a preschool nutrition and physical activity programme with regional measures of body size and dental health at age of 4 years. Nutrients. 2017 May 4;9(5):456. Reason for exclusion: does not use DMFT as measure of dental decay.

Schluter PJ, Lee M. Water fluoridation and ethnic inequities in dental caries profiles of New Zealand children aged 5 and 12–13 years: analysis of national cross-sectional registry databases for the decade 2004–2013. BMC Oral Health. 2016 Feb 18;16:21. Reason for exclusion: secondary data analysis of national cross sectional registry databases; contains population estimates from 2004 to 2015; mean values without any SD.

Shackleton N, Jamieson LM, Ha D, Luzzi L. Inequalities in tooth decay in Australian children by neighbourhood characteristics and indigenous status. J Health Care Poor Underserved. 2016;27(1A):161-177. Reason for exclusion: same data set as Ha et al., 2014; data analyzed according to neighborhood characteristics.

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References

Alves Filho P, Santos RV, Vettore MV. Factors associated with dental caries and periodontal diseases in Latin American indigenous peoples: a systematic review. Rev Panam Salud Publica. 2014 Jan;35(1):67–77.

Arantes R, Jamieson LM, Frazão P. Dental caries, periodontal disease and restorative dental care among Indigenous and non-Indigenous groups in Brazil: A descriptive study. Community Dent Oral Epidemiol. 2021 Feb;49(1):63–9.

Arantes R, Santos RV, Coimbra CE Jr. Oral health among the Xavante Indians in Pimentel Barbosa, Mato Grosso, Brazil. Cad Saude Publica. 2001 Mar-Apr;17(2):375–84.

Armitage A. Comparing the policy of aboriginal assimilation: Australia, Canada, and New Zealand. Vancouver: UBC Press; 1995.

Aromataris E. JBI manual for evidence synthesis. 2020. Available from: https://doi.org/10.46658/JBIMES-20-01.

Arrow P. Oral health of schoolchildren in Western Australia. Aust Dent J. 2016 Sep;61(3):333–41.

Australian Institute of Health and Welfare. Australia’s dental generations: the national survey of adult oral health 2004–06. Canberra: Australian Institute of Health and Welfare; 2007.

Baghdadi ZD. Early Childhood Caries and Indigenous Children in Canada: Prevalence, Risk Factors, and Prevention Strategies. J Int Oral Health. 2016;8:830–7.

Brennan DS, Roberts-Thomson KF, Spencer AJ. Oral health of Indigenous adult public dental patients in Australia. Aust Dent J. 2007 Dec;52(4):322–8.

Christian B, Blinkhorn AS. A review of dental caries in Australian Aboriginal children: the health inequalities perspective. Rural Remote Health. 2012 Oct;12(4):2032.

Council of Australian Governments. Healthy mouths healthy lives: Australia’s national oral health plan 2015-2024. Adelaide: COAG Health Council; 2015.

Davies MJ, Spencer AJ, Westwater A, Simmons B. Dental caries among Australian Aboriginal, non-Aboriginal Australian-born, and overseas-born children. Bull World Health Organ. 1997;75(3):197–203.

de Muñiz BR. Epidemiologic oral health survey of Argentine children. Community Dent Oral Epidemiol. 1985 Dec;13(6):328–33.

de Silva AM, Martin-Kerry JM, McKee K, Cole D. Caries and periodontal disease in Indigenous adults in Australia: a case of limited and non-contemporary data. Aust Health Rev. 2017a Aug;41(4):469–78.

de Silva AM, Martin-Kerry JM, McKee K, Cole D: Caries and periodontal disease in Indigenous adults in Australia: a case of limited and non-contemporary data. Aust Health Rev. 2017b Aug;41(4):469–78.

del Rio Gomez I. Dental caries and mutans streptococci in selected groups of urban and native Indian schoolchildren in Mexico. Community Dent Oral Epidemiol. 1991 Apr;19(2):98–100.

Dogar F, Kruger E, Dyson K, Tennant M. Oral health of pre-school children in rural and remote Western Australia. Rural Remote Health. 2011;11(4):1869.

Drummond AM, Ferreira EF, Gomes VE, Marce- nes W. Inequality of Experience of Dental Caries between Different Ethnic Groups of Brazilians Aged 15 to 19 Years. PLoS One. 2015 Dec;10(12):e0145553.

Durey A, McAulay D, Gibson B, Slack-Smith LM. Oral Health in Young Australian Aboriginal Children: Qualitative Research on Parents’ Perspectives. JDR Clin Trans Res. 2017 Jan;2(1):38–47.

Endean C, Roberts-Thomson K, Wooley S. Anangu oral health: the status of the Indigenous population of the Anangu Pitjantjatjara lands. Aust J Rural Health. 2004 Jun;12(3):99–103.

Erni C. The Concept of Indigenous Peoples in Asia: A Resource Book. Copenhagen, Chiang Mai: IWGIA; 2008a.

Erni C. The concept of indigenous peoples in Asia. A resource book. Copenhagen: International Work Group for Indigenous Affairs;2008b.
Foster Page LA, Murray Thomson W. Dental caries in taranaki adolescents: A cohort study. NY Dental J. 2011;107:91–96.

Glenn EN. Settler Colonialism as Structure: A Framework for Comparative Studies of U.S. Race and Gender Formation. Sociol Race Ethn (Thousand Oaks). 2015(1):52–72.

Gowda SS, Thomson W, Foster Page LA, Crouch-er NA. Dental caries experience of children in Northland/Te Tai Tokerau. NZ Dent J. 2009 Dec;105(4):116–20.

Gracey M, King M. Indigenous health part 1: determinants and disease patterns. Lancet. 2009 Jul;374(9683):65–75.

Grim CW, Broderick EB, Jasper B, Phipps KR. A comparison of dental caries experience in Native American and Caucasian children in Oklahoma. J Public Health Dent. 1994;54(4):220–7.

Ha DH. Australian Research Centre for Population and Health Services Research. Oral Health Inequalities among Indigenous and Non-Indigenous Children. J Clin Trans Res. 2020. Forthcoming.

Hallett KB, O’Rourke PK. Dental caries experience of preschool children from the North Brisbane region. Aust Dent J. 2002 Dec;47(4):331–8.

 Higgins JP, Chandler J, Cumpston M, Li T, Page MJ, Welch VA: Cochrane handbook for systematic reviews of interventions. 2nd edition. Chichester: Wiley; 2019.

Jamieson LM, Armfield JM, Roberts-Thomson KF. The role of location in indigenous and non-indigenous child oral health. J Public Health Dent. 2006a;66(2):123–30.

Jamieson LM, Armfield JM, Roberts-Thomson KF. Oral health inequalities among indigenous and nonindigenous children in the Northern Territory of Australia. Community Dent Oral Epidemiol. 2006b;34(4):267–76.

Jamieson LM, Armfield JM, Roberts-Thomson KF. Indigenous and non-indigenous child oral health in three Australian states and territories. Ethn Health. 2007a;12(1):89–107.

Jamieson LM, Armfield JM, Roberts-Thomson KF, Sayers SM. A retrospective longitudinal study of caries development in an Australian Aboriginal birth cohort. Caries Res. 2010a;44(4):415–20.

Jamieson LM, Elani HW, Mejia GC, Ju X, Kawachi I, Harper S, et al. Inequalities in indigenous oral health: findings from Australia, New Zealand, and Canada. J Dent Res. 2016 Nov;95(12):1375–80.

Jamieson LM, Parker EJ, Armfield JM. Indigenous child oral health at a regional and state level. J Paediatr Child Health. 2007b Mar;43(3):117–21.

Jamieson LM, Roberts-Kennedy Th, Roberts-Thomson KF. Indigenous children and receipt of hospital dental care in Australia. Int J Paediatr Dent. 2006c Sep;16(5):327–34.

Jamieson LM, Sayers SM, Roberts-Thomson KF. Clinical oral health outcomes in young Australian Aboriginal adults compared with national-level counterparts. Med J Aust. 2010b May;192(10):558–61.

John SB, Asokan S, Aswathn K, Priya PR, Shanmuga-veal AK. Dental caries and the associated factors influencing it in tribal, suburban and urban school children of Tamil Nadu, India: a cross sectional study. J Public Health Res. 2015 Mar;4(1):361.

Jones DB, Schlie CM, Phipps KR. An oral health survey of Head Start children in Alaska: oral health status, treatment needs, and cost of treatment. J Public Health Dent. 1992;52(2):86–93.

Kapellas K, Skilton MR, Maple-Brown LJ, Do LG, Bartold PM, O’Dea K, et al. Periodontal disease and dental caries among Indigenous Australians living in the Northern Territory, Australia. Aust Dent J. 2014 Mar;59(1):93–9.

King M, Smith M, Gracey M. Indigenous health part 2: the underlying causes of the health gap. Lancet. 2009 Jul;374(9683):76–85.

Kral MJ, Ildout L, Minore JB, Dyck RJ, Kirmayer LJ. Unikkaartaatit: meanings of well-being, un-happiness, health, and community change among Inuit in Nunavut, Canada. Am J Community Psychol. 2011 Dec;48(3-4):426–38.

Krug E, Jacobs A, Tennant M. Sustaining oral health services in remote and indigenous communities: a review of 10 years experience in Western Australia. Int Dent J. 2010 Apr;60(2):129–34.

Kumar KR, Reddy NV, Prasad Rao VA, Krishnas- Kumar R, Sugumaram DK, Mohan G. Prevalence of Caries in Urban, Rural & Tribal Chil-dren in Tamil Nadu. J Indian Dental Associa-tion. 2013;7:24–32.

Lalloo R, Jamieson LM, Ha D, Ellershaw A, Luzzi L. Does fluoride in the water close the dental caries gap between Indigenous and non-Indigenous children? Aust Dent J. 2015 Sep;60(3):390–9.

Lawrence HP, Binguis D, Douglas J, McKeown L, Switzer B, Figueiredo R, et al. A 2-year community-randomized controlled trial of flou-ride varnish to prevent early childhood caries in Aboriginal children. Community Dent Oral Epidemiol. 2008 Dec;36(6):503–16.

Lawrence HP, Binguis D, Douglas J, McKeown L, Switzer B, Figueiredo R, et al. Oral health inequalities among young Aboriginal and non-Aboriginal children living in Ontario, Canada. Community Dent Oral Epidemiol. 2007a;35(4):495–508.

Marmot MG. Dignity, social investment and the Indigenous health gap. Med J Aust. 2017 Jul;207(1):20–1.

Martin-Iverson N, Pacza T, Phatoouros A, Ten-nant M. Indigenous Australian dental health: a brief review of caries experience. Aust Dent J. 2000 Mar;45(1):17–20.

Phelan C, Byun R, Skinner JC, Blinkhorn AS. Child Dental Health Survey 2007: a snapshot of the oral health status of primary school-aged children in NSW. NSW Public Health Bull. 2009 Mar-Apr;20(3-4):40–5.

Phipps KR, Ricks TL, Manz MC, Blahut P. Preva-lence and severity of dental caries among American Indian and Alaska Native preschool children. J Public Health Dent. 2012;72(3):208–15.

Rao SP, Bharambe MS. Dental care and peri-odontal diseases among urban, rural and trib-al school children. Indian Pediatr. 1993 Jun;30(6):759–64.

Richmond CA, Ross NA. The determinants of First Nation and Inuit health: a critical popu-lation health approach. Health Place. 2009 Jun;15(2):403–11.
Sarfati D, Robson B, Garvey G, Goza T, Foliaki S, Millar E, et al.; participants of the Indigenous Peoples and Cancer Symposium. Improving the health of Indigenous people globally. *Lancet Oncol.*, 2018 Jun;19(6):e276–276.

Schamschula RG, Cooper MH, Adkins BL, Barmes DE, Agus HM. Oral conditions in Australian children of Aboriginal and Caucasian descent. *Community Dent Oral Epidemiol.* 1980 Oct;8(7):365–9.

Schroth RJ, Smith PJ, Whalen JC, Lekic C, Moffatt ME. Prevalence of caries among preschool-aged children in a northern Manitoba community. *J Can Dent Assoc.*, 2005 Jan;71(1):27.

Schuch HS, Haag DG, Kapellas K, Arantes R, Peres MA, Thomson WM, et al. The magnitude of Indigenous and non-Indigenous oral health inequalities in Brazil, New Zealand and Australia. *Community Dent Oral Epidemiol.* 2017 Oct;45(5):434–41.

Singh A, Purohit B, Sequeira P, Acharya S. Oral health status of 5-year-old Aborigine children compared with similar aged marginalised group in south western India. *Int Dent J.*, 2011 Jun;61(3):157–62.

Slade GD, Ballie RS, Roberts-Thomson K, Leach AJ, Raye I, Endean C, et al. Effect of health promotion and fluoride varnish on dental caries among Australian Aboriginal children: results from a community-randomized controlled trial. *Community Dent Oral Epidemiol.* 2011 Feb;39(1):29–43.

Spencer A, Do L. Oral health of Australian children: The National Child Oral Health Study 2012–14. Adelaide: University of Adelaide Press; 2016.

Shen A, Zeng X, Cheng M, Tai B, Huang R, Bernabé E. Inequalities in dental caries among 12-year-old Chinese children. *J Public Health Dent*. 2015;75(3):210–7.

Shi C, Faris P, McNeil DA, Patterson S, Potestio ML, Thawer S, et al. Ethnic disparities in children’s oral health: findings from a population-based survey of grade 1 and 2 schoolchildren in Alberta, Canada. *BCMA Oral Health*. 2018 Jan;18(1):1.

Simangwa LD, Åstrøm AN, Johansson A, Minja IK, Johansson AK. Oral diseases and sociodemographic factors in adolescents living in Maasai population areas of Tanzania: a cross-sectional study. *BMC Oral Health*. 2018 Dec;18(1):200.

Steadman D, Sheiham A. Inequalities in oral health: a review of the evidence and recommendations for action. *Br Dent J*. 1999 Jul;187(1):6–12.

Takeshima N, Sozu T, Tajika A, Ogawa Y, Hayasaka Y, Furukawa TA. Which is more generalizable, powerful and interpretable in meta-analyses, mean difference or standardized mean difference? *BMC Med Res Methodol.* 2014 Feb;14(1):30.

Tiwari T, Jamieson L, Broughton J, Lawrence HP, Batliner TS, Arantes R, et al. Reducing Indigenous Oral Health Inequalities: A Review from 5 Nations. *J Dent Res*. 2018 Jul;97(8):869–77.

United Nations: United Nations declaration on the rights of indigenous peoples. Geneva: UN; 2007.

United Nations Department of Economic and Social Affairs. Study of the problem of discrimination against indigenous populations. Geneva: United Nations; 1981.

Watt RG. From victim blaming to upstream action: tackling the social determinants of oral health inequalities. *Community Dent Oral Epidemiol.* 2007 Feb;35(1):1–11.

Weltin HP, Spencer AJ, Do LG, Rugg-Gunn AJ. Fluoride Revolution and Dental Caries: Evolution of Policies for Global Use. *J Dent Res*. 2019 Jul;98(8):837–46.

Williams DM, Mossey PA, Mathur MR. Leadership in global oral health. *J Dent*. 2019 Aug;87:49–54.

Wolf P. Settler colonialism and the transformation of anthropology: The politics and poetics of an ethnographic event. London: Cassell; 1999.

Yin P. Colonisation, racism and indigenous health. *J Popul Res (Canberra)*. 2016;33(1):83–96.

Zeng X, Luo Y, Du M, Bedi R. Dental caries experience of preschool children from different ethnic groups in Guangxi Province in China. *Oral Health Prev Dent*. 2005;3(1):25–31.