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

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Keywords

Enamel caries · Epidemiology · Public dental health · Systematic review

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

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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-analysis (PRISMA) guidelines were followed for reporting of this systematic review and meta-analysis [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 chukotka* OR circumpolar OR eskimo* OR greenland* OR hmong OR indian* OR indigen* OR inuit* OR inupiaq 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"]). The 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 (m/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 finding 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 nonndigenous 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

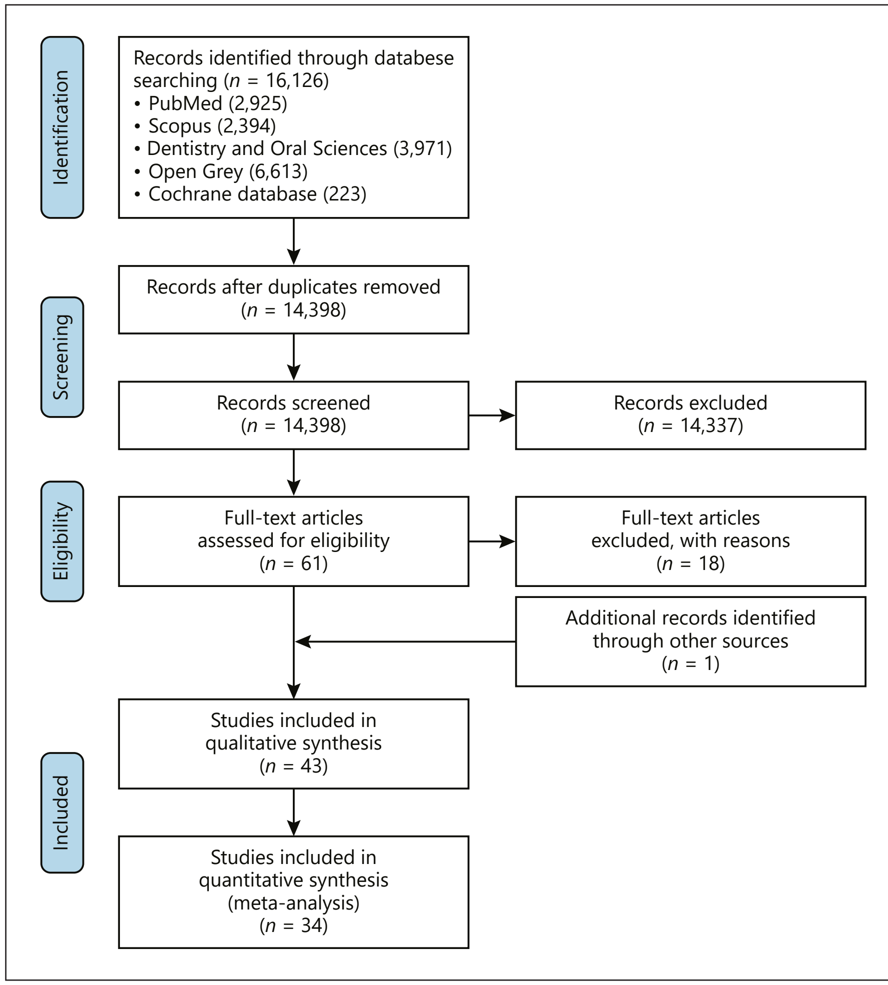

Fig. 1. PRISMA flow diagram.

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 WebPlotDigitizer 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 = $\sqrt{N} \times$ (upper limit – 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 [Takeshima et al., 2014]. Heterogeneity was assessed statistically using the standard χ^2, Tau^2 and I^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
							cases, *n*	controls, *n*		
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, Kaio-wa, Terena, and Kadiweu	Nonindigenous population	606 543 415 266	1,124 1,179 884 1,435	5 12 15–19 35–44	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	268 349	6,047 8,023	5–10 6–15	The aboriginal children had a higher dmft 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	429 407	1,218 696	6 12	The oral disease experience and the prevalence of untreated dental caries were higher among aboriginal children
5	de Munz [1985], Argentina, (2 parts)	Cross-sectional	Data from school children in Argentina residing in urban and rural areas	N/A	Amerindians	Caucasians children	135 362	312 657	7 12	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 Guarda de 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 National 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	Pitjantjatjaraand Yankunytjatjara-speaking communities of the northwest of South Australia	N/A	Anangu adults	Nonindigenous Australians	317 289	1,198 1,706	5–6 >12	Aboriginal children and adults experienced more dental caries than their national counterparts
10	Foster Page and Thomson [2011], New Zealand (2 parts)	Cohort	Taranki region of New Zealand	Random sample	Maori adolescents	Non-Maori adolescents	342 226	88 29	13 16	Maori people had a worse DMFT score than non-Maori people
11	Gowda et al. [2009], New Zealand	Cross-sectional	Children attending schools in Kaitaia, Kaikohe, Kawakawa/ Moerewa, and Dargaville	N/A	Maori children	Pakeha/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 chil-dren	457 367	456 332	5–6 15–17	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 12–13	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

Table 1 (continued)

No.	Study, country	Study design	Location	Sampling method	Cases	Controls	Study participants		Age, years	Inference
							cases, *n*	controls, *n*		
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; comparison of metropolitan areas	Random sampling	Indigenous metropolitan children Indigenous rural children	Nonindigenous metropolitan children Nonindigenous rural children	3,450 7,023	22,964 85,662	4–10 6–14 4–10 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	365 476 426 514 556 542 534 503 377 121	961 967 981 924 890 913 880 847 649 158	4 5 6 7 8 9 10 11 12 13	Findings suggested that indigenous status and SES have strong oral health outcome correlations but are not mutually exclusive (indigenous children had a worse dmft/DMFTscore 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	N/A	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 comapred to the nonindigenous population
20	Jamieson et al. [2010a], 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	NSAOH- 3 stage clustered sampling design, ABC-N/A	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 for CDHS	Aboriginal birth cohort study	Northern Territory CDHS	145 145 145	4,467 2,666 119	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	A stage/stratified cluster sampling Multistage stratified sampling	Aboriginal and Torres Strait Islander Canada Native American Indian, Metis or Inuit Maori	Nonaboriginal	64 104 386	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 dft 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
							cases, *n*	controls, *n*		
24	Jones et al. [1992], America	Cross-sectional	Children enrolled in Rural CAP Head Start and American Indian Program Branch Head Start programs from 20 communities in Alaska	Convenience sample	Native	Nonnative	381	163	3–5	Native children had higher dmft scores than nonnative children
25	Kapellas [2014], Australia	Cross-sectional	Darwin, Katherine, and correctional facility in Darwin and Alice Springs, Northern Territory	Convenience sample	Indigenous Australian	National Survey of Adult Oral Health 2004–2006	312	4,967	20–55+	Untreated dental caries were prevalent among indigenous Australians compared to the general Australian population
26	Kumar et al. [2013], India	Cross-sectional	Urban region: various corporation schools of Chennai, the capital of Tamil Nadu 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
27	Lallo et al. [2015]. Australia	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	Nonindigenous	6,817	91,255	5–15	Indigenous children had worse dmft and DMFT scores than nonindigenous children
28	Lawrence et al. [2008], Canada	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
29	Lawrence et al. [2009], Canada (3 parts)	Cross-sectional	Children entering junior kindergarten in the Thunder Bay District, Northwest Ontario, Canada	Cluster sampling	Aboriginal	Nonaboriginal	65 76 63	351 611 481	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
30	Medina et al. [2008], Ecuador	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
31	Miranda et al. [2018], Brazil, (2 parts)	Cross-sectional	National Oral Health (SB Brasil 2010) database	Stratified multistage sampling	Indigenous	Nonindigenous	308 52	37,211 7,295	All ages 5	There were unequal differences in the state of tooth decay between the indigenous population and the national population
32	Page and Thomson [2011], New Zealand	Cross-sectional	Taranaki, New Zealand	NA	Maori	Non-Maori	29	226	16	Maori people had a higher caries incidence than the non-Maori population
33	Phelan et al. [2009], Australia	Cross-sectional	Metropolitan and nonmetropolitan public, Catholic, and independent schools in New South Wales	Representative sampling	Aboriginal	Nonaboriginal	458	6,591	5–12	The indigenous children of NSW had poor DMFT scores compared to the nonaboriginal children
34	Rao and Bharambe 1993, India	Cross-sectional	Kasturba Rural Health Training Centre, situated 17 km from the Wardha District, India	Stratified cluster sample	Tribal children	Urban children	250	123	5–14	Tribal children had a higher prevalence of dental caries compared to urban children
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	31 52	6–8 10–11	Tooth defects were more severe in aborigines than in Caucasians

Table 1 (continued)

No.	Study, country	Study design	Location	Sampling method	Cases	Controls	Study participants		Age, years	Inference
							cases, *n*	controls, *n*		
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	128 108	105 67	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 New Zealand Oral Health Survey (NZOHS), conducted in the 2009 PerioCardio study, and the NSAOH component of the Northern Territory	Stratified multistage cluster sampling	Indigenous	Nonindigenous	144 250 107	17,254 510 140	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	2,201	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 probalistic sampling	Indigenous children including First Nations, Metis, and Inuit	Children of all races	95	5,600	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	185	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 Udupi district	NA	Tribal children	Other government school children	418	428	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	5,505	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	487	3–5	The Zhuang children had higher dmft scores than the Han children

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 datasets 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., 1997; Hallett and O'Rourke, 2002; Endean et al., 2004; 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; 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; Lalloo et al., 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; Lalloo 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; Lalloo 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; Lalloo 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

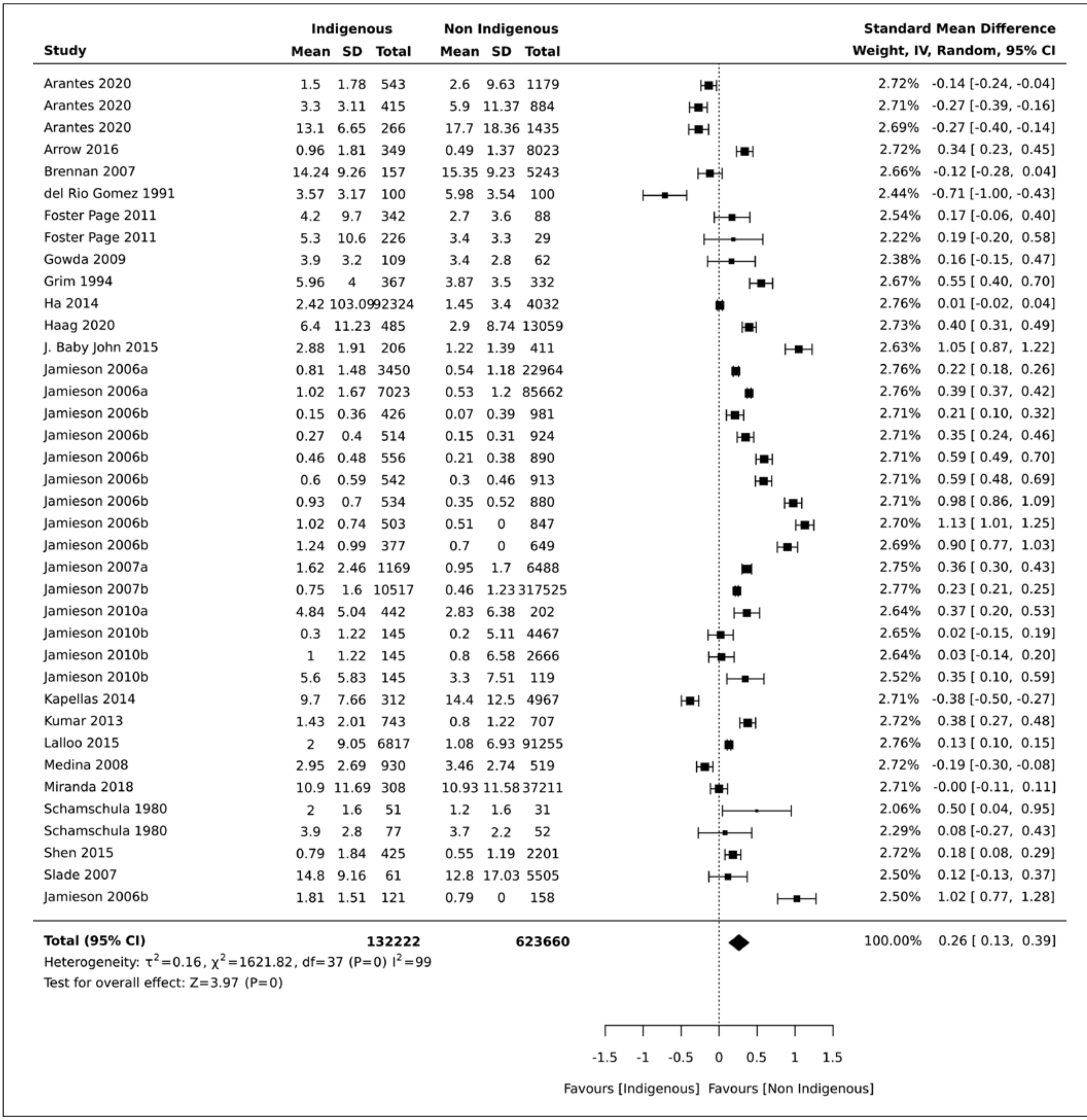

Fig. 2. Forest plot comparing mean DMFT scores in indigenous vs. nonindigenous populations.

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; Lalloo 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].

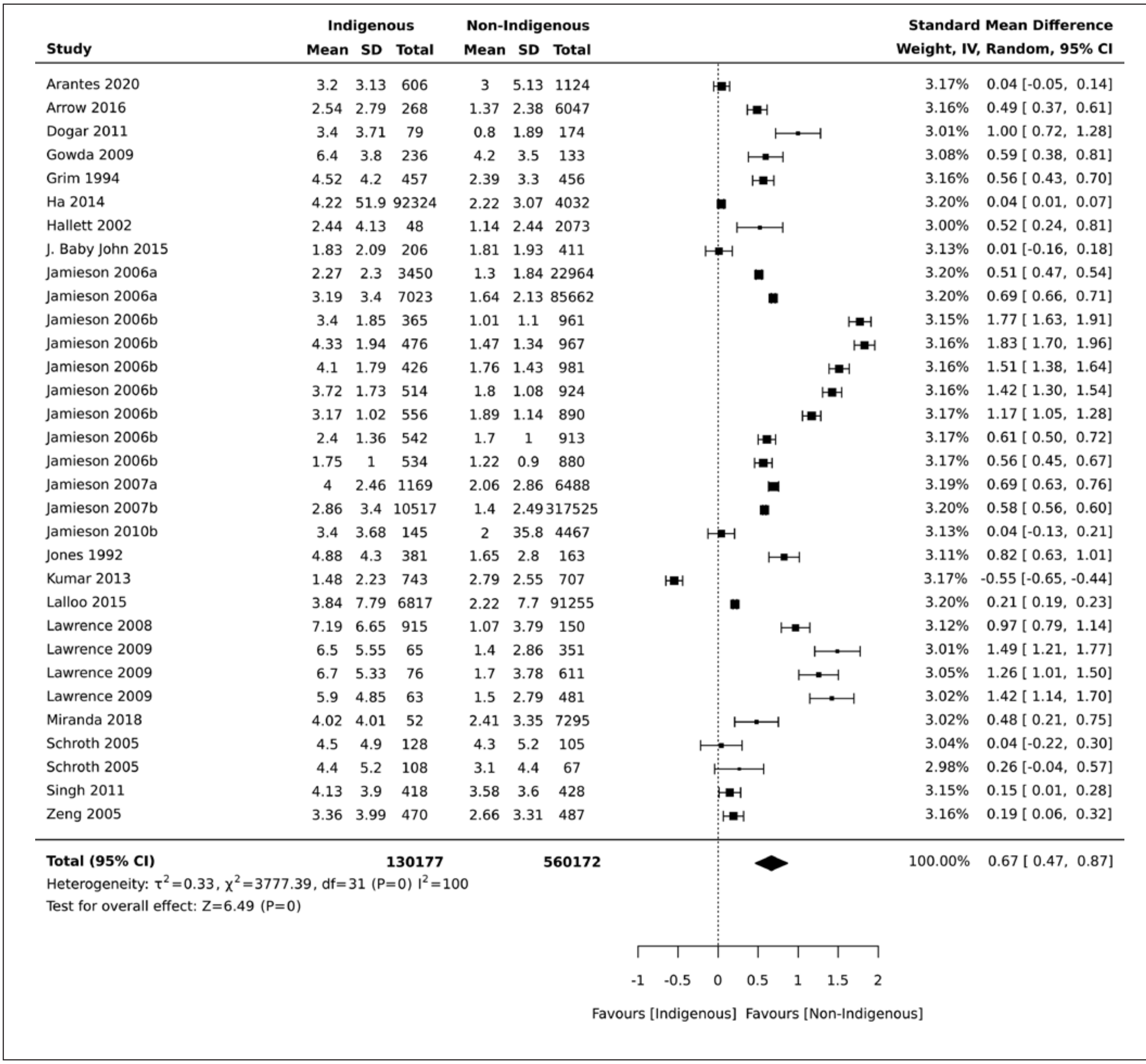

Fig. 3. Forest plot comparing mean dmft scores among indigenous vs. nonindigenous children.

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.

DMFT Score

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; Lalloo 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.

dmft Score

The meta-analysis was performed for 22 studies. [Jones et al., 1992; Grim et al., 1994; Hallett and O'Rourke, 2002; Schroth et al., 2005; Zeng et al., 2005; Jamieson et al., 2006b, 2007a; Lawrence et al., 2008; Gowda et al., 2009; Lawrence et al., 2009; Jamieson et al., 2010a; Dogar et al., 2011; Singh et al., 2011; Kumar et al., 2013; Ha, 2014; John et al., 2015; Lalloo et al., 2015; Arrow, 2016; Miranda et al., 2018; Arantes et al., 2021]. The mean dmft score for the deciduous dentition was significantly higher (SMD = 0.67; 95% CI 0.47–0.87) among indigenous than nonindigenous children (Fig. 3). Globally, 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 Decayed (D) Teeth Score

The meta-analysis was performed on 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; Dogar et al., 2011; Kapellas et al., 2014; Shen et al., 2015; Arrow, 2016; Haag et al., 2020; Arantes et al., 2021] that observed the mean decayed tooth score (online suppl. Fig. 1; see www.karger.com/doi/10.1159/000516137 for all online suppl. material). There was a significantly higher number of decayed teeth among indigenous populations than their nonindigenous counterparts (SMD = 0.44; 95% CI 0.25–0.62). Except for 1 study [Medina et al., 2008], all of the studies recorded a higher score of decayed teeth among the indigenous group. In a report by Arantes et al. [2021], the study was divided into 4 parts according to different age groups (5 years, 12 years, 15–19 years, and 35–44 years), and caries severity was higher among the indigenous group in 5 year-olds compared to the other age groups.

The Missing (M) Teeth Score

Several authors [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] reported the mean number of missing teeth (online suppl. Fig. 2). There were slightly more missing teeth among indigenous people compared to nonindigenous people (SMD = 0.11; 95% CI –0.05 to 0.26). Only 3 studies [Jamieson et al., 2010a, b; Kapellas et al., 2014] showed a trend of the general population having more missing teeth.

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).

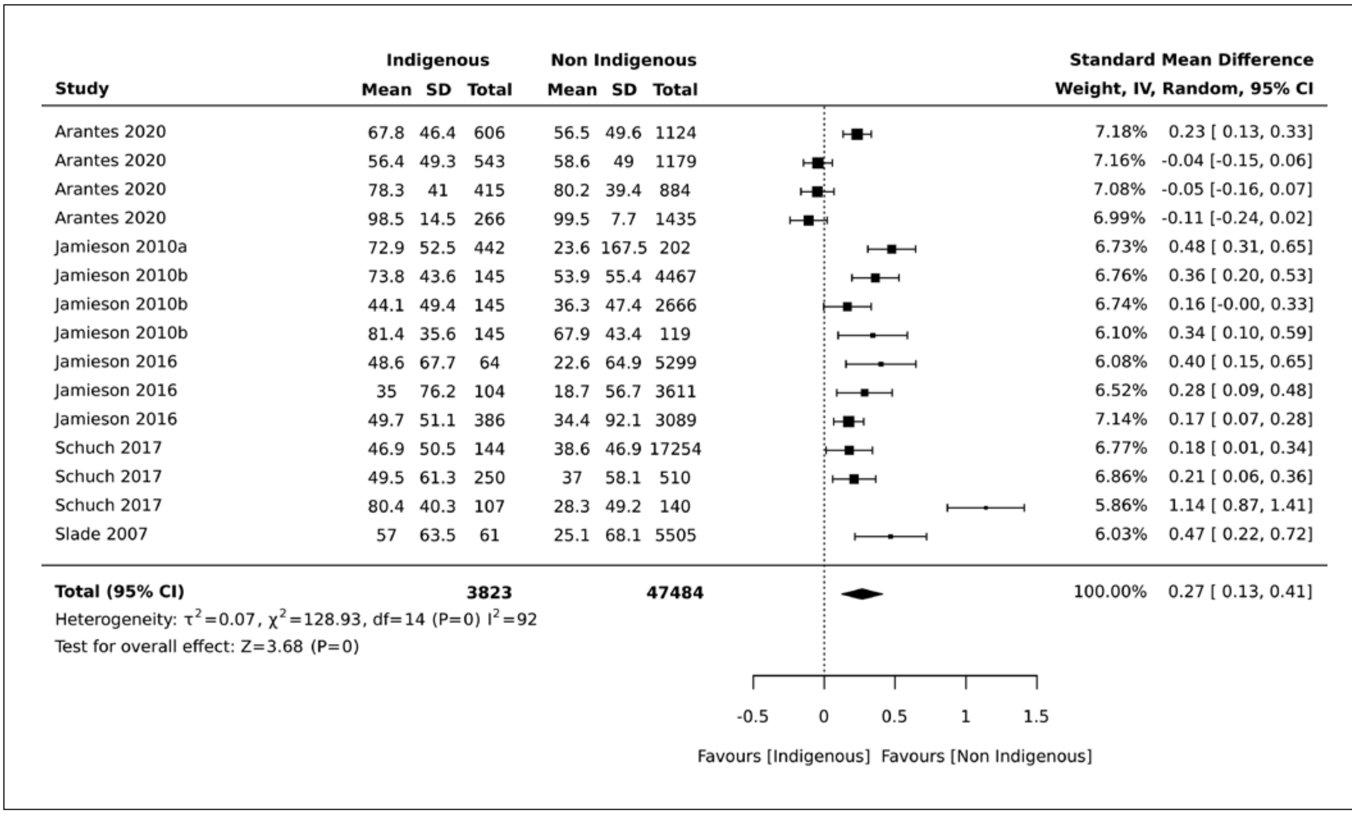

Fig. 4. Forest plot comparing the mean (%) prevalence of dental caries among indigenous vs. nonindigenous populations.

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 impacted 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, irrespectively 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 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 [Jamieson 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 sociocultural 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 nonondigenous 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.

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 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 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”)
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 TITLE-ABS-KEY (eskimo* OR greenland* OR hmong OR indian* OR indigen* OR inuit* OR inupiaq 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 TITLE-ABS-KEY (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 TITLE-ABS-KEY (“ethnic groups”))

Database	Search string
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 "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 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"
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 "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 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 "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 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" in Title Abstract Keyword - (Word variations have been searched)

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, Jonsson 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, Tabaccanti 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 Australian children. Community Dent Health. 2007;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.

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.

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Simangwa LD, Johansson A-K, Johansson A, Minja IK, Åstrøm AN. Oral impacts on daily performances and its socio-demographic and clinical distribution: A cross-sectional study of adolescents living in Maasai population areas, Tanzania. Health Qual Life Outcomes. 2020 Jun 12;18(1):181. Reason for exclusion: same data set in a previous study (i.e., Simangwa et al. 2018) was used.

Thomson WM. Ethnicity and child dental health status in the Manawatu-Wanganui Area Health Board. NZ Dent J. 1993 Jan;89(395):12-4. Reason for exclusion: for dental caries experience, MFT was recorded in place of DMFT.

Thornley S, Marshall RJ, Bach K, Koopu P, Reynolds G, Sundborn G, et al. Sugar, dental caries and the incidence of acute rheumatic fever: A cohort study of Māori and Pacific children. J Epidemiol Community Health. 2017;71(4):370.

Appendix 3

Critical Appraisal of the Included Studies

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total score
Arantes et al. [2021]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Arrow [2016]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Brennan et al. [2007]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Davies et al. [1997]	Y	U	U	Y	Y	Y	Y	Y	U	6
de Muñiz [1985]	Y	U	U	Y	Y	Y	Y	U	Y	6
del Rio Gomez [1991]	Y	U	U	Y	Y	Y	Y	Y	Y	7
Dogar et al. [2011]	Y	U	U	Y	Y	Y	Y	Y	Y	7
Drummond et al. [2015]	Y	Y	U	N	Y	Y	Y	Y	Y	7
Endean et al. [2004]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Foster Page and Murray Thomson [2011]	Y	U	U	Y	Y	Y	Y	Y	U	6
Gowda et al. [2009]	U	U	U	Y	Y	Y	Y	Y	U	5
Grim et al. [1994]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Ha [2014]	U	Y	U	Y	Y	Y	Y	Y	Y	7
Haag et al. [2020]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Hallett and O'Rourke. [2002]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Jamieson et al. [2006a]	Y	U	U	Y	Y	Y	Y	Y	Y	7
Jamieson et al. [2006b]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Jamieson et al. [2007b]	U	U	U	Y	Y	Y	U	Y	Y	5
Jamieson et al. [2007a]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Jamieson et al. [2010a]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Jamieson et al. [2010b]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Jamieson et al. [2016]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Jones et al. [1992]	Y	U	U	Y	Y	Y	Y	Y	Y	7
John. [2015]	Y	U	Y	Y	Y	Y	Y	Y	Y	8
Kapellas et al. [2014]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Kumar et al. [2013]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Lalloo et al. [2015]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Lawrence et al. [2008]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Lawrence et al. [2009]	Y	Y	U	Y	Y	Y	Y	Y	Y	8

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total score
Medina. [2008]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Miranda et al. [2018]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Page and Thomson [2011]	Y	U	U	Y	Y	Y	Y	Y	Y	7
Phelan et al. [2009]	Y	Y	U	Y	Y	Y	Y	N	Y	7
Rao and Bharambe [1993]	Y	Y	U	Y	U	Y	Y	Y	Y	7
Schamschula et al. [1980]	Y	U	Y	Y	Y	Y	Y	Y	Y	8
Schroth et al. [2005]	Y	Y	Y	N	Y	Y	Y	Y	Y	8
Schuch et al. [2017]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Shen et al. [2015]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Shi et al. [2018]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Simangwa et al. [2018]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Singh et al. [2011]	U	Y	Y	Y	Y	Y	Y	Y	Y	7
Slade et al. [2007]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Zeng et al. [2005]	Y	Y	U	Y	Y	Y	Y	Y	Y	8
Total (%) yes	90.69	72.09	37.2	95.34	97.67	100%	97.67	95.34	90.69	

Critical appraisal questions: Q1. Was the frame appropriate to address the target population? Q2. Were study participants sampled in an appropriate way? Q3. Was the sample size adequate? Q4. Were the study subjects and the setting described in detail? Q5. Was data analysis conducted with sufficient coverage of the identified sample? Q6. Were valid methods used for identification of the condition? Q7. Was the condition measured in a standard, reliable way for all participants? Q8. Was there appropriate statistical analysis? Q9. Was the response rate adequate and, if not, was the low response rate managed appropriately? Y, yes; U, unclear; N, no.

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