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A scoping review on early childhood caries and inequalities using the Sustainable Development Goal 10 framework

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Abstract

Background Social inequalities contribute to health disparities. This study aimed to map evidence on early childhood caries (ECC) related to the United Nations' Sustainable Development Goal 10 (SDG 10).

Methods A scoping review was conducted in May 2024 following the PRISMA-ScR guidelines. A literature search was performed in PubMed, Web of Science, and CINAHL for studies published in English and addressing population level social inequalities. Studies measuring individual level of social inequalities were excluded as they were covered by other SDGs. However, studies incorporating individual measures as additional measures of population level social inequality were included. Retrieved papers were summarized, inductively analysed and a conceptual framework linking SDG 10 was developed.

Results Of 452 studies retrieved, 42 met the inclusion criteria. Studies measured inequality among groups (deprivation, family income, indigenous communities, ethnicity, minority status) [14 studies], institutions (type of school, nursery or school facility, school poverty index, public primary health care units) [five studies], and inequality in communities (neighbourhood socio-economic status, Human Development Index, employment rate, income inequality, sanitary sewer and water supply, residents/household ratio, urban vs rural vs remote rural, accessibility index, location index, the slope index of inequality) [24 studies]. These levels of social inequalities were linked to higher prevalence of ECC; social and economic policies contributed to widening inequalities in ECC severity; and although effective interventions targeted at at-risk populations could reduce dental health disparities, study interventions differed by deprivation status. Six studies (14.3%) addressed SDG 10.1, 33 (78.6%) addressed SDG 10.2, 11 (26.2%) addressed SDG 10.3, and three (7.1%) addressed SDG 10.4. Fourteen studies (33.3%) addressed a combination of SDGs. The conceptual framework highlights the role of structural inequalities stemming from the cumulative impact of institutional decisions and systemic inequalities.

Conclusion This scoping review underscores the profound influence of social inequality on ECC through interactions between multi-level factors. Further research is needed to explore the links between ECC and other SDG 10 targets, especially in low- and lower-middle-income countries.

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Keywords Caries, Health Inequity, Sustainable development goals, Health disparity, Racial disparities, Geographical location, Community water fluoridation, Policy implications

Introduction

Early childhood caries (ECC) is the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to dental caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger [1]. It is a major public health problem affecting infants, toddlers, and preschool children around the world. It is estimated that 532 million children have been affected with dental caries in their primary teeth before their sixth birthday [2]. Dental caries is also the tenth most prevalent chronic disease in children [3] and it often goes untreated [4]. Untreated dental caries significantly reduces the quality of life of affected children [5], with the possibility of impacting nutritional status, health and well-being and brain development [6, 7].

In addition, various approaches have been adopted to prevent, manage, and treat dental caries in children including the use of fluoridated toothpaste [8], fluoride varnish [9], community water fluoridation, surgical interventions such as the use of pulp therapy [10, 11], restorative treatment [12–14], and the use of teledentistry to improve oral health access [15, 16]. These services may be difficult to obtain in communities that are socio-economically disadvantaged.

ECC, a non-communicable disease, is influenced by the social determinants of health. Thus, poor oral health is more prevalent in populations where child's ability to address individual needs are challenged by their experience of inequalities. Inequality denotes the uneven allocation of resources due to factors like social status, including ethnicity and gender [17]. It increases the risk for ECC by influencing factors such as frequent consumption of sugar-containing drink and food [18], poor oral hygiene practices [19], limited access to preventive care, delayed dental visits for timely treatment [20], and low parental educational attainment [21].

The alleviation of social inequality is, therefore, an ethical imperative before individuals can aspire to lead healthy lives. For this reason and more, the United Nations prioritizes the reduction and elimination of social inequalities through the Sustainable Development Goal 10 (SDG10), which is inextricably linked to other goals including reduction of poverty, decent jobs and economic growth and responsible production and consumption [22]. Inequality is unjust as the disadvantaged and vulnerable are often left behind as reflected in the skewed expenditure on oral health to countries, leaving low-income nations and marginalized communities with limited access to care [23]. Such inequities perpetuate poor oral health outcomes and widen the gap in healthcare access.

Dental caries is increasingly acknowledged as a condition stemming from social disparities. Racial inequities and societal imbalances, which amplify exposure to environmental toxins, lack of access to fluoridated water, and barriers to oral health care, all combine to elevate the likelihood and severity of dental caries [24, 25]. Indigenous communities, culturally and linguistically diverse minority individuals, geographic remoteness and area deprivation (areas in need of targeted interventions) are societal factors identified to possibly contribute to inequalities that increase the risk of ECC [26].

It is, therefore, important to address the challenge of social inequalities in every country, especially in the developing countries to effectively tackle childhood non-communicable diseases like ECC. Studies are also beginning to explore the pathways linking social inequalities to the risk of ECC [24] because of the harm to the health, including oral health, of entire groups of people [27]. The increasing advocacy to address ECC through the lens of social justice, health equity and human rights [28, 29] makes it an imperative to understand how ECC and social inequality intersect.

The framework in Fig. 1 shows how various factors—structural, institutional, family, and individual—contribute to disparities in ECC and align with SDG 10's targets. At the structural level, barriers like cost, healthcare access, and discrimination create unequal access to resources, such as dental care, with the most disadvantaged being the most impacted [30], while policies promoting equitable distribution of resources can benefit individuals across this spectrum [31]. At the institutional level, factors like school type, economic conditions, and geographic location mediate access to preventive care and dental services, affecting people along the social gradient [32]. At the family-level, health inequalities increase among ethnic minorities, those living in indigenous communities and families with lower socioeconomic status because of barriers related to education, employment, income, and oral health behaviours [33]. At the child level, factors such as sugar consumption, access to topical fluoride, oral hygiene and dental services utilization impact oral health, with children from lower socioeconomic backgrounds less likely to receive preventive services

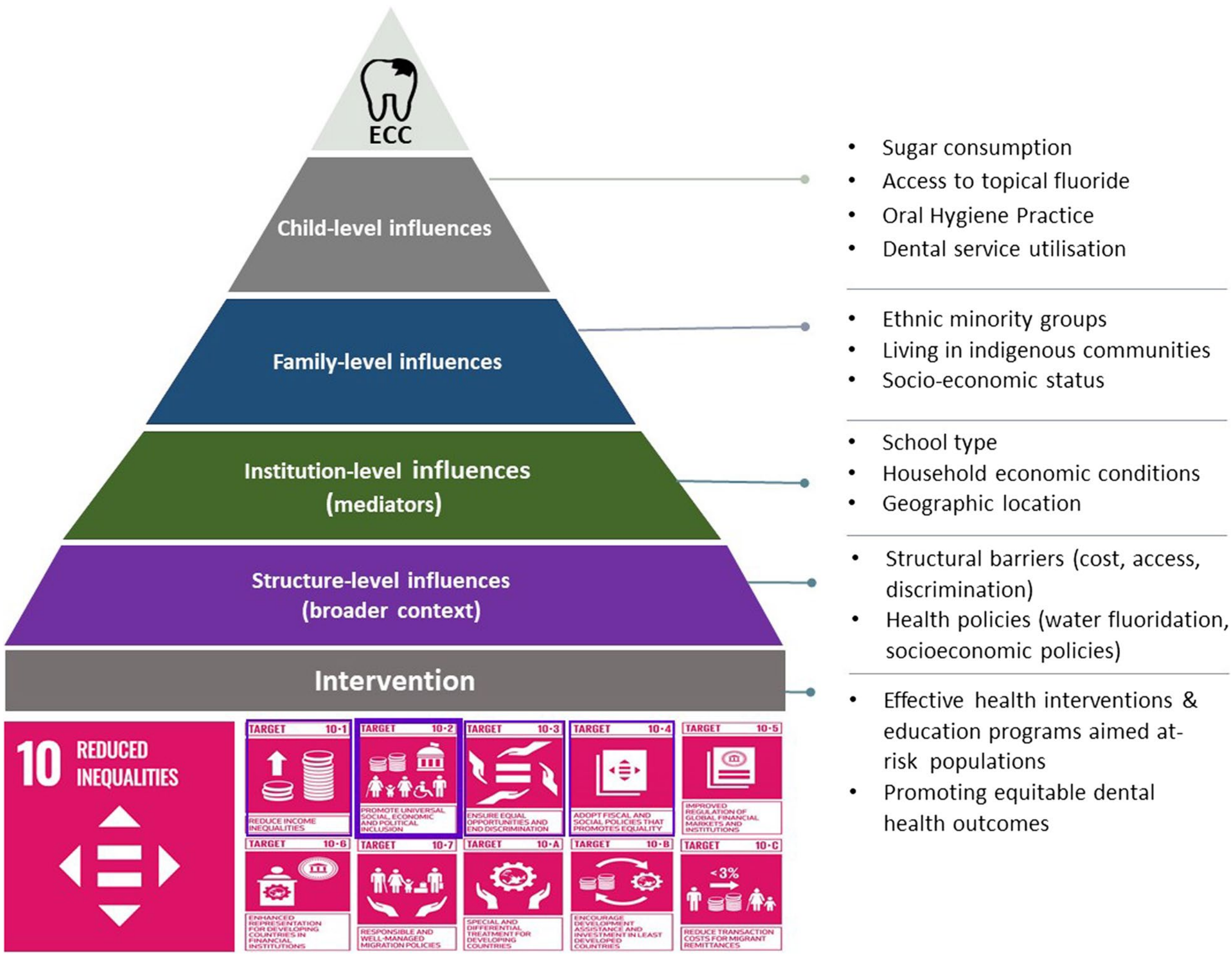

Fig. 1 Conceptual framework on the association between social inequality and ECC

or adopt protective oral health behaviours [34]. The framework illustrates that health inequalities are multiple [35]; and that addressing these multiple factors is essential to reducing inequalities.

This scoping review aims to map the publications linking ECC with social inequalities, validate the developed conceptual framework on the links between ECC and social inequalities, identify the gaps in the literature on the plausible links between ECC and the SDG 10.

Methods

This scoping review was performed in accordance with the Joanna Briggs Institute methodology guidelines [36] and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guidelines (PRISMA-ScR) [37].

Research questions

Broadly, the review was based on the Population, Concept and Context (PCC) framework, where the population was children younger than 72 months, the concept was inequalities as risk factors for ECC, and the context was SDG 10. This scoping review was guided by the following questions: (i) What is the existing evidence on the association between social inequality and ECC? (ii) What are the SDG 10 social inequality-related factors (lack of basic amenities, poor social, economic and political inclusion; discriminatory laws, policies and practices; and low development assistance and financial flows to developing countries) associated with ECC? (iii) what is the conceptual framework on the link between ECC and social inequalities based on the study findings?

Identifying relevant articles

One author (OA) performed a search in May 2024 in three databases namely, PubMed, Cumulated Index to Nursing and Allied Health Literature (CINAHL) and Web of Science. The search terms can be found in Appendix 1.

The search included the scientific databases listed above and was complemented by searching the grey literature (theses retrieved from accessible online university repositories). The reference lists and bibliographies of relevant studies were also hand-searched for further references.

Articles identified through the three databases were exported to RAYYAN Software where duplicates were removed by the "Remove Duplicates" function. Two authors ran the search separately and lists of retrieved articles were then shared with all and screened for eligibility. Authors and institutions were not consulted for additional resources.

Eligibility and selection

The selected articles included only those published in English, where the patients or participants in the study were children younger than 72 months, the study outcome was ECC as defined by non-cavitated and cavitated lesion on tooth surfaces of children younger than 72 months [1]. Indicators of ECC included the presence of ECC experience, the presence of untreated ECC, and ECC severity. The studies also had to have one or more measures of social inequality (socioeconomical issues, racial and ethnicity issues, and geographical/residential locations). Studies of any design or publication date were included. There was no limitation placed on the year of publication.

Studies reporting on the individual and household measures of poverty status like household income and socioeconomic status (SDG1), parental educational status (SDG4), and studies focusing on other childhood diseases were excluded. In addition, studies with variables measuring the characteristics of migrants and refugees (SDG15), and those that addressed urban and rural differences (SDG11) were excluded. Prior publications by the team had reported on these links. However, when the measures of other SDGs are used in conjunction with the measures of social inequality, the publication was retained. Furthermore, studies that included preschool children but without clinical data for this age group were excluded. Publications with no full text available were also excluded.

Data charting

Documents that cleared the initial screening underwent full-text retrieval, and essential details were extracted using Microsoft Excel 2019 (Microsoft Corporation, United States). The data extraction form and items to extract were established through collaborative discussions among co-authors, and a pilot test was carried out to calibrate the data extraction process. The following information were extracted from the selected publications for this review: author name(s), publication year, type of journal in which the article was published, study location defined as the country in which the study was conducted, study design, sample size, study aim, measures for ECC and indicators of social inequality, and main study findings. Table 1 contains the extracted information from all included publications.

Data analysis

There were two steps for data synthesis. First a quantitative analysis was conducted. A descriptive analysis of the publications included in the review was done. The publication year were grouped into decades, and the countries were grouped using the World Health Organization region into Americas region (AMR); Eastern Mediterranean Region (EMR); African region (AFR), European region (EUR); South East Asian region (SEAR) and the Western Pacific region (WPR). The countries were also grouped by income level (low-income countries (LICs), lower middle-income countries (LMICs), upper middle-income countries (UMICs) and high-income countries (HICs)) based on the World Bank 2022–23 classification [79].

The design of the study was extracted and classified as cross-sectional, ecological, case control, cohort, randomized clinical trial, protocols of any of the above, narrative reviews, systematic reviews, scoping reviews, and opinions pieces.

The measures of ECC and the social inequality indicator were extracted. Social inequality was measured using the following variables: residential area, community, school, and country income levels. In addition, an analysis was conducted on the SDG 10 indicators that each of the study addressed. Gaps in assessment of the SDG 10 were also identified.

Second, a qualitative analysis was conducted using inductive coding to identify key themes, and concepts, that capture the main ideas emanating from the study findings [80]. The findings were used to develop a conceptual framework that could guide future empirical studies on the links between social inequality and ECC. Next, we conducted a grounded theory analysis by developing axial coding to organize the concepts into categories, and then integrated and refine the categories to form a cohesive theory.

Role of the funding source

There was no funding for the study. The study design selection, data collection, data analysis, data interpretation and writing of the report were free from any form of influence. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Table 1 Summary of included studies ($N=42$)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
The Americas								
1	Freire and Melo, 1996 [38]	Cross-sectional	Brazil	10.2	2,267 0–6 years old	dmft	Type of nursery	ECC prevalence was higher in those attending public nurseries than in those attending private nurseries. Amongst children from public nurseries, the highest dmf component was untreated decay while in private nurseries it was filled teeth
2	Lawrence et al., 2009 [39]	Cross-sectional	Canada	10.2 10.3	1,647 3–5 years old	dmft/s	Indigenous communities Sex	Off-reserve Aboriginal children had 1.9 to 2.3 times the risk of having ECC, 2.9 to 3.5 times the risk of a dmft > 3 and 1.8 to 2.5 times the risk of untreated decayed teeth
3	Nowak, 2011 [40]	Narrative review	USA	10.2	NA	def dmft	Minority individuals Poverty Educational status	Interventions that have the highest level of success and targeting at-risk populations are needed
4	Piovesan et al., 2011 [41]	Cross-sectional	Brazil	110.2	411 1–5 years old	dt	Type of school	Children of public schools presented significantly higher prevalence of ECC than those enrolled in private schools
5	Ardenghi et al., 2013 [42]	Cross sectional	Brazil	10.2	7,217 5 years old	dmft	Race Income of municipalities	Children living in municipalities with a lower average income and municipalities with a lower proportion of homes connected to water supply had a higher prevalence and severity (dmft) of ECC

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
6	Matsuo et al., 2015 [43]	Cross sectional	USA	10.2 10.3	70,089 5 years old	dmft	Race Ethnicity School poverty index	Racial/ethnic oral health disparities exist among kindergarten children regardless of school's poverty status. Disparities between white and black children are larger in non-poor schools than in poor schools
7	Poon et al., 2015 [44]	Cohort	Canada	10.1 10.2	70,817 4–6 years old	Visible inspection	Neighbourhood socio-economic status	Neighbourhood-level socio-economic circumstances significantly influence health outcomes, with higher rates of visible ECC found in the most disadvantaged neighbourhoods
8	Priesnitz et al., 2016 [45]	Cross sectional	Brazil	10.1 10.2	1,110 0–5 years old	dmft	Human Development Index Average income Public primary health care units	Children living in neighbourhoods with higher average incomes were 2.9 times (95% CI: 1.05–7.86) more likely to have one of their teeth missing or filled. In addition, the teeth of children living in richer areas had higher chances of being treated
9	Rozier et al., 2017 [46]	Narrative review	USA	10.2	NA	NA	NA	ECC experience remains high in the primary dentition. and long-standing inequalities in untreated ECC appear to be narrowing
10	Amato et al., 2020 [47]	Cross sectional	Brazil	10.2	483 5 years old	dmft	Sanitary sewer and water supply Residents/household ratio Percentages of families living with up to 1 minimum wage	There was an increase in the odds of having ECC experience for each unit percent higher of houses with well water and families which live with up to 1 minimum wage was observed

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
11	Arantes et al., 2021 [48]	Cross-sectional	Brazil	10.2 10.3	1,730 5 years old	dmft	Indigenous communities	Indigenous communities often faced barriers to dental care, leading to more untreated ECC and missing teeth than non-indigenous groups
Europe								
12	Jones and Worthington, 1999 [49]	Cross sectional	UK	10.3	10,004 5 years old	dmft	Townsend deprivation index score	ECC is strongly associated with social deprivation. The implementation of water fluoridation halved tooth decay in 5-year-old children and reduced the ECC divide between the rich and the poor
13	Riley et al., 1999 [50]	Ecological	UK	10.2	41,879 5 years old	dmft	Townsend deprivation index score	Water fluoridation reduced ECC experience more in materially deprived wards than in affluent wards
14	Watt and Sheiham, 1999 [51]	Narrative review	UK	10.2	NA	dft	Social class Deprivation Region and district Minority ethnic population	The main social class and minority ethnic differences in ECC is in pre-school children. Wide district and regional differences also exist in prevalence of ECC in young children. The area differences relate very strongly to deprivation
15	Sundby and Petersen, 2003 [52]	Cross sectional	Denmark	10.2	441 3–5 years old	dmfs	Minority status	Marked differences in ECC prevalence were observed when different ethnic minorities (Turkish, Pakistani, Albanian, Somali, and Arabian) were compared to Danish children. These differences were most prominent in the primary dentition

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
16	Tickle et al., 2003 [53]	Cross sectional	UK	10.2	677 Primary dentition	dmft	Townsend deprivation index score	Children from poorer backgrounds were significantly more likely to receive oral hygiene instruction than their more affluent peers. Children from affluent backgrounds were significantly more likely to have fluoride varnish applied to their teeth than children from deprived backgrounds after controlling for other factors
17	Ellwood et al., 2004 [54]	Cohort	UK	10.2	3,467 5–6 years	dmft	Townsend deprivation index score	For the most-deprived groups, postal provision of either a low- or high-fluoride toothpaste provided similar levels of benefit. In the less deprived groups, only provision of the high-fluoride toothpaste provided a benefit. The absolute ECC reduction seen for provision of the high-fluoride toothpaste was not related to the deprivation status and hence the programme did not reduce deprivation-related health inequalities
18	Conway et al., 2007 [55]	Cross-sectional	Scotland	10.2 10.3	721 5 years old	dmft	Ethnicity Deprivation	Children of Pakistani ethnicity had a significantly higher prevalence of ECC compared to white children, even when adjusting for socio-economic factors. The risk factors contributing to these differences included mothers' inability to speak English and Muslim religion, however, socio-economic deprivation was identified as the most critical factor in dental health inequalities

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
19	Levin et al., 2010 [56]	Cross sectional	UK	10.2	11,417 5 years old	dmft care index	Urban vs rural vs remote rural Deprivation	Children of rural Scotland have better dental health than those of urban areas, largely but not entirely explained by socio-economic inequalities
20	McMahon et al., 2010 [57]	Cross sectional	UK	10.2	4,139 3 years old	dmft	Scottish Index of Multiple Deprivation	The adjusted odds-ratio for caries experience for children living in the most deprived areas was almost three times higher than children not living in deprived areas
21	Tubert-Jeannin et al., 2012 [58]	Cross-sectional	France	10.2	931 5 years old	dmft	Deprivation Type of school	Children from low socioeconomic status backgrounds exhibited a higher prevalence of ECC and untreated dental issues than their counterparts. The persistence of disparities accentuated the continuous requirement for effective interventions targeting the social determinants of oral health
22	Jones et al., 2017 [59]	Cross sectional	Scotland, UK, and Wales	10.2	16,251 5 years old	dmft Significant caries index	The Slope Index of Inequality The Relative Index of Inequality	Tooth decay levels remain higher in more deprived areas across Great Britain, with clear inequalities gradients demonstrated across all geographies. Changes in dental health inequalities across the three countries showed no conclusive trends

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
23	Paisi et al., 2018 [60]	Cross-sectional	UK	10.2	3,776 4–5 years old	dmft	Neighbourhood English Index of Multiple Deprivation	At area level, deprivation was related to the rates of obesity and ECC. A significant positive autocorrelation was observed across neighbourhoods for ECC. Among several neighbourhood characteristics, the proportion of people on benefits was found to be a significant predictor of ECC rates
24	Rouxel et al., 2019 [61]	Cross-Sectional	UK, Wales and Northern Ireland	10.2	2,217 5 years old	dmft	Ethnicity Socioeconomic position Index of Multiple Deprivation	Children from disadvantaged family socioeconomic backgrounds have a higher risk of dental caries. Socioeconomic position and ethnicity influence ECC by impacting oral health behaviours
25	Ganbavale et al., 2024 [62]	Ecological study	UK	10.4	NA	dmft	Neighbourhood deprivation	Higher deprivation at the neighbourhood-level, have an impact on children's sugar consumption and ECC
Western Pacific								
26	Thomson et al., 2002 [63]	Cohort	New Zealand	10.4	2,804 5 years old	dmft	Minority status Socioeconomic status	Social and economic policy changes were associated with substantial and persistent widening of ethnic and socio-economic inequalities in ECC severity among five-year-old children. The oral health of ethnic minority children deteriorating in comparison to their European counterparts

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
27	Jamieson et al., 2006 [64]	Cross sectional	Australia	10.2	2,769 4–5 years old	dmft	Location index Indigenous communities	Fewer rural Indigenous children were ECC-free than non-indigenous children. Rural Indigenous children had almost twice the mean number of dmft of rural non-indigenous children. The % d/dmft was higher among rural indigenous children than rural non-indigenous children
28	Aida et al., 2008 [65]	Cross-sectional	Japan	10.1	3,086 3 years old	dmft	Community context Ethnicity	Place of residence was identified as significant risk factor for ECC, while race and ethnicity did not show a clear association with ECC
29	Kilpatrick et al., 2012 [66]	Cross-sectional	Australia	10.2 10.3	4,606 2–3 years old	Parent reported caries	Indigenous communities Residential remoteness	Indigenous communities had was higher rates of ECC
30	Ha, 2014 [67]	Cross sectional	Australia	10.2	NA 5 years old	dmft	Indigenous communities	The level of ECC experience in deciduous teeth was consistently higher for indigenous children in each state and territory in both severity and prevalence
31	Smith et al., 2015 [68]	Cross-sectional	Australia	10.2 10.3	173 2–5 years old	dmft	Indigenous communities Rural, remote and metropolitan residency	There was a high prevalence of untreated ECC among the Aboriginal children, particularly for those in remote locations
32	Schluter and Lee, 2016 [69]	Cross-sectional	New Zealand	10.2 10.3	417,318 5 years old	dmft	Ethnicity Water fluoridation	Māori children experience a higher oral health burden than non-Māori children, regardless of whether they lived in community water fluoridated (CWF) or non-CWF regions

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
33	Shackleton et al., 2018 [70]	Cross-sectional	New Zealand	10.2 10.3	318,321 4 years old	Visual inspection	Ethnicity The New Zealand Index of Multiple Deprivation	Indigenous children and those from more socioeconomically deprived backgrounds were at a higher risk of experiencing ECC
34	Durey et al., 2023 [71]	Narrative review	Australia	10.2 10.3	NA	NA	Indigenous communities	Aboriginal Australian children have poorer health outcomes with twice the rate of ECC as non-Aboriginal children. Structural factors outside individual control, including access to and cost of dental services and discrimination from service providers, prevent Aboriginal families from making optimum oral health decisions, including returning to services
35	Huang et al., 2023 [72]	Cross sectional	Japan	10.2	995,003 3 years old	dft	Accessibility index Accessibility index rate	Dental accessibility is significantly related to the prevalence of ECC and dft after adjusting for other sociodemographic variables. Preschool children in areas with poor dental accessibility are likely to have poor ECC status
36	Lopez et al., 2023 [24]	Cross-sectional	Australia	10.2	10,688 <6 years old	dmft	Indigenous communities Socioeconomical status Urban vs rural residency	Indigenous children in Australia have been identified as experiencing poorer oral health compared to non-indigenous children, with higher rates of untreated ECC

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
37	Zheng et al., 2024 [73]	Meta-regression	Hong Kong	10.1 10.2	8,663	dmft	Gross Domestic Product Human Development Index Dentist-to-population ratio	ECC prevalence decreased with improvements in HDI, the provision of 9-year free education, the establishment of a dental school, fluoridation of water supply, and implementation of territory-wide oral health promotion
Africa								
38	Postma et al., 2008 [74]	Cross sectional	South Africa	10.2 10.3	5,822 3–6 years	Wyne's ECC classification	Race Employment rate	Increased per capita sugar expenditure and decreasing water fluoride levels were significantly associated with an increased risk for any ECC but were not significantly associated with the severe forms of ECC. Compared to blacks, being of mixed race and white were respectively associated with an increased and a decreased risk for ECC. Unemployment increased the risk for the severe forms of ECC
39	Peters et al., 2022 [75]	Cross sectional	Ghana	10.3	93 3–4 years old	dmft, Significant Caries Index, Specific Affected Caries Index	Urban vs rural residency Type of school facility	When parents were married, ECC experience was higher in urban and lower in rural area. In private schools of urban area, ECC experience was higher than in government schools, but in the rural area, the government school type had slightly higher ECC scores

Table 1 (continued)

S/N	Author and Year of Publication	Study design	Study Location	SDG 10 target	Sample size, age	Measure of dental caries	Indicators of social inequality	Main Study Findings
Global								
40	Bernabé and Hobdell, 2010 [76]	Ecological study	Global	10.1 10.4	48 countries	dmft	Income inequality Income	GNI per capita, but not the Gini coefficient, was inversely correlated with the dmft index in the 48 countries. However, the results showed an opposite pattern when analyses were restricted to rich countries. Income inequality was correlated more strongly with ECC than was income in rich countries
41	Nath et al., 2021 [77]	Systematic review and meta-analysis	Global	NA	234,352 Indigenes 700,357 non-Indigenes	dmft	Indigenous communities	The pooled mean dmft for deciduous dentition was higher for the indigenous population than for the general population. Indigenous populations experienced more decayed teeth, a slightly higher number of missing teeth, and lesser filled teeth than their nonindigenous counterparts
42	Wang et al., 2024 [78]	Scoping review	Global	NA	-	NA	NA	Indigenous children continue to experience ECC at an approximately twice higher rate than non-indigenous children with no discernible improvement in ECC rates among Australian Indigenous children

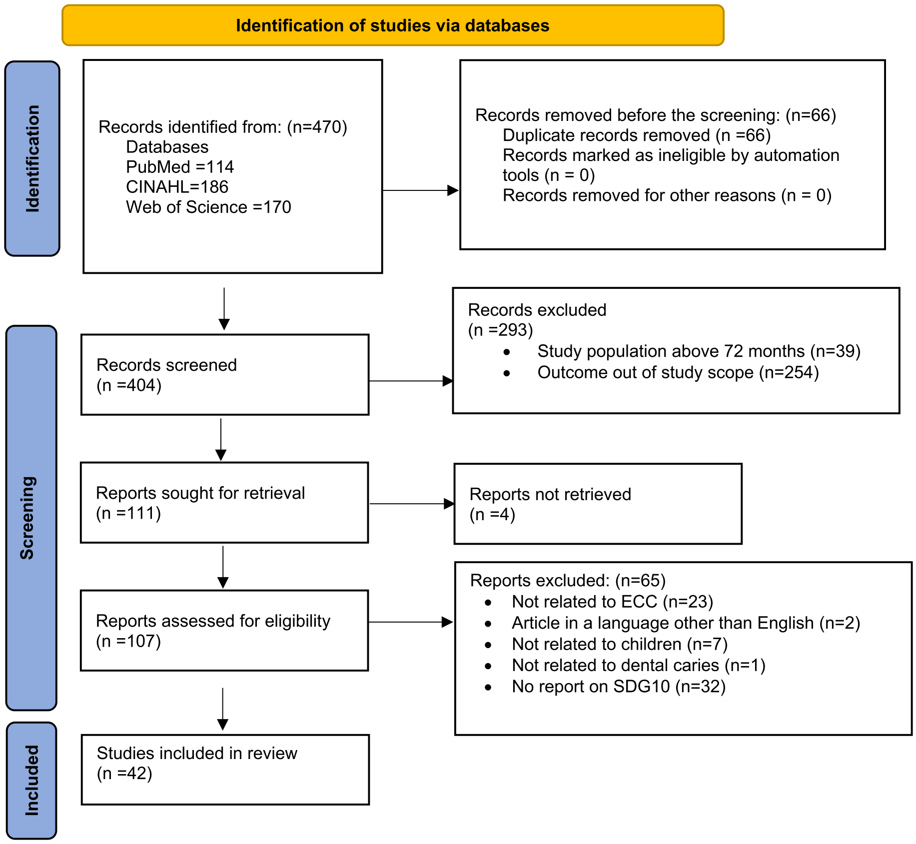

Fig. 2 A Flowchart showing the process of studies selection

Results

As Fig. 2 indicates, the initial search from 470 reports yielded 404 potentially relevant articles. Overall, 297 publications were excluded based on the pre-identified exclusion criteria leaving 107 reports for full screening. On full screening of the full manuscript, 42 manuscripts [24, 38–78] met the inclusion criteria.

Characteristics of included studies

The year of publication of the 42 manuscripts ranged from 1995 to 2024. Figure 3 shows the number of articles published at each 5-year interval. Between 1995 and 2009 the number of articles varied from 4 to 5 every 5 years (mean: approximately 1 article per year) [38, 39, 49–55, 63–65, 74]. From 2010 onwards, there has been a significant increase in the number of articles published that include data on the link between ECC and SDG 10, with a mean of approximately 2 articles per year, which has remained stable since then [24, 40–48, 56–62, 66–73, 75–78].

Table 1 shows that of the 42 studies analyzed, the majority ($N=14$, 33.3%) were conducted in Europe, comprising nine from UK [49–51, 53, 54, 56, 57, 60, 62], one from Denmark [52], Scotland [55], and France [58] respectively, one from a combination of Scotland, England and Wales [59], and one from England, Wales and Northern Ireland [61]. In addition, there were 12 (28.6%) studies from the WPR, which included Australia [24, 64, 66–68, 71], New Zealand [63, 69, 70], Japan [65, 72], and Hong Kong [73]. There were also 11 (26.2%) studies conducted in the AMR, which included six from Brazil [38, 41, 42, 45, 47, 48], three from the United States [40, 43, 46], and two from Canada [39, 44]. Studies conducted in AFR were only two (4.8%), with one conducted in South Africa [74] and one in Ghana [75]. In addition, there were three (7.1%) global studies [76–78]. There were no studies from SEAR or EMR.

The 42 studies were conducted in 15 countries: 13 (86.6%) countries are in HICs, one (6.7%) in a UMIC, and one (6.7%) in a LMIC. There was no study conducted in a LICs. Thirty-four of the 42 studies reported data of 2,955,923 participants ranging from 93 [75] to 995,003 [72]. There were 29 cross-sectional [24, 38, 39, 41–43, 45, 47–49, 52, 53, 55–61, 64–70, 72, 74, 75], and three cohort [44, 54, 63] studies. There were four

Fig. 3 Distribution of studies included in the current scoping review by year of publication

narrative reviews [40, 46, 50, 71], three ecological studies [50, 62, 76], two meta-analyses [73, 77], and one scoping reviews [78].

Assessment of dental caries

Dental caries was assessed clinically in 36 (85.7%) studies using indices such as decayed and filled teeth (dft) [51, 72], decayed teeth (dt) [41], decayed, extracted and filled teeth (def) [40], decayed, missing and filled teeth (dmft) [24, 38, 40–43, 45, 47–50, 53–55, 57–65, 67–69, 73, 75–77], decayed, missing and filled surfaces (dmfs) [39, 52], Wyne's ECC classification [74], care index [56], significant caries index [59, 75], and specific affected dental caries index [75]. Non-tactile assessment of dental caries was by visual inspection [44, 70]. In addition, one study used non-clinical assessment of ECC by parental report [66]. Three studies did not report ECC measures [46, 71, 78] and five studies used two or more measures for ECC [39, 40, 56, 59, 75].

Assessment of social inequality

Social inequality indicators were used singly or in combination. The diverse measures of social inequalities in the studies were divided into measures at the level of:

1. Groups: deprivation, family income, Indigenous communities, ethnicity, minority status [24, 39, 46, 47, 51, 55, 60–71, 74, 77].
2. Institution: type of school, nursery or school facility, school poverty index, public primary health care units [38, 43, 45, 58, 75].
3. Community: neighbourhood socio-economic status, Human Development Index, employment rate, income inequality, sanitary sewer and water supply, residents/household ratio, urban vs rural vs remote rural, accessibility index, location index, the slope index of inequality [24, 42, 44, 45, 47, 49–51, 53, 54, 56, 57, 59, 60, 62, 64–66, 68, 69, 72–74, 76].

Sustainable Development Goal 10 targets

The SDG 10 has 10 targets [81]. The studies included in this scoping review addressed four of the 10 targets: six (14.3%) addressed SDG 10.1 [38, 44, 45, 65, 73, 76], 33 (78.6%) addressed SDG 10.2 [24, 39–48, 50–61, 64, 66–74], 11 (26.2%) addressed SDG 10.3 [39, 43, 49, 55, 66, 68–71, 74, 75] and three (7.1%) addressed SDG 10.4 [62, 63, 76]. Fourteen studies (33.3%) addressed a combination of SDG 10 targets: 10 addressed a combination of SDG 10.2 and 10.3 [39, 43, 48, 55, 66, 68–71, 74], three addressed a combination of SDG 10.1 and 10.2 [44, 45, 73], and one addressed a combination of SDG 10.1 and 10.4 [76].

Inductive analysis of the study findings

A. *Ethnic minority groups and Indigenous communities:* Racial and ethnic disparities in ECC are evident, with ethnic minority children (e.g., Turkish, Pakistani, Albanian, Somali, Arabian) showing higher prevalence than Danish children [52, 55]. Among kindergarteners, disparities between White and Black children were larger in non-poor schools compared to poor schools [43]. Indigenous children, including Aboriginal, Māori, and other groups, experience significantly higher rates of untreated ECC and poor oral health than their non-Indigenous peers [24, 48, 66–71], often due to structural barriers such as cost, access, and provider discrimination [71].

B. *Impact of institutions:* Children attending public schools have a significantly higher prevalence of ECC than those in private schools, where untreated decay is more common in public schools and filled teeth in private schools [38, 41]. Poor accessibility to dental care in certain areas was linked to higher prevalence of ECC among preschool children [72].
C. *Impact of community factors:* The prevalence of ECC is influenced by community factors, including water supply and sugar consumption. Lower water fluoride levels and higher per capita sugar expenditure increase ECC risk [74]. Children in municipalities with lower incomes and limited access to fluoridated water experience higher ECC prevalence and severity, while those in higher-income neighbourhoods are more likely to receive treatment [42, 45]. ECC levels are notably higher in deprived areas, reflecting strong geographic inequalities [59, 60]. Rural children generally have better oral health than urban counterparts, but rural Indigenous children face poorer outcomes compared to non-Indigenous peers [56, 64].
D. *Influence of health policies***:** Social and economic policies contributed to widening ethnic and socioeconomic inequalities in ECC severity [63]. Water fluoridation reduced the risk of ECC and the divide in the prevalence of ECC between the rich and the poor [49, 50].
E. *Health interventions and education:* Persistent disparities in oral health underscore the need for targeted efforts addressing social determinants of health [58]. Effective interventions for at-risk populations are crucial. Children from poorer backgrounds more often receive oral hygiene instruction, while affluent children are more likely to access preventive treatments like fluoride varnish [40, 53]. Postal provision of high-fluoride toothpaste benefits children across socioeconomic statuses, though its impact varies with deprivation levels [54].

Conceptual framework for studying early childhood caries using the SDG10

From the inductive analysis, three key social inequality factors linked to ECC risk were identified: (1) socioeconomic status (poverty, deprivation, education), (2) health access (availability of healthcare and educational institutions), and (3) geographical disparities (urban vs. rural settings, water, and sanitation infrastructure). These factors shape ECC risk through socioeconomic and environmental influences, with institutional and community inequalities exacerbating vulnerabilities for marginalized groups and rural populations with limited resources.

Figure 4, adapted from the WHO framework on social determinants of health [31], illustrates the structural, intermediary, and individual determinants of ECC within a health equity context, aligned with SDG10. Structural factors include governance, macroeconomic and social policies, and cultural values, forming the foundation of health inequalities. Community-level inequalities include socioeconomic status, Human Development Index, and sanitation access ($N=24$ studies); institutional factors include school types and public healthcare availability ($N=5$ studies); and group-level inequalities include income, indigenous status, ethnicity, and minority status ($N=14$ studies).

Figure 4 also indicates that social cohesion and capital mediate structural and individual determinants. At the individual level, material circumstances, biological characteristics, behaviors, and psychosocial factors shape oral health and ECC susceptibility. The health system further influences access and equity in oral healthcare services.

Discussion

This current scoping review presents an overview of studies focusing on ECC and social inequality. Most studies were conducted in HICs, with no publication from LICs. Most studies were cross-sectional and they used dmft related measures. There were multiple social inequality indicators often used in combination. The findings indicated that the lack of basic amenities, poor social, economic and political inclusion, and discriminatory laws, policies and practices were associated with ECC. We did not find evidence on the relationship between development assistance and financial flows to developing countries and ECC risk.

Findings from this scoping review underscore the impact of socioeconomic factors, racial disparities, and geographical location on dental health outcomes, particularly among vulnerable populations. The study conclusions focused on tailored interventions addressing access to fluoridated water, dental care, and community-level interventions to reduce oral health disparities acknowledging the need to address the structural determinants of ECC to achieve equitable oral health.

This is the first attempt to assess the link between ECC and the SDG 10. It included a large number of studies with many participants, making it robust. The scoping review also combined qualitative and quantitative analysis strengthening our methodological approach and supporting the conclusions and making the development of a conceptual framework feasible and objective.

The restriction of the study to those only published in English and to three databases may have, however,

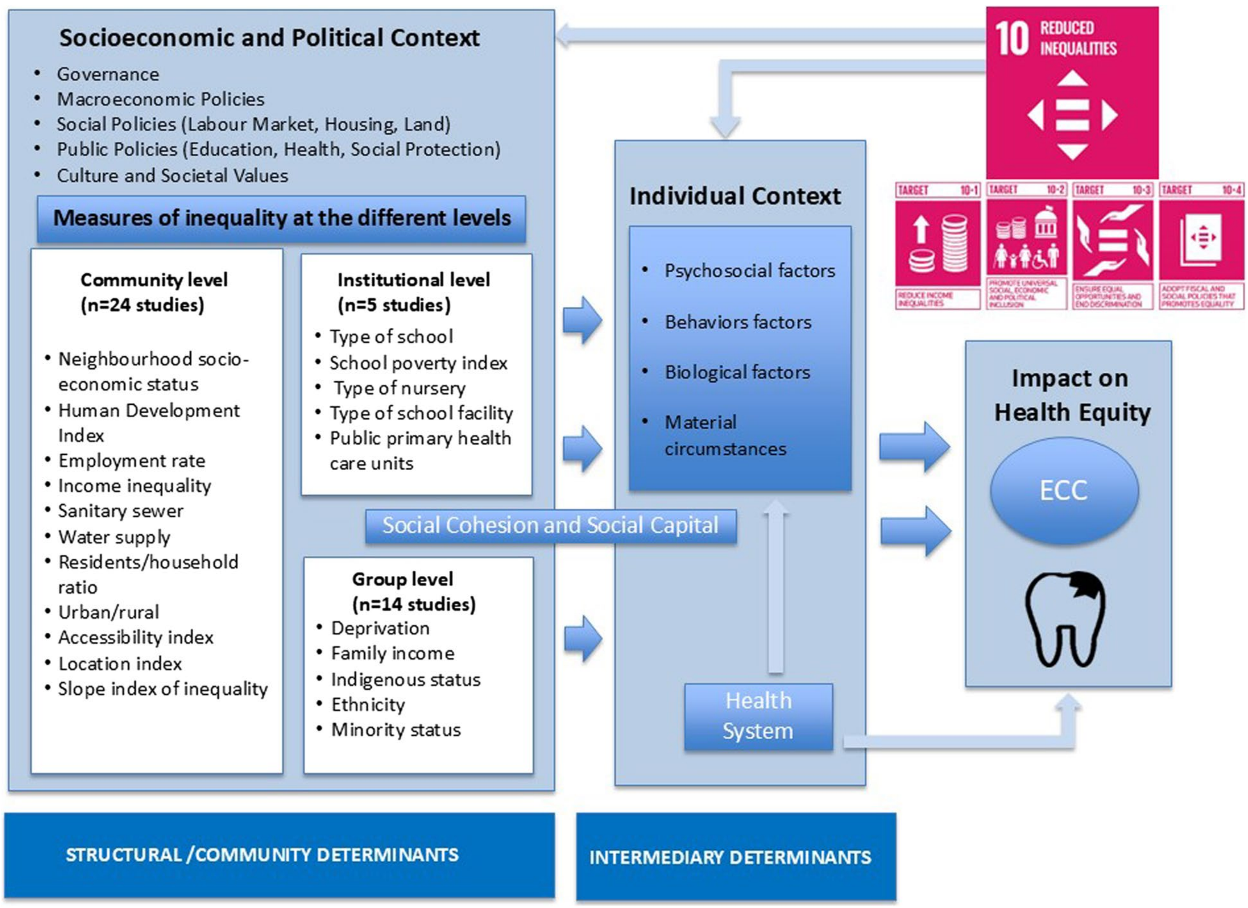

Fig. 4 Conceptual framework on the association between social inequality and ECC

selectively excluded other studies with the risk of underreporting the number of eligible publications, the scope of social inequality explored, and the number of SDG targets addressed. In addition, a limitation of the review is the focus on the term "inequalities," which may have influenced the included studies. While we used terms such as "disparities," "inequities," and "differentials" in our search, the primary framing around "inequalities" aligned with SDG 10 might have inadvertently excluded some studies that used alternate terminologies. Although an iterative approach was adopted to ensure a broad capture of relevant literature, there remains the possibility that the emphasis on certain terms may have constrained the comprehensiveness of our findings. Despite these limitations, the study had several valuable findings.

The conceptual framework emphasizes the role of structural inequalities stemming from institutional decisions and systemic inequalities [82]. It also provides an understanding of the multifaceted nature of oral health disparities and highlights the need for targeted, context-specific interventions to address these disparities. Low socioeconomic status, a reflection of poverty [83, 84] and low parental education [12], are risk factors for limited access to preventive dental care [85, 86], nutritious diets [87], resources for oral hygiene practices [88, 89], and higher levels of parental stress [90]. These are known pathways for ECC. Similarly, marginalized ethnic groups often face systemic barriers to dental care resulting from limited access to dental insurance, discrimination where clinics may not serve underserved communities, and cultural or language differences that hinder effective communication and trust between providers and patients [77, 91, 92]. In addition, rural and underserved areas often lack adequate infrastructure, including fluoridated water and dental clinics further exacerbating geographic disparities [93]. Social disparity also contributes to chronic stress and poor mental health outcomes which are linked to immune system dysregulation with higher susceptibility to diseases, including ECC [94–96].

While structural barriers (cost, access, discrimination) and health policies (water fluoridation, socioeconomic policies) shape the broader context within which oral health disparities manifest, school type, and household economic conditions, seem to serve as mediating factors that influence the extent of oral health disparities. Effective health interventions and education programs targeting at-risk populations can mitigate disparities and promote equitable oral health by addressing systemic challenges and individual-level factors influencing oral health behaviours [97, 98]. Furthermore, although the WHO's Global Oral Health Action Plan has highlighted the relevance of monitoring the impact of out-of-pocket spending on oral health care to achieve Universal Health Coverage by 2030, this topic remains a gap in studies on inequalities and ECC [99]. Further studies, guided by the conceptual framework, are warranted to validate the suggested pathway regarding the link between ECC and SDG 10. In addition, investigations are needed to explore the potential connections between ECC and other SDG targets.

The conceptual framework for the risk factors for ECC using the SDG 10 as a framework, reflects a conflation of multiple theories such as the social determinants of health theory [100, 101] that emphasizes how socioeconomic factors influence health outcomes, including oral health; the ecological systems theory [102] that highlights the interaction between individual, institutional, and community factors in shaping child development and health outcomes; the fundamental cause theory [103] that suggests that social factors, such as socioeconomic status, are fundamental causes of health disparities; the health inequity framework [104] that focuses on how structural inequalities and social determinants lead to differential health outcomes across populations; the life course theory [105] that examines how early life experiences and exposures to socioeconomic factors influence health trajectories over time; and the theory of agency and structuration [106] which reflects on how humans interact with systems created through biopolitics [107]. Findings from this scoping review highlight the dynamic interplay between individual actions, social structures, and broader policy contexts. Understanding these interactions may help address the inequalities that drive the risk for ECC.

The publication distribution over time observed in the current scoping review may illustrate the changing landscape of ECC research and its link with social inequality. The rise in publications between 2011 and 2020, along with recent studies from 2021 to 2024, indicates a growing interest and ongoing efforts to tackle health inequalities. This increasing attention is significant, particularly given current discussions framing ECC as a justice and rights issue, as those most impacted are individuals with limited ability to mitigate their risk [108].

Mitigating disparities to decrease the risk of ECC among social minority groups requires a comprehensive approach that recognizes and tackles the underlying social determinants of health recognising that those who face social disparity hold less social power or influence to change their society [109]. As identified in the current study, tailored interventions addressing access to fluoridated water, dental care, and community-level interventions are needed to reduce oral health disparities. This entails efforts to dismantle barriers to dental care, enhance access to preventive services, address socioeconomic disparities, promote culturally sensitive oral health education, and confront systemic discrimination within healthcare systems. Moreover, community-based interventions that empower minority groups to advocate for their oral health needs and address the social and environmental determinants of health can play a pivotal role in reducing ECC. In addition, prioritizing oral health research, and leveraging technological advancements such as teledentistry are imperative actions for effective responses to social disparities contributing to ECC risk.

Research can also foster inclusive and sustainable development for all. The strongest research focus on the on the SDG 10 was on target 2 which is about promoting equity in the access of children to oral health care and ECC risk reduction interventions. This topic is also embedded in the SDG 3. Thus, using an interconnected approach between SDGs for designing ECC control programs recognizes that ECC is not just a biological state but an existential condition influenced by socio-political structures that results in inequalities. Interventions must therefore transcend clinical approaches, incorporating policies that tackle underlying social inequalities. Further studies of the link between social inequalities and ECC in low- and middle-income countries is needed.

Capacity-building for researchers is needed to acquire the agency to generate needed empirical evidence for action. This is in view of scoping review findings that four of the ten SDG 10 targets were addressed in ECC/SDG 10 research. We found no studies on development assistance and financial flows to low income countries although they can significantly address systemic disparities and financing gaps [110]. Effective utilization of international funding provided through development assistance and investments in health infrastructure can enhance access to dental care, preventive measures, and education. However, the lack of publications on ECC development assistance limits our understanding of and responding to ECC challenges in LICs. Bridging this knowledge and funding gap is essential to support equitable oral health interventions and the achievement of the SDGs.

Investments in targeted, low-cost oral health interventions, such as the provision of fluoride toothpaste and school-based oral hygiene education and supervised toothbrushing, are feasible and impactful [111]. Community-level approaches, including parental education and engagement in children's oral health care, are also feasible [112]. These approaches rely on human resources rather than expensive infrastructure, have lower financial demands and have incremental implementation potential making them scalable. The programs can leverage local health workers, school networks, and community health workers to facilitate innovative delivery models in underserved areas [113]. Tailoring education and advocacy to local beliefs and practices can further enhance acceptance and effectiveness of health promotion programs [114]. However, ensuring consistent fluoride product supply would be a challenge for many LICs where there is little or no local production of fluoride dentifrices.

To enhance scalability and feasibility, ECC prevention efforts should be incorporated into existing maternal and child health programs to optimize resource utilization [115]. For infrastructure-intensive interventions like teledentistry in LICs, international funding and multilateral support are crucial to address the needs of remote areas with limited access to dental professionals, especially as digital connectivity continues to improve. Public–private partnerships can also play a critical role in scaling interventions such as subsidized dental care services or oral health product distribution, provided there are clear agreements aligning public health goals with private sector contributions. It is therefore important to also scale policies to address systemic socioeconomic disparities, but this needs robust governance and cross-sector collaboration. Research and pilot programs specifically targeting LICs are crucial to evaluate and optimize these interventions in resource-constrained settings.

In conclusion, this scoping review underscored the significant impact of socioeconomic factors, racial disparities, and geographic location on ECC. The conceptual framework emphasizes the complex interplay between behaviours, social structures, and policy contexts in shaping oral health outcomes by committing to reducing social inequalities and recognizing that the health of marginalized children is an urgent ethical and existential issue. More research representation from LICs exploring the links between ECC and other SDG targets is needed to advance efforts to reduce social disparities in the oral health of preschool children.

Abbreviations

AFR	African region
AMR	Americas region
dmft	Decay, missing, filled teeth index
ECC	Early Childhood Caries
EMR	Eastern Mediterranean Region
EUR	European region
HICs	High-Income Countries
LICs	Low-Income Countries
LMICs	Lower Middle-Income Countries
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guidelines
SDG	Sustainable Development Goal
SEAR	South East Asian region
UMICs	Upper Middle-Income Countries
WPR	Western Pacific region

Supplementary Information

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Supplementary Material 1.

Authors' contributions

M.O.F conceived the study. The Project was managed by M.O.F., E.M.R.deB.C., C.A.F., B.G., J.I.V., M.E.T, and R.S. Data curating was done by M.O.F., O.R.A. C.A.F. and E.M. R. de B.C. C. Data analysis was conducted by M.O.F., E.M. R. de B.C. C., and C.A.F. D.D. drew the conceptual framework. M.O.F. developed the first draft of the document. E.M.R.deB.C., C.A.F., B.G., J.I.V., O.R.A., D.D., O.B.A-B., A.V., M.E.T, and R.S. read the draft manuscript and made inputs prior to the final draft. All authors approved the final manuscript for submission.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

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Competing interests

Duangporn Duangthip and Jorma Virtanen are editorial board members with BMC Oral Health. Morẹ́nikẹ́ Oluwátóyìn Foláyan and Maha El Tantawi are Senior Editorial Board members with BMC Oral Health. All other authors declare no conflict of interest.

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