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SYSTEMATIC REVIEW

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Prevalence of early childhood caries in Southern Africa: systematic review and meta-analysis

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Abstract

Background There is currently no comprehensive pooled analysis or regional synthesis previously been conducted on the prevalence of early childhood caries (ECC) in the Southern Africa region. This study determined the prevalence of ECC and its associated risk factors in the Southern African region.

Methods The systematic review and meta-analysis were registered with PROSPERO (CRD420251004718). PubMed, Scopus, Web of Science, and AJOL databases were searched up to April 2025. Studies were included if they were cross-sectional, cohort, or case-control. had to be published between 1st January 2000 and 31st March 2025 and had to report the prevalence of ECC and associated risk factors in Southern Africa. There were no language restrictions. Studies among children with special needs were excluded. Heterogeneity was evaluated using the I^2 statistic, while a random-effects model was applied to estimate the overall prevalence of dental caries. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. It utilised the Joanna Briggs Institute Critical Appraisal Checklist to assess the methodological quality of the studies.

Results A total of 113 publications were identified through databases, and 15 publications (including 25,935 children) met the eligibility criteria for the systematic review and nine for the meta-analysis. The pooled prevalence of ECC in Southern Africa was 52% (95% CI: 44 to 59%; $p < 0.00001$). Studies with sample sizes greater than 500 reported an ECC prevalence of 53% (95% CI: 41–65%), while those with fewer than 500 participants reported a prevalence of 50% (95% CI: 46–54%). Hospital-based and school-based studies each reported a prevalence of ECC of 49% while studies conducted in mixed settings reported a higher prevalence of 72%. The prevalence of ECC was higher among males at 51% (95% CI: 42–61%) compared to females at 46% (95% CI: 38–54%). The risk factors associated with ECC include sociodemographic and environmental risk factors, oral hygiene practices, feeding practices, dietary habits and sugar consumption, and access to dental care and fluoride exposure.

Conclusions The prevalence of ECC in Southern Africa is high, driven by behavioural, environmental, and sociodemographic factors. The results highlight the critical need for tailored preventive measures, such as better oral

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hygiene, appropriate feeding and dietary habits, and increased access to fluoride-based care to support effective policy and planning to reduce the prevalence of ECC.

Keywords Caries, Dmft, Pufa, Primary dentition, Southern africa countries

Introduction

Early Childhood Caries (ECC), defined as decayed (non-cavitated or cavitated), missing because of caries, or filled surfaces in any primary teeth of children aged 71 months or younger [1], is a significant public health problem globally. The burden is higher in lower-income countries, including Africa [2, 3], and among children from lower socioeconomic backgrounds [4]. However, the global epidemiological profile suggests that the prevalence of ECC increases with age, with a higher growth rate of Gross National Income (GNI), and as the inequality index improves [3, 5]. Countries with universal health coverage and countries with the highest life expectancy are less likely to have a high prevalence of ECC [3, 5].

This ECC profile has implications for countries in Africa where the growth rate of the GNI varies significantly across countries and periods [6], the inequality index is poorer [7], and the life expectancy is lower [8] than the global average. In addition, there is the human resource challenge with poor human dental resources [9, 10] that makes the availability of ECC more challenging to access for effective resource allocation and planning [5]. This is because, when untreated, the impact on the quality of life of the children and the parent, and its long-term impact in adult life, is huge [1–4]. This has implications for developing and implementing preventive programs for ECC in the worst-affected countries.

Currently, the prevalence of untreated dental caries in the permanent dentition of people five years and older in Southern Africa is the second highest in the five sub-regions in Africa, and the availability of dentists is the third lowest after Western and Central Africa [10]. Although much of the available evidence on ECC in South Africa has previously been synthesized in a systematic review [11], little is known about the broader ECC profile across the Southern African subregion. This current review is expanded in scope to other countries in the sub-region and examines associated risk factors. In doing so, it aims to generate evidence to inform policy decisions, guide targeted prevention and treatment strategies, and allocate resources effectively for improving early childhood oral health outcomes in the sub-region [3]. Socioeconomic factors such as high-income inequality, poverty, urban-rural disparities, and health challenges such as high HIV prevalence are shared by countries of the Southern African Development community, distinguishing them from other African sub-regions [12, 13]. These factors intersect with limited access to oral health services and weak public health infrastructure, aggravating the burden of ECC [13, 14]. Thus, a region-specific synthesis is necessary to fill the gap and address the public health [15] concern unique to the sub-region. The study objective was to determine the estimated prevalence of ECC in Southern Africa and to identify associated risk factors for ECC in the region.

Methods

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines [16]. The protocol was registered with the International Prospective Register of Systematic Reviews PROSPERO (CRD420251004718) and registered on 1 st of April 2025.

Research questions

This systematic review and meta-analysis addressed these two research questions: (1) What is the prevalence of ECC in the Southern Africa region? (2) What are the risk factors associated with ECC in the Southern Africa region?

Eligibility criteria

Cross-sectional studies, cohort studies, clinical trials that reported prevalence of ECC in the baseline data, and case-control studies published with no language restrictions from 1 st January 2000 to 31 st March 2025 that reported the prevalence of ECC and associated risk factors in South Africa, Angola, Zimbabwe, Zambia, Botswana, Namibia, Lesotho, Eswatini, Malawi, and Mozambique were eligible for inclusion in the analysis. The year 2000 serves as a cutoff point as it effectively captures the modern era of public health in Southern Africa, characterized by the post-ART landscape, globalized dietary patterns, and more contemporary healthcare policies. Excluding earlier studies ensures that the synthesized evidence on ECC prevalence and its risk factors is temporally relevant and directly applicable to current and future public health decision-making in the region, thereby enhancing the validity, utility, and impact of the review's findings.

Studies among children with congenital abnormalities, systemic diseases, special needs, children with comorbid states, and multiple age groups beyond 71 months were excluded. Furthermore, review articles, systematic reviews and meta-analyses, case reports, case series, in vitro studies, and commentaries or letters (including editorials and opinion pieces) were excluded.

Data sources, search terms, and search strategy

Detailed search strings and strategies were appropriately created with terms related to the keywords (caries, early childhood caries, dmft, pufa, primary dentition) and adapted to PubMed, Scopus, Web of Science, and AJOL databases (Supplemental Files 1–4). The search was conducted in April 2025. All articles from the initial search results were uploaded to the Rayyan software. An additional hand search was performed by reviewing the references of included studies, including previous systematic reviews and meta-analyses. In addition, unpublished studies, surveys, and school-based oral health initiatives data that may provide valuable insights into the prevalence of ECC and its associated risk factors in Southern African countries were retrieved and reviewed. The dental schools and oral health institutions listed with the World Health Organization African Region were contacted for possible grey materials through the email contacts provided. Where manuscripts were needed, authors were also contacted to share copies of their manuscripts.

Study selection

Eligibility screening for the studies was conducted using the PEO framework, which considers Population, Exposure, and Outcomes. The target population included children aged 71 months and below living in any country in Southern Africa, regardless of sex. ECC served as the primary exposure of interest, with the main outcome being its prevalence within this population group.

The study selection occurred in three stages. First, the titles and abstracts of all retrieved articles were screened against the predefined inclusion and exclusion criteria by two authors (RA and OO) independently. Studies that met the eligibility requirements were retrieved for full-text review. The full content of each retrieved article was assessed independently by the two authors to confirm its relevance to the research question. Discrepancies were resolved by consensus through discussion and consulting a third reviewer (AA) when consensus could not be reached. The final synthesis included only studies that met the eligibility criteria. Details of the studies excluded and the reasons for exclusion are provided in Supplemental File 2.

Inter-rater reliability was assessed using the intraclass correlation coefficient to establish the level of agreement between the two reviewers. For the full texts screened, an intraclass correlation coefficient of 0.88 was obtained, indicating strong agreement [33]. Supplemental File 3 shows the mean quality scores assigned by each assessor across the 15 included studies. The scores were similar between assessors, with Assessor A averaging 8.07 (SD = 0.88) and Assessor B averaging 8.27 (SD = 0.80), suggesting general agreement in appraisal of study quality.

Data extraction

A data extraction form was developed to collate relevant information from the included studies. The data extracted were the study characteristics (name of first author, year of publication, country where the study was conducted, study design, sampling method, study setting, and sample size), prevalence of ECC (overall and age-specific), and risk factors associated with ECC.

The extracted data were recorded in Microsoft Excel to facilitate data management and analysis by OO and AOA. A third independent reviewer (RA) cross-checked the extracted data to ensure accuracy and minimise errors. Discrepancies between the reviewers were resolved through discussion.

Quality and risk of bias assessment

The risk of bias of included studies was assessed with the Joanna Briggs Institute (JBI) critical appraisal checklist for prevalence studies. A high risk of bias was identified when positive responses were 49% or lower; a moderate risk of bias was assigned when positive responses ranged between 50% and 69%; and a low risk of bias was determined when positive responses were equal to or exceeded 70% in the studies [17]. Similar to the thresholds that have been applied in previous systematic reviews [18, 19].

The assessment was carried out independently by two trained authors (RA and OO) and discrepancies resolved by consensus. Details of the quality assessment were provided in Supplemental File 3. Disagreements at the full-text stage were resolved through discussion with a third reviewer (AA).

Publication bias assessment

The publication bias was assessed with the symmetry of the funnel plot of the studies included in the meta-analysis.

Sensitivity assessment

A sensitivity analysis was conducted using a leave-one-out approach to examine how the risk of bias influences the prevalence of ECC in the Southern Africa region.

Subgroup assessment

Structured subgroup analyses were conducted to evaluate how predetermined moderating factors influenced the overall prevalence of ECC in the Southern African nations. The following variables were selected due to their ability to account for differences between studies: the sample size and the setting of the study.

Data analysis

The data analysis for this systematic review and meta-analysis was conducted using RevMan 5.4.1 (The Nordic Cochrane Centre, Copenhagen, Denmark), ensuring a rigorous and standardised approach to synthesising findings. The primary analysis focused on pooling prevalence estimates of ECC across included studies. The effect size was presented by a 95% confidence interval (CI). For all statistical tests, except for heterogeneity assessment, a $p < 0.05$ was considered statistically significant.

To ensure statistical robustness, the inverse variance method (Generic Inverse Variance) was applied to calculate the pooled effect to minimise bias. Cochran's Q statistic test and Higgins and Thompson's I^2 statistic were used to evaluate the level of variability across studies. A $p > 0.05$ for the Q-statistic indicated significant heterogeneity. An I^2 value above 50% was indicative of substantial heterogeneity.

Forest plots were drawn to condense data from multiple studies into a single, intuitive visual that provides a more statistically reliable pooled prevalence of ECC. It shows whether studies are consistent, highlights outliers, and communicates the uncertainty of estimates through confidence intervals. The column labelled 'events/total' shows the number of children with ECC out of the total sample in each study, while the 'total' column indicates the overall sample size for each study. The 'prevalence' column provides the proportion affected.

Results

Study selection

A total of 113 publications were identified from Scopus, Web of Science, PubMed, and AJOL. The publications were uploaded to Rayyan, and 31 articles were removed due to duplication. Of the 82 publications screened, five were identified for full-text screening. Details of the 77 excluded are in Supplemental File 2. Additionally, 62 publications were retrieved from other sources, of which 10 were selected for full-text screening. Finally, 15 publications were eligible for full-text screening. A PRISMA flow diagram (Fig. 1) was used to document the selection process.

Characteristics of the included studies

Table 1 shows that the 15 included studies were from four of the 10 countries in the Southern Africa region: Angola [28], Namibia [25], Mozambique [24, 29], and South Africa [18–24, 26, 27, 30–32]. Twelve (80%) of the included studies were from South Africa.

The data from the reported studies were published between 2000 and 2023: eight (53.3%) between 2000 and 2008 [18–23, 30, 32], five (36%) between 2012 and 2018 [24–27, 31], and 2(14%) between 2022 and 2023 [28, 29]. The studies included 25,935 children. The sample sizes ranged from 120 [22] to 7555 [20]. The number of female participants was 4,276, and the number of male participants was 4,272, as reported by 11 (73%) of the included studies, while 4 (27%) [18, 19, 30, 32] of the included studies did not report the sample sizes by sex.

Five studies reported ECC prevalence among children aged 2 to 5 years [18, 20, 21, 26, 29], two among 4- to 5-year-olds [19, 24], one among 5-year-olds [28], and four reported the prevalence among children 5 months to

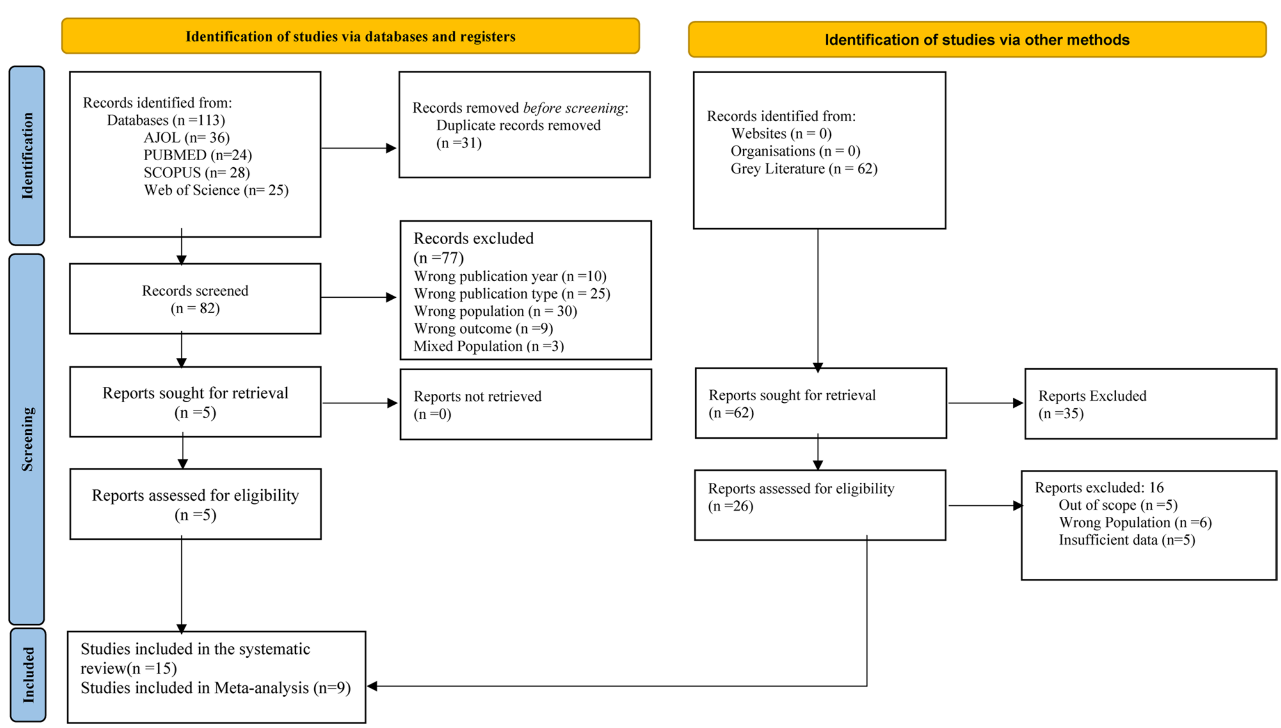

Fig. 1 PRISMA flow diagram of ECC in Southern Africa

Table 1 Characteristics of included studies

SN	Author/Publication Year	Country	Study Design	Study Setting	Sample Size by Age	Sample Size by Sex	Diagnostic Criteria	ECC Prevalence	Risk Factors Reported	Risk Assessment
1	Cleaton-Jones, et al., 2000 [20]	South Africa	Cohort	School	6,843 2years: 851 3 years: 1706 4 years: 2103 5 years: 2183	Not available	dmft	34.3%	Not reported	Low
2	MacKeown et al., 2003 [32]	South Africa	Cohort	Community	259 1 year old 5 year old	Not available	dmft	1-year-old: 1.5% 5-year-old: 62%	Vitamin B12, magnesium, riboflavin, and biotin were significantly associated with caries occurrence	Low
3	Vanwyk et al., 2004 [21]	South Africa	Cross sectional	School	7555 4-5yrs	Not available	dmft	50.6%	Not reported	Low
4	Jacob, 2006 [22]	South Africa	Cross sectional	School	133 2-3year: 42 4year: 54 5year: 37	Male: 88 Female: 53	dmft	75.0%	Poor parental oral health, poor parental dental hygiene habits, and poor feeding habits	Low
5	Wanjau & Plessis, 2006 [34]	South Africa	Cross sectional	Hospital	269 3years:59 4years:77 5years: 133	Not available	dmft	47.96%	Not reported	Low
6	Cleaton-Jones et al., 2008 [23]	South Africa	Cross sectional	School	342 2years: 64 3years: 78 4years: 76 5years: 124	Male: 174 Female:168	dmft	46.5%	Older age	Low
7	Ali, 2008 [24]	South Africa	Cross sectional	Hospital	120 12-18months: 60 19-24months: 60	Male: 64 Female: 56	dmft	23.3%	Bottle feeding for 13–24 months, breastfeeding beyond 18 months, and night feeding significantly increased the risk of ECC	Low
8	Postma, 2008 [25]	South Africa	Cross sectional	School	5,822 36–71 months	Male: 2,816 Female:2,868	dmft	55.0%	Increased sugar expenditure was linked to a higher risk of ECC (OR: 1.07;1.02–1.12). Urban areas had lower fluoride levels in drinking water (OR:0.80; 0.64–0.99), and urbanisation was associated with greater ECC prevalence because of lower fluoride (OR: 0.75; 0.59–0.95). ECC frequency and severity were higher among coloured children (OR: 2.34;1.78–3.07), children of unemployed parents (OR = 1.51; 1.15–1.98), and those from middle-income occupational backgrounds (OR: 1.25;1.05–1.50).	Low

Table 1 (continued)

SN	Author/Publication Year	Country	Study Design	Study Setting	Sample Size by Age	Sample Size by Sex	Diagnostic Criteria	ECC Prevalence	Risk Factors Reported	Risk Assessment
9	Thekiso et al., 2012 [26]	South Africa	Cross sectional	School	282 4–5-year-old	Male:149 Female:133	dmft and pufa	49.0%	Not reported	Low
10	Thopil, 2013 [27]	Namibia	Cross sectional	Hospital	228 5–11 months: 49 12–23 months: 64 24–35 months: 43 36–47 months: 41 48 months: 31	Male: 109 Female:119	dmft	31.9%	Method of feeding ($p = 0.0456$)	Low
11	Mndzebele, 2014 [33]	South Africa	Cross sectional	Hospital	245 0-2years: 80 2-4years: 112 4–5 years: 53	Male: 119 Female: 126	dmft	51.02%	Tooth cleaning habits (OR:0.97;0.44–2.15) and bottle-feeding (OR: 2.32;1.15–4.68), age 2.1 to 4.0 years (OR: 7.07;3.38–14.79), and age 4.1 to 6 years (OR: 18.40;7.22–47.11) had a higher risk for ECC.	Low
12	Kalil, 2017 [28]	South Africa	Cross sectional	School and hospital	222 2years: 50 3years: 68 4years: 59 5years: 45	Males: 97 Female: 125	dmft and pufa	47.7%	Age 4–5 years had higher levels of dmft than 2-3years ($p < 0.001$)	Low
13	Mohamed, 2018 [28]	South Africa	Cross sectional	School and hospital	659 6–11 months: 10 12–23 months: 103 24–35 months: 129 36–47 months: 172 48–59 months: 142 60–71 months: 103	Male: 357 Female: 302	ICDAS and ICDAS-LAA	71.6%	Not reported	Low
14	Songa et al., 2022 [30]	Angola	Cross sectional	School	240 5-year-olds	Male: 114 Female:126	dmft	57.9%	Children attending schools in peri-urban areas (OR = 2.371),, brushing only once daily (OR = 0.78), and daily consumption of candies and sugary drinks (OR = 0.75)	Low
15	Suemma Issufo Issa, 2023 [31]	Mozambique	Cross sectional	Hospital	3852years: 112 3years: 1124years:845years: 77	Male: 185 Female: 200	dmft	41.6%	Older children (OR:0.134;048–379) and bottle use (OR:0.315;114–871) were associated with a lower risk of ECC. Caregivers with low education levels (OR:3.87;1,38-10,82) and a lack of caregiver supervision during oral hygiene (OR:25.17;7.14–88.76.14.76) increased the risk for ECC	Low

71 months [22, 23, 25, 27]. One study included data on children from less than 1 year to 5 years [31], and another study included data on 1- and 5-year-olds alone [30]. The study settings were schools [18, 21, 23, 24, 27, 28, 32], the community [30], creches [19, 20, 26], and hospital-based [22, 25, 29, 31, 32].

The prevalence and severity of ECC were measured with the decayed missing and filled Teeth (dmft) index by 12 (80%) of the included studies, 2(13%) used dmft and pulpal involvement, ulceration, fistula and abscess (pufa) index, and 1(7%) used the International Caries Detection and Assessment System (ICDAS), Lesion Activity Assessment (LAA).

Associated risk factors for early childhood caries

Table 2 shows the summary of associated risk factors for early childhood caries from the included studies, categorised into social, behavioural, structural, and environmental risk factors.

Social risk factors

Peri-urban school settings [30], low parental education [28] (OR:3.87;1,38 – 10,82) [31], and limited access to dental services [30] were associated with increased risk of ECC. Similarly, ECC was more common and severe among children of unemployed parents (OR: 1.51; 1.15–1.98) and those from middle-income families (OR: 1.25;1.05–1.50) [24]. In addition, race/ethnicity was highlighted, with ECC being more severe in coloured children (OR: 2.34;1.78–3.07) than among white children [23]. Furthermore, the prevalence of ECC was lower among older preschool-aged children (4–5 years) (OR:0.134; 0.48–3.79) [31] compared to younger children aged 2–3 years, who had higher odds of developing severe forms of ECC [23, 28].

Behavioural risk factors

Some of the included studies suggested associations between oral hygiene practices and ECC. Brushing the teeth once daily [32], not cleaning teeth after feeding (OR:0.97;0.44–2.15) [33], delayed initiation of brushing beyond 12 months [29], a lack of caregiver supervision during brushing (OR:25.17;7.14–88.76) [31], and limited caregiver knowledge of children's toothbrushing [28] were reported as potential risk factors from the included studies. ECC appeared more prevalent and severe among urban children facing higher sugar exposure (OR: 1.07;1.02–1.12) and lower fluoride levels in drinking water (OR: 0.80; 0.64–0.99) [25]. Increased risk for ECC was reported with improper feeding habits, such as bottle use (OR: 2.32;1.15–4.68) [33] and sugary diets [22, 27], prolonged bottle feeding [24], breastfeeding beyond 18 months [24], and nighttime feeding more than twice nightly [24, 31]. In addition, daily consumption of candies and sugary drinks [30] was identified as an ECC contributory factor in these studies.

Table 2 Summary of associated risk factors for early childhood caries in the Southern African region from included studies

Category	Risk Factor	Associated ECC Risk	Reference(s)
Social Factors	Peri-urban school settings	Increased risk	[30]
	Low parental education	Increased risk	[30, 31]
	Limited access to dental services	Increased risk	[30]
	Children of unemployed or middle-income parents	More common and severe ECC	[25]
	Race/Ethnicity: Coloured children	More severe ECC	[25]
	Race/Ethnicity: White children	Less severe ECC	[25]
	Older preschool children (4–5 years)	Higher ECC prevalence and severity	[23, 28, 31]
Behavioural Factors	Brushing teeth once daily	Increased ECC risk	[30, 33]
	Delayed brushing initiation (> 12 months)	Increased ECC risk	[31]
	No caregiver supervision during brushing	Increased ECC risk	[31]
	Limited caregiver knowledge of toothbrushing	Increased ECC risk	[28]
	High sugar exposure and low fluoride (urban children)	More prevalent and severe ECC	[25]
	Improper feeding habits (bottle use, sugary diets)	Increased ECC risk	[22, 27, 33]
	Prolonged bottle feeding	Increased ECC risk	[24]
	Breastfeeding beyond 18 months	Increased ECC risk	[24]
	Nighttime feeding > 2 times/night	Increased ECC risk	[24, 31]
	Higher household sugar expenditure (urban)	Increased ECC risk	[25]
	Daily consumption of candies/sugary drinks	Increased ECC risk	[30]
Structural/ Environmental Factors	Poor access to dental services (Angola and South Africa)	Higher ECC prevalence	[28, 30]
	Reduced fluoride levels in urban water supplies	Increased ECC risk	[25]

Structural and environmental risk factors

Limited or poor access to dental services was associated with higher ECC rates in both Angola and South Africa [28, 30]. Reduced fluoride levels in urban water supplies also correlated with increased risk for ECC (OR: 0.75; 0.59–0.95) [25]. Five studies [20, 21, 26, 29, 35] did not report risk factors for ECC.

Quality assessment and interrater reliability

All the studies achieved a score of 90, which is greater than 69% on the JBI checklist, indicating a low risk of bias consistent with [17].

Pooled prevalence of ECC in Southern Africa

Table 1 shows the ECC prevalence estimate of the 15 included studies. This prevalence ranged from 1.5% in the study involving 1-year-old children to 75% in the research focused on children aged 2 to 5 years. Ten (67%) studies reported a prevalence less than 52%, two (13%) were above 70%, and three (20%) ranged from 55% to 62%.

Nine of the 15 studies included were used in the meta-analysis. Six studies were excluded to ensure methodological rigour, consistency, and comparability across the studies included in the quantitative synthesis. Figure 2 shows the prevalence estimates from each study and the pooled estimate. In the forest plot, the squares represent the prevalence reported in individual studies, and the horizontal lines indicate the 95% confidence intervals (CI). The diamond shows the overall pooled prevalence.

The pooled estimated prevalence from the nine included studies was approximately 52% (95% CI: 44 to 59%), with a highly significant effect ($p < 0.00001$) and heterogeneity ($I^2 = 99\%$). The estimated pooled prevalence suggests that about half of the children had ECC.

Prevalence of ECC by sample size

As shown in Fig. 3, studies with fewer than 500 participants reported an ECC prevalence of 50%. For studies

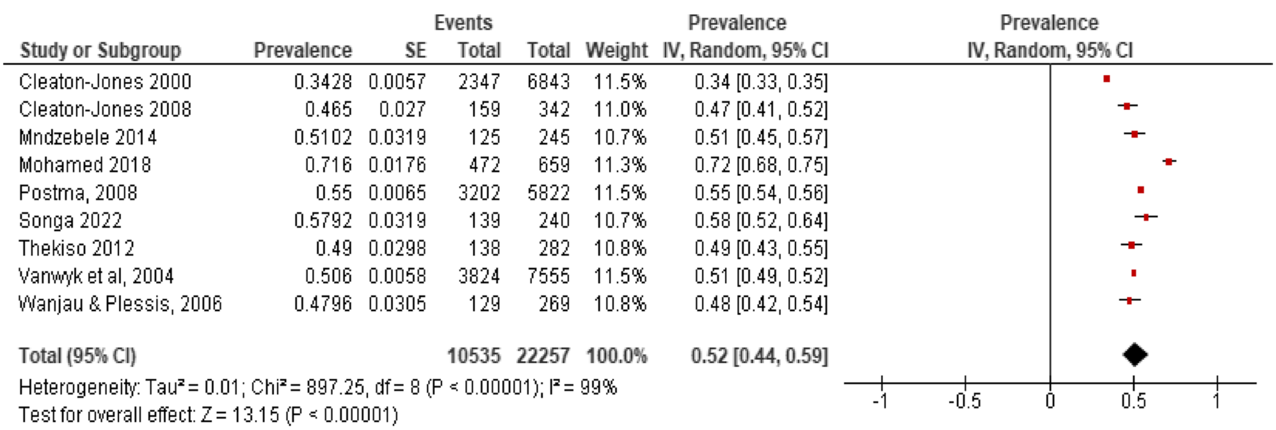

Fig. 2 Pooled prevalence of early childhood caries in the Southern Africa Region

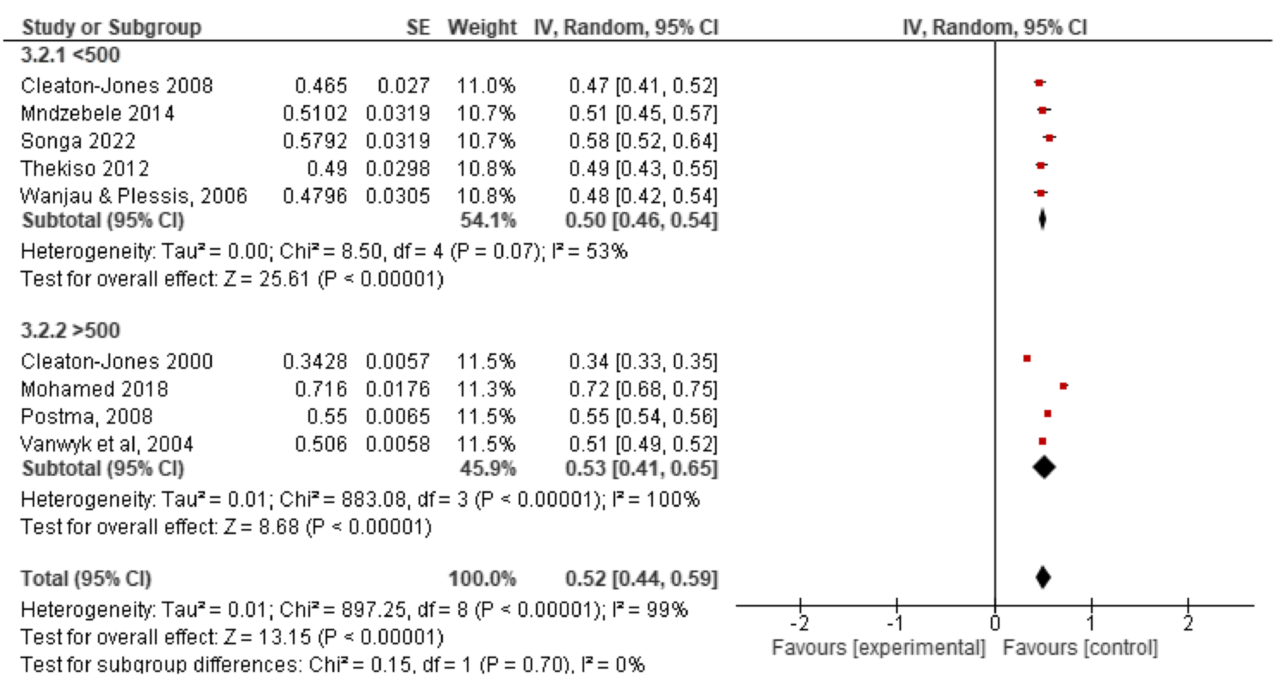

Fig. 3 Subgroup analysis by sample size

with more than 500 participants, the pooled prevalence was slightly higher at 53%. However, this difference was not statistically significant ($p = 0.70$).

Prevalence of ECC by study setting

Figure 4 shows the pooled prevalence of 49% for the data collected from schools and 49% for the data collected from hospitals. There was no significant difference in the ECC prevalence reported by study setting ($p = 0.90$).

Prevalence of ECC by sex

The pooled prevalence by sex, as shown in Fig. 5, among males was 51% and among females was 46%. The overall prevalence of ECC was 49%. There was no statistically

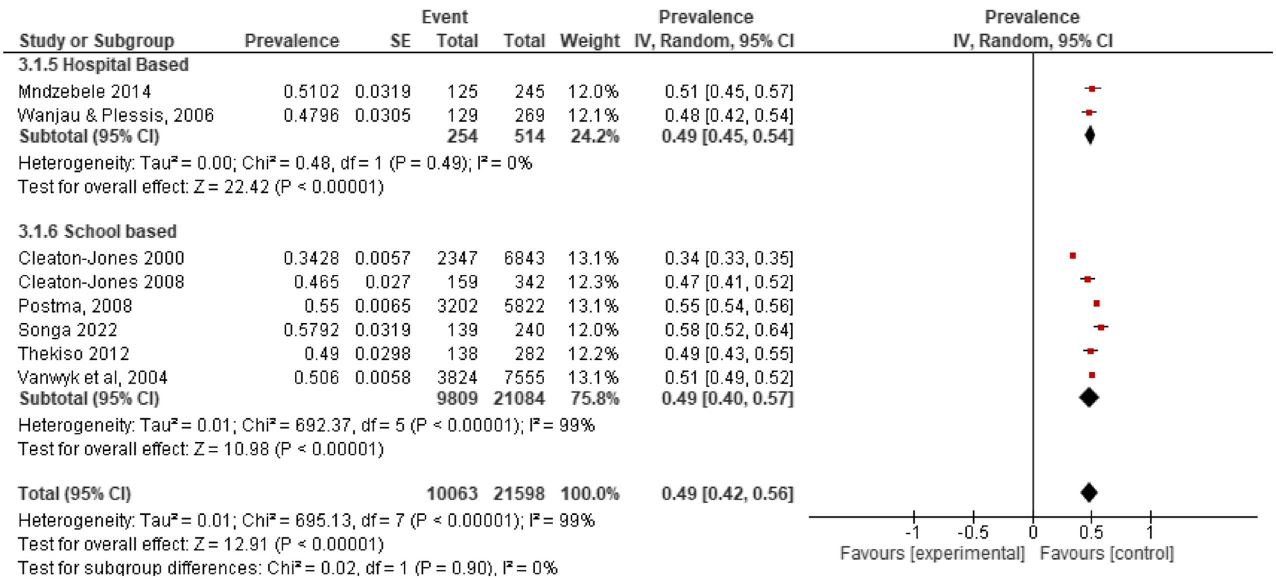

Fig. 4 Subgroup analysis by study setting

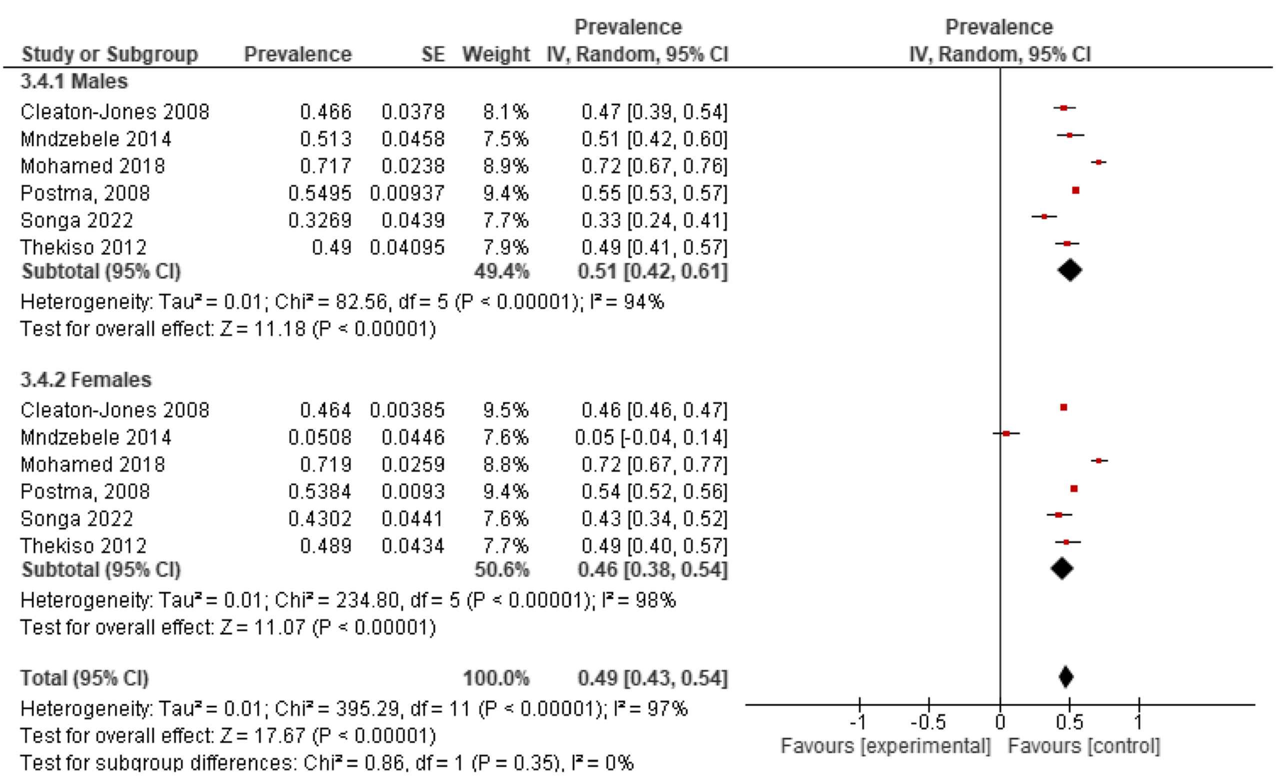

Fig. 5 Subgroup analysis by sex

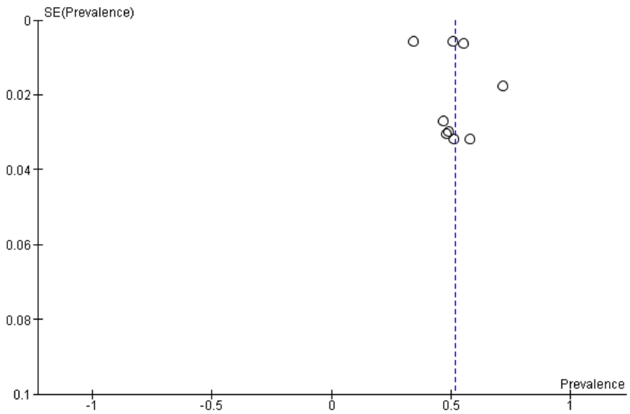

Fig. 6 A funnel plot showing the publication bias of the meta-analysis included studies

significant difference between the males and females ($p < 0.05$).

Sensitivity assessment

A sensitivity analysis was performed by progressively excluding each study. The overall effect size stayed stable, suggesting that no single study had an outsized impact on the pooled estimate.

Publication bias assessment

The funnel plot (Fig. 6) was created to visually evaluate the possibility of publication bias. Although the plot seemed fairly symmetrical, indicating a low likelihood of publication bias, Egger's regression test was not carried out because of the limited number of studies included [36].

Discussion

This systematic review and meta-analysis show that one in every two children in the Southern Africa region has ECC. In addition, risk factors for ECC identified were social, behavioural, and structural/environmental factors. Methodological inconsistencies complicated the synthesis of the risk factors. As a result, the review presented a qualitative synthesis of risk factors instead of a quantitative meta-analysis. This approach is consistent with best practices when meta-analytical pooling is not feasible due to inconsistent methodologies, metrics, and data availability [37].

This is the first study to examine ECC prevalence across multiple countries in the Southern Africa region. While a previous systematic review had focused on South Africa, our review differs by reporting on Southern Africa, incorporating new data from Angola, Namibia, and Mozambique, thereby expanding the geographical scope of knowledge on ECC in the subregion. By synthesising data from a large sample of children across four countries, this study provides a robust pooled estimate of the regional burden and highlights key risk factors highly relevant to policy and public health planning. Furthermore, by examining both prevalence and associated risk factors, this study offers a broader understanding of ECC in Southern Africa. The methodological and analytical rigour applied ensures the dependability of these findings.

However, several study limitations should be acknowledged. The dataset is heavily weighted toward South Africa, with no data from six eligible countries: Botswana, Lesotho, Eswatini, Malawi, Zambia, and Zimbabwe. This limitation restricts the generalisability of the findings to the broader Southern African region. In addition, the included studies span over two decades, introducing temporal variability that complicates comparisons across time. Diagnostic criteria varied, and age reporting was inconsistent, further challenging data synthesis. Furthermore, the variability in sampling settings, ranging from schools to clinics and communities, introduces potential bias, and some studies failed to report sex-disaggregated outcomes, limiting subgroup analysis.

Moreover, the meta-analysis of risk factors for ECC could not be performed due to substantial heterogeneity in the reporting and measurement across the included studies: some studies reported odds ratios [25], others used unadjusted frequencies [30, 33], and a few provided only qualitative descriptions [23, 32]. In addition, the statistical approaches varied, with some reporting univariate associations and others presenting adjusted estimates without consistent reference categories. Only a few studies examined the same risk factor, and even then, definitions and thresholds (such as for low parental education or inadequate oral hygiene) differed, making it impossible to pool the data meaningfully. Nevertheless, the thematic synthesis of the risk factors provides valuable insights, while recommending that future studies adopt standardized reporting of effect sizes and risk estimates to facilitate meta-analyses in subsequent reviews. Despite these limitations, the pooled analysis presented in this study represents a novel methodological contribution in covering multiple Southern African countries and offering updated estimates on an ECC crisis well-known in South Africa. The contextualization is also vital to understanding the magnitude, drivers, and implications of the issue.

The report of individual study estimates varied widely, highlighting potential heterogeneity in ECC burden across subpopulations and settings. South African scholars had drawn attention to this high prevalence for decades. For example, van Wyk and van Wyk [38] provided a foundational overview of the country's oral health challenges, while Hobdell et al. [39] emphasised the strong link between socioeconomic status and oral health across diverse settings, including South Africa. Nonetheless, the very high heterogeneity observed ($I^2 > 90\%$) limits the precision of the pooled prevalence estimate.

This variability likely reflects differences in how ECC was diagnosed, the contexts in which studies were conducted, and the populations under study, making direct comparisons challenging and suggesting that caution is needed when generalising these findings across the region.

The results show that the prevalence of ECC in the subregion is considerably higher than that reported in pooled global ECC prevalence rates [3]. The prevalence is also higher than the estimated prevalence of ECC in West (23%) and East (45%) Africa, but lower than the estimated prevalence in Central (57%) and North (55%) Africa (personal communications). The higher prevalence of ECC in Southern Africa compared to global and some regional estimates highlights an urgent need for targeted prevention and intervention strategies in the subregion. It suggests that current oral health promotion and service delivery may be inadequate to address the burden, and that socioeconomic, cultural, or health system factors unique to Southern Africa could be driving the disparity. At the same time, the fact that prevalence is lower than in Central and North Africa points to opportunities for cross-regional learning and the adaptation of best practices. These findings underscore the importance of strengthening surveillance, improving access to preventive and curative dental services, and prioritizing ECC within broader child health policies across Africa.

The characterisation of ECC as a "substantial public health challenge" is supported by several well-documented consequences and system-level constraints. Clinically, ECC often results in untreated decay, leading to pain, infection, nutritional deficiencies, and lost school days. It adversely affects children's growth, weight, and quality of life [40], emphasizing that the condition is far more than a cosmetic concern. Health system pressures are also considerable: ECC-related extractions frequently require general anaesthesia, yet public facilities often suffer from long waiting times, resource shortages, and overburdened dental staff, especially in rural provinces [41]. The inequality is compounded by a lack of access to basic preventive tools such as fluoride toothpaste, sealants, and oral health education, leaving children in underserved areas particularly vulnerable.

Petersen et al. [42], using WHO data, further underscored the widespread inequity in oral health care access across the African region. Their analysis pointed to significant shortages of oral health professionals, with Southern Africa having 0.16 dentists per 10,000 population [10]. The number of dental assistants, dental therapists, and dental prosthetic technicians serving the population is equally decimally low [10]. This highlights the limited reach of preventive interventions to the population.

The high burden of ECC in Southern Africa cannot be understood in isolation from the region's colonial past. Indigenous and historically marginalised populations are likely to be the worst affected due to the deep structural inequities rooted in colonial legacies that continue to shape poverty, access to care, and health knowledge systems [43]. Colonial dental services were primarily designed for settler elites, leaving Indigenous communities with little or no care and minimal oral health education [44]. These colonial regimes also disrupted indigenous food systems, facilitating dietary shifts toward sugar-rich, processed foods that have become major contributors to ECC [44].

Postcolonial health systems inherited these inequities, remaining urban-centric and chronically underresourced in rural areas. In addition, Colonisation imposed a knowledge hierarchy that devalued Indigenous oral hygiene practices, leading to lasting epistemic injustice and weakened oral health literacy [45]. Children in marginalised communities bear a disproportionate burden of the impact of poverty, food insecurity, overcrowding, and limited access to preventive care on oral health. These conditions increase ECC severity and affect children's growth, development, and quality of life [43]. As a result, many oral health interventions have overlooked community knowledge and local contexts, resulting in poorly aligned solutions.

While the current study does not produce the evidence to objectively support this postulation, historical events of colonised populations in Australia and the United States, among others [44], point to the feasibility of this reality. The ongoing neglect of oral health in national policy and funding structures of countries in the region is a form of structural violence, perpetuating intergenerational cycles of poor health and poverty. Addressing ECC in the region, thus, requires more than clinical interventions. It demands a decolonised, equity-focused approach that centres historically excluded communities, redresses systemic injustices, and values Indigenous knowledge in shaping oral health policy and practice. Studies to address ECC in Southern Africa seeking to address inequalities will need to be embedded in the realities of its historical past to find sustainable solutions to contribute to the global goal of ECC control.

This review provided region-specific evidence on the prevalence and risk factors of ECC in Southern Africa as a useful foundation for targeted prevention and policy intervention. However, some limitations of this systematic review and meta-analysis are acknowledged. Most of the included studies are from South Africa, and variations in the study design, diagnostic criteria, and reporting among the included studies may have contributed to the heterogeneity in the pooled estimates.

In conclusion, the prevalence of ECC in Southern Africa from this current review is high, associated with behavioural, environmental, and sociodemographic factors. These findings highlight the need for preventive measures, such as better oral hygiene, appropriate feeding and dietary habits, as well as increased access to fluoride-based care to support effective policy and planning to reduce the prevalence of ECC. However, further high-quality data from underrepresented countries is needed to inform region-wide strategies. The study reinforces an urgent call for comprehensive and equity-focused public health responses. Interventions must go beyond individual behaviour change to address the broader structural and systemic factors that perpetuate ECC in the region. Future studies are needed to generate evidence on the prevalence of ECC in the countries in the Southern African sub-region where data are currently missing. It is also important to ensure that these future studies produce high-quality evidence to generate information on the risk profile for ECC in the sub-region.

Abbreviations

ECC	Early Childhood Caries
PEO	Population, Exposure, and Outcome Framework
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International Prospective Register of Systematic Reviews

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12903-026-07724-w.

Supplementary Material 1: PRISMA 2020 checklist

Supplementary Material 2: Supplemental File 1: Search Terms. Supplemental File 2: Summary of Excluded Studies. Supplemental File 3: Quality Assessment of Included Studies

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Authors' contributions

All authors contributed to the design of the systematic review. FTA, AOE, GUE, OCE, QOL, AB, and MOF conceived the study and its methodology. OBO, RAA, and AOA contributed to the study design and methodology. MOF, FTA, OBO, RAA, and AOA designed the search strategy with input from all co-authors. OBO and RAA screened articles for inclusion, extracted the data, and all authors contributed to the interpretation of results. OBO, RAA, and MOF were involved in drafting and critically reviewing the manuscript. All authors reviewed the manuscript for intellectual inputs. All co-authors approved the final version for submission.

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Data availability

All extracted data and quality assessments are available in the manuscript and supplementary files to meet BMC transparency standards.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

Morenike Oluwatoyin Folayan is a member of the Editorial Board for BMC Oral Health. The other authors have no competing interests to disclose.

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