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Prevalence and pattern of Early Childhood Caries in Africans and African Americans: Protocol for a Systematic review and Meta-analysis

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Abstract

Background

A high prevalence of early childhood caries in African and black Africans in developed countries has been reported in documented studies. A plethora of factors, ranging from individual, social and environmental factors, have also been identified in these studies. Despite the knowledge of these factors and preventive strategies to resolve them, the potential risks and prevalence of caries in these populations are still relatively high. This, coupled with attendant economic liabilities and lingering potential health outcomes of these diseases, makes early detection and management necessary in susceptible individuals. Therefore, we plan to conduct a systematic review and meta-analysis to evaluate the prevalence of depression in sub-Saharan African children and Black children in developed countries to explore the potential risk factors for increased caries prevalence within this cohort.

Methods

We will search literature databases recorded in MEDLINE via PubMed, EBSCOhost, Scopus, CINAHL via EBSCO, African Journals Online (AJOL), and the Web of Sciences from their inception onward. We will also perform searches through selected relevant articles, and we will also search gray literature and relevant websites. Two reviewers will screen studies, extract data, and evaluate the risk of bias independently. The risk of bias will be assessed with the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Studies Reporting Prevalence Data. Statistical analysis will be conducted on the included studies using random effects meta-analysis of observational data to summarize the pooled prevalence, and odds ratios for categorical data will be used to explore potential risk factors if available. Prevalence estimates will be stratified according to age, sex, year of publication, country and other factors. Statistical heterogeneity will be estimated using Cochran's *Q* and *I2* indices. We will conduct meta-regression to investigate the potential sources of heterogeneity and funnel plots and Egger's test to assess publication bias and small study bias.

Discussion

This systematic review and meta-analysis provide robust evidence of the prevalence and risk factors for early childhood caries in this population. We expect to provide evidence for healthcare planning and policy formulation.

Systematic review registration:

The protocol of this systematic review was registered with PROSPERO with registration number CRD42024521637.

Introduction

Early childhood caries (ECC) can be defined as the presence of caries lesions affecting the primary teeth of children younger than 71 months of age(1). The American Academy of Pediatric Dentistry (AAPD) also defined ECC as the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child ≤ 71 months of age(2) Although dental caries is a major global public health concern affecting all age groups, with an estimated 2.4 billion people battling it worldwide(3), caries affecting the primary teeth have a major impact on children's oral health quality of life. Its major consequences include premature deciduous tooth loss and space challenges, malnutrition, delayed development and increased duration of school days(1)

The World Health Organization (WHO) reports that more than 530 million children have ECC, making it a significant dental public health problem that has a significant influence on families because its management is a source of economic burden(4). It thus remains untreated in most countries, thus leading to more critical complications such as abscess formation, inability to eat properly, sleep difficulties and a potential risk factor for dental caries in the permanent dentition. These challenges are more prominent in relatively limited settings, such as sub-Saharan Africa, where diagnostic methods and management modalities for ECC are not well developed or utilized. These reasons may underscore the higher prevalence of ECC in developing countries relative to developed countries; the highest prevalence has been reported in the lower socioeconomic group in these developing countries(5)

ECC has a complex multifactorial etiology with predisposing factors and an interplay of biological, dietary and social causes(5). These factors are compounded by barriers to dental utilization and service uptake, especially in developing countries; a lack of auspicious oral health policy, poor oral health promotion programs and poor health systems in these countries further forestall prompt diagnosis and immediate management of cases of ECC. Folayan et al(1), in their cross-sectional study, outlined many risk factors for ECC, including the abundance of dental plaque, increased age of patients, sex, frequency of consumption of refined carbohydrates and a number of salient maternal factors. These factors individually or in combination are poor indices for ECC in a community; however, the interplay among these factors has not been well studied or documented.

In contrast, the prevalence of dental caries in children in western countries is lower than the prevalence in children in sub-Saharan Africa. Documented studies in the Western literature have reported a prevalence of between 1 and 12%(6), while an extremely high prevalence of 70% has been reported in some sub-Saharan studies(7, 8). Despite this low reported prevalence, studies have also revealed that caries in preschool children remain a major problem even in developed countries(9, 10). Factors that have been highlighted in prevalence in sub-Saharan Africa studies are equally critical in cariogenesis, namely, socioeconomic status, lifestyle, dietary pattern, and oral hygiene practices. A salient factor that has also been reported in these studies is the unequal prevalence among Caucasians and low minority communities such as Blacks, Hispanics and Native Americans. The Centers for Disease Control and

Prevention (CDC) reported that minority children are more likely to experience tooth decay and have their cavities untreated(11).

Despite preventive programs that have been rolled to combat ECC and the WHO manual focusing on the Management, Screening, Diagnosis and Treatment of ECC, the prevalence of ECC is still high in developing countries, and ECC is still an imperative economic and health problem. Additionally, while global systematic reviews and meta-analyses of patterns, factors and prevalence of ECC have been conducted with some specific countries and countries also reviewing their peculiar patterns, there has been no systematic review in sub-Saharan Africa to detail the peculiar risk factors in this region and to quantify the sub-Saharan prevalence of ECC. Overall, the prevalence of ECC is comparatively greater in low- and middle-income nations worsened by reduced access and lack of dental utilization. Furthermore, the availability of dental care remains unequal even in developed countries, resulting in inadequate support for underprivileged children and families and thus increasing the prevalence of dental care for children of minorities. This study thus aimed to assess the prevalence, patterns, severity, and prominent social and behavioral determinants of ECC in Sub-Saharan African children under 71 months of age and to compare these findings with the prevalence of ECC in black African children in developed countries.

Research Questions

1. What is the prevalence of ECC in sub-Saharan African children?
2. What is the prevalence of early childhood caries in African Americans in developed countries?
3. What factors contribute to the prevalence in both populations?

Methods/Study design

This protocol is used for a systematic review and meta-analysis of the prevalence and pattern of early childhood caries in Africans and African Americans. This study will be conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidelines(12) and the guidelines for Meta-Analyses and Systematic Reviews of Observational Studies (MOOSE)(13). The protocol of this systematic review was registered with PROSPERO, CRD42024521637, in March 2024 and will utilize the PRISMA-P 2015 checklist(14). The results will also adhere to the MOOSE guidelines(13) and the PRISMA-P 2015 Statement(14).

Study eligibility criteria

Types of Studies

This systematic review and meta-analysis will determine the prevalence of ECC confirmed by the presence of at least one tooth exhibiting a carious lesion. Common diagnostic criteria for caries will be included, with the most common being decayed, missing, and filled teeth (dmft) scores (lower case indicates deciduous teeth). The PUFA index, which measures the number of severely decayed teeth with

pulpal involvement (P), ulceration caused by dislodged fragments (U), fistula (F) and abscess (A), will also be considered.

Inclusion criteria

Characteristics of the studies

1. Cross-sectional or observational studies, cohort studies and clinical audits reporting the prevalence of ECC in healthy children aged 71 months in Sub-Saharan Africa and black or colored minorities in developed countries will be included in the review. Baseline findings from longitudinal studies will also be considered. If a cohort is reported in multiple publications, the study with the largest sample size will be included in the study, and others will be excluded. This is a prevalence and incidence study, and consequently, no interventions will be assessed. The incidence of ECC in these groups will be our main and primary outcome.
2. Only studies that were conducted in English were included.
3. All articles published from 1900 until the end of March 2024 were eligible for inclusion in this review.
4. Only articles with full text will be included; where full texts for relevant articles are not available, the authors will be contacted for access to the manuscript or journal editors contacted for reprints. Articles for which the authors or editors can provide the manuscript or reprint will be removed from the selected list.
5. Secondary searching (PEARLing) and manual searching will also be conducted to include relevant manuscripts in the study.

Characteristics of the population

1. Children from sub-Saharan Africa and African Americans in developed countries who are under the age of 71 months. The Blacks designation will also include children designated as blacks in other countries, such as Europe and North America.
2. Children who are in the above designation and who have been diagnosed with ECC by caries diagnostic instruments and common World Health Organization (WHO) caries diagnostic criteria, such as dmft and PUFA, were included.

Outcome Measurements

1. Our main outcome will be the pooled prevalence of ECC in sub-Saharan African children, African American children and Black children in other developed countries.
2. The secondary outcome will include risk and predisposing factors, such as age, gender, health inequality, socioeconomic factors, educational status of parents, abundance of dental plaque, increased age of patients, frequency of consumption of refined carbohydrates, and maternal factors, among others.

Exclusion criteria

1. Articles not written in English.
2. Articles without available full text.
3. Systematic reviews, commentaries, protocols, conference abstracts and proceedings, commentaries/letters, unpublished studies and other gray literature were excluded.

Information Source and Search Strategy

The following electronic databases will be searched: MEDLINE via PubMed, EBSCOhost, Scopus, CINAHL via EBSCO, African Journals Online (AJOL), and Web of Sciences. The search terms that will be utilized in these databases include

(a) “Early childhood caries” OR “caries” OR “decay” OR “dmft” OR “dental” OR “oral” OR PUFA

(b) “Prevalence” and (c) “children” OR “peri-natal” OR “pediatric” OR “pediatric” OR neonatal OR infant and
(d) Africans
(e) Blacks
(f) African Americans
(g) Sub-Saharan Africa

Keywords were used in the following combinations: a + b + c + d + e + f + g. Both Medical Subject Headings (MeSH) and free-text words relating to these words were combined in PUBMED. The search words and concepts will also be transferred to other search databases for article retrieval from these databases before preliminary screening by reviewers.

The search results will be retrieved in cation formats such as Endnote, Bibtex or any compatible format (.ris, .nbib) in Rayyan software. Rayyan is an online-based web tool application that can be utilized for study selection in systematic reviews and meta-analyses. Rayyan allows collaboration between authors and joint screening with reasons for exclusion and inclusion for individual studies. Duplicates were also removed by the Rayyan application. Following deduplication, two independent reviewers (AOA and CCO) screened the titles and abstracts of all included studies for preliminary inclusion. Subsequently, the full pdf or html texts of preliminary included articles will be retrieved, added to the Rayyan application and perused according to the study characteristics and final inclusion in the final evaluation. Any discrepancy between these two reviewers will be discussed with a third author (CO) to arrive at a unanimous decision. A PRISMA 2020 flow diagram is presented to describe the whole screening process. Likewise, reasons for exclusions of the study will also be provided.

Data Extraction and Management

Two review authors (AOA and CCO) will independently assess all of the titles and abstracts of the identified studies against the inclusion criteria. For each study that met the inclusion criteria or for which there was insufficient information to make a clear decision, the authors obtained the full text, and two review authors independently assessed it to establish whether the study met the inclusion criteria. When

agreement is not achieved, the authors will consult a third review author. The search process will include all prevalence studies until the end of September 2024. All eligible studies will be included, and the authors will be contacted if any further clarification is needed.

The data will be entered into Microsoft (MS) Excel spreadsheets. For each study, the following data were retrieved: year of publication, area where the study took place, details of the participants, population, demographic characteristics (age, socioeconomic status, sex, ethnicity, prevalence), data collection period and criteria for diagnosis. Retrieved information will be aggregated in a table of 'Characteristics of included studies'.

Risk of bias (quality) assessment

The quality assessment of studies will be performed twice by two authors, independent of each other, while using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Studies Reporting Prevalence Data(15). The JBI Critical Appraisal tool will be modified if deemed necessary. If any discrepancies existed between the two authors, the third author was consulted to resolve any queries.

Data Analysis

From the retrieved information from each of these studies, a pooled prevalence will be computed using either the crude prevalence from each study or the transformed prevalence ratio for the purpose of normalization(16, 17). This approach enables accurate estimation of summary proportions of prevalence. Pooled estimates will then be calculated using a random effect model, as studies from different countries, study designs, and different populations will exhibit sufficient heterogeneity. Heterogeneity will be assessed using the I^2 statistic, Cochran's Q and the estimates of between-study variance ($\tau 2$). The confidence interval will be set at 95%, while p will be set at less than 0.05 for the pooled estimates, while a P value < 0.10 for the Q test and an $I2$ > 50% will be set as the thresholds for statistically significant heterogeneity. Pooled estimate results and the indicators of heterogeneity will be visualized via tables and forest plots(18).

Outlier studies will be determined via studentized residuals and visualized by diagnostic plots such as Baujat plots(19). Outlier studies with z scores greater than 2 or 3 may then be removed to determine their overall effect on the pooled prevalence estimate. In the case of 5 or more studies being available, small study bias and publication bias will be assessed by visual inspection of funnel plots. Formal tests to assess publication bias include the Egger test and rank correlation test set at a threshold of $p < .05$ to indicate funnel plot asymmetry. Possible sources of heterogeneity between studies were investigated utilizing subgroup analyses. When publication bias is made apparent by plot asymmetry, the trim-and-fill method will be utilized to estimate the number of potential missing studies and determine their hypothetical location on the funnel plot to achieve asymmetry. All the statistical analyses will be performed using R software (version 4.3.3).

Analysis of subgroups or subsets

We will use subgroup analysis to examine the causes of heterogeneity in our study. This will include exploring the influence of factors such as country, ethnicity, and quality of study. Meta-regression will also be performed for continuous variables such as the mean age and year of publication.

Discussion

This systematic review and meta-analysis evaluated the prevalence of ECC in black children under 71 months of age in both sub-Saharan Africa and other developed countries. The aim of this study was to identify similar factors involved in cariogenesis and decipher their common predispositions in these populations. A thorough exhaustive search across various databases will be conducted to include all relevant peer-reviewed articles on the subject matter to increase the potential sensitivity of the search outcome. To limit the inherent bias of observational studies, which will form the core of the included articles, quality assessment of each included article will be performed. Furthermore, adherence to both the PRISMA guidelines and the MOOSE guidelines will help reduce bias in this systematic review. This article has already been registered in the PROSPERO database, and any further corrections or modifications will be made for study transparency. Africa is the second most populous continent, with an increasing population that is expected to triple in the coming years. Thus, knowledge of the prevalence of an economically costly burden such as caries will aid in planning and promoting policies for the booming African population. Knowledge of the prevalence of caries in black minorities in developed countries will also help alleviate health inequalities in these societies and assist public health experts in comprehensive oral health promotion programs to eliminate potential risk factors. This study will thus be instrumental for promulgating health policies and fostering preventive approaches to combating early childhood caries in Black children.

Abbreviations

Early Childhood Caries (ECC), The World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), Decayed, Missing, Filled Teeth (DMFT), Pulpal involvement (P), ulceration caused by dislodged fragments (U), fistula (F) and abscess (A) (PUFA), Medical Subject Headings (MeSH), Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA), Meta-Analyses and Systematic Reviews of Observational Studies (MOOSE), Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P), International Prospective Register of Systematic Reviews (PROSPERO), and Joanna Briggs Institute (JBI)

Declarations

Conflicts of interest

None declared.

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Supplementary information

1. Additional file 1. Supplementary Table 1: Search strings according to medical database platforms
2. Additional file 2. PRISMA-P checklist
3. Additional file 3. MOOSE checklist
4. Additional file 4. PROSPERO registration

Authors' contributions

AOA and CCO wrote the manuscript; AOA and OA conceptualized the study; AOA and CO designed the search strategy and performed the searches; AOA, CO and CCO selected the studies; OA, OA and AMO extracted the data; and AMO, OA and CCO assessed the quality of the included studies. All the authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

Not needed.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Subject index terms

Child, Preschool; Dental Caries; Dental Caries Susceptibility; Humans; Nigeria; Prevalence

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Supplementary Table 1

Supplementary Table 1 is not available with this version.

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