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Review

A Scoping Review of Early Childhood Caries Experience Assessment Tools Used for Studies in Nigeria

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Abstract: This scoping review provides an overview of the tools used to assess for early childhood caries (ECC) in Nigeria. A search of the literature in African Journals Online, Google Scholar, Medline, and Cochrane database was conducted in June 2023 using the PRISMA-ScR guidelines. A combination of keywords related to caries risk assessment, preschool children, and evaluation tools was used for the search. Studies reported in English and assessing ECC were extracted. Descriptive statistics were used to summarise the information on study characteristics, types of caries assessment tools, and study outcome. Caries assessment tools were divided into behavioural, social, and biological. After screening 964 potential studies, 16 were included in the review. ECC assessment tools were categorised into behavioural (snacking, frequency of consumption of refined carbohydrate in-between-meals, dental service utilisation, frequency of tooth brushing, use of fluoridated toothpaste, breast and bottle feeding patterns and duration), biological (birth rank, age, sex, anthropometric measures, molecular characterisation of isolated organisms, presence of plaque), and social (socioeconomic status of the child's household, mother's level of education, maternal income, occupation of the father, maternal decision-making ability). Twelve studies used behavioural assessment tools, 11 used biological, and 11 used social tools. Furthermore, 11 (70.1%) used a combination of tools, four (25.0%) used only biological tools, and one (6.2%) used only behavioural tools to assess ECC experience. No study screened for the risk of caries. In conclusion, we identified the need for comprehensive studies to identify the risk indicators of ECC in Nigeria. This will support the development of a caries risk assessment tool appropriate for the country context.

Keywords: caries assessment; early childhood caries; preschool children; Nigeria

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1. Introduction

Despite being preventable, early childhood caries (ECC) is still one of the most prevalent diseases in children [1]. It is primarily attributed to long-term exposure to a diet rich in refined sugar, poor dental hygiene, and suboptimal oral care procedures [2]. In addition, a variety of behavioural and environmental factors make ECC risk more complex. Furthermore, the pain associated with this illness restricts chewing abilities, interferes with sleep, alters mood, and decreases productivity, which all negatively affects the child's quality of life [1,2]. In low- and middle-income countries, ECC prevalence is still as high as 70% despite being a disease that is preventable [2]. In addition, treating caries is expensive, placing a heavy financial strain on people in countries like Nigeria where out-of-pocket healthcare payment is predominant [1,2]. Preventive interventions are essential since they are more economical than therapy given the scarce resources in places like Nigeria [3,4].

Accurate and early caries risk prediction can greatly enhance caries prevention outcomes in children, leading to timely and appropriate interventions and improved oral health results [5,6]. Caries Risk Assessment (CRA) can effectively identify children at risk of ECC and enhance the process of offering personalised preventive measures promptly [7]. CRA is the determination of the likelihood that caries will occur, or the likelihood that there will be a change in the size or activity of existing lesions during a specific period [8], and can be performed by non-dental health care providers to identify and refer high-risk children before caries development or progression occurs [8]. When the tool assesses a variety of factors, children can be categorised as low, moderate, or high risk for ECC development and managed appropriately [9].

CRA tools also help to enhance objectivity, documentation, and motivation for caries management for preschool children [10]. They are developed for different populations [5] and often include several socio-demographic, behavioural, and clinical factors that are assessed jointly to decide about the caries risk status of the children. Some examples of globally tested tools are the Caries Management by Risk Assessment (CAMBRA), the American Dental Association Caries Risk Assessment, the American Academy of Paediatric Dentistry Caries Risk Assessment, and the computer-based assisted CRA methods (e.g., Cariogram) [11]. These tools have, however, only been used for the screening of ECC in high-income countries like the United States and Europe [12,13]. We did not find any study that screened for ECC using any of CRA in Africa.

Despite the low prevalence but high burden of ECC in Nigeria [4], little is known about the CRA tools used for ECC risk assessment and the consistency of their application [10]. The absence of a validated and accurate CRA tool to assess the risk of ECC in children in Nigeria limits the comparison of data between studies, and the application of evidence-based clinical management of ECC [14]. In addition, the absence of a validated CRA tool for the country makes it challenging to develop a national ECC risk profile with identified geographical areas and sub-populations more affected by inequalities associated with ECC that require special attention to reduce their risk for ECC [15]. This scoping review, therefore, aimed to map the existing literature on the tools used to assess ECC in Nigeria and to highlight the strengths and gaps in the use of these tools to assess the risk of ECC in children.

2. Materials and Methods

The method for this review was developed using the Population/participants, Concept and Context (PCC) framework [16], where the population of interest is preschool children, the concept is the CRA tools, and the context is Nigeria. The methodology was based on the Joanna Briggs Institute (JBI) scoping review methodology [17] to provide a systematic and transparent search strategy to identify relevant studies.

2.1. Research Questions

This review was guided by the research questions: (i) what are the CRA tools used for assessing the risks of ECC among preschool children in Nigeria? (ii) what are the strengths

and weaknesses of the CRAs used for assessing the risks of ECC among preschool children in Nigeria?

2.2. Relevant Studies

A systematic search of the literature, from inception till June 2023, on MEDLINE [PubMed], African Journals Online, Google Scholar, and Cochrane Library [CENTRAL] was conducted using the terms shown in Appendix A. A search of related citations and references was also carried out. Non-English articles were excluded if no English translation was available.

2.3. Study Selection

Publications identified through the search strategy were downloaded into Endnote, imported into Rayyan, and duplicates were removed. Three researchers performed title and abstract screening independently using pre-defined inclusion and exclusion criteria. Studies were included if there was an agreement between two or all the reviewers. The same three researchers completed the full-text review. Uncertainty regarding whether publications met the inclusion criteria was resolved via consensus among the three researchers.

2.4. Inclusion Criteria

Peer reviewed full length articles focusing on CRA tools for preschool children in Nigeria, published in English, were included in this review. There was no restriction on study design or date of publication.

2.5. Exclusion Criteria

Letters to the editor, commentaries on studies, and studies whose full lengths cannot be accessed were excluded. In addition, retrieved documents without data on children <72 months of age were excluded. Other data sources, such as websites or books, were excluded.

2.6. Data-Charting Process

A data-charting form was developed by two authors (AOE and AOA) to extract relevant variables. All authors independently extracted data and continuously updated the data-charting form. Each study's data were extracted by two separate authors blinded to each other's results to ensure accurate data extraction. Authors charted variables related to literature characteristics (e.g., authors, year of publication), study design, sample size, category of tool, population characteristics (e.g., part or region of the country), and variables related to the research questions (e.g., ECC risk factors, ECC protective factors). The range of behavioural, social, and biological assessment tools used for caries assessment was also charted.

2.7. Expert Consultation

The developed chart was shared with experts in the field of ECC (MET and MOF) and a Cochrane-trained expert on systematic review, meta-analysis, and scoping review (GUE) to validate the process and to ensure the extracted data were comprehensive.

2.8. Data Analysis

The results of the scoping review were reported according to the Preferred Reporting Items for Systematic reviews and Meta Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [18]. The tools used for caries risk assessment were classified into tools using biological, behavioural, and social indicators. In addition, the Joanna Briggs Institute Critical Appraisal Checklist for analytical cross-sectional studies, case-control studies, and cohort studies [19] was used for critical appraisal of the quality of all included studies. The extent to which the studies addressed the possibility of bias in eight areas of study design, conduct, and analysis was analysed. Each of the eight domains received a score from 0

(poor quality) to 2 (high quality), and a total quality score was calculated by summing the individual domain scores. Total scores ranged from 0 to 16, with higher scores indicating higher quality. Three researchers independently assessed each included publication and any uncertainty regarding the quality of publications was resolved through discussion among the team.

3. Results

The search resulted in 1040 records, which were downloaded into Endnote and imported into Rayyan. After de-duplication, 964 records remained. After reviewing titles and abstracts, and screening, 33 articles were eligible for full-text screening. On screening the full articles, 17 articles were excluded either because the data were not specific to the study group of interest or they were not specific to Nigeria, leaving 16 articles [20–35] for this review. Figure 1 shows the flow diagram of the publication screening process.

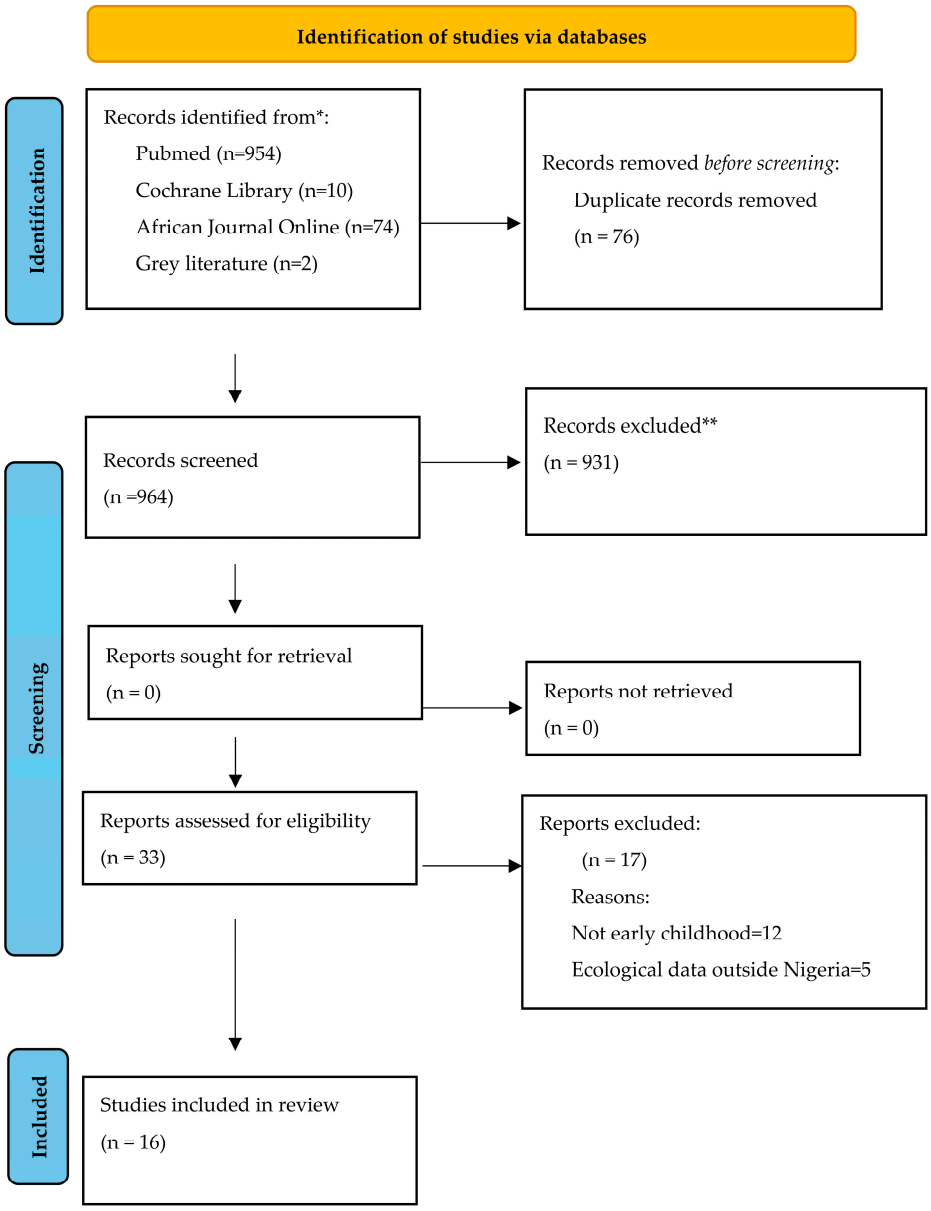

Figure 1. Flow diagram of studies included in scoping review [36]. * Only these databases were used for this study; ** Studies were excluded for the following reasons: Wrong population (n = 540), Wrong outcome (n = 327), Wrong publication type (n = 52), Publication in foreign language (n = 12).

Table 1 shows that the 16 extracted articles were conducted among preschool children in the south-west geopolitical zone of Nigeria: seven (43.8%) in Ile-Ife [20,23,25,28,30–32], seven (43.8%) in Lagos [21,24,27,29,34,35], one (6.2%) in Enugu [26], and one (6.2%) in Benin [33]. Two (12.5%) studies analysed urban and rural differences in the prevalence of ECC [22,35].

Four (25.0%) of the studies were hospital-based [21,28,33,35], one (6.2%) was school-based [21], and 11 (68.8%) were population-based [20,22–25,27,29–32,35]. All the studies were cross-sectional, and all but two [20,31] assessed ECC at the cavitated level.

Altogether, 34 tools were used to assess ECC risk in the 16 studies. These were 12 tools using behavioural indicators, 11 tools using social indicators, and 11 tools using biological indicators. Furthermore, 11 (70.1%) of the studies used a combination of tools, four (25.0%) used only biological indicators [25,29,32,34], and one (6.2%) used only behavioural indicators [31].

Table 1 shows that the behavioural indicators were associated with ECC risk: Frequency of sugar consumption [23,28,35], long duration of breastfeeding [21,23,33], exclusive breastfeeding [24], sleeping with bottle in the mouth [21], and supervised tooth brushing [21]. On the contrary, the following behavioural indicators were not associated with ECC experience: tooth brushing frequency [21–23,26,27,33,35], night feeding [23,24,33,35], frequency of sugar consumption [20,26,33], duration and content of bottle feeding [20,23,27], use of toothpaste [19,21,22], form of breast feeding [23,28], dental service utilisation [20,26], duration of breast feeding [28,35], supervised tooth brushing [22], tooth cleaning tool [27], onset of tooth cleaning [21], tooth brushing method [27], and oral rehydration therapy [31]. The only behavioural indicator found to be protective against ECC was tooth brushing more than once a day [20].

Table 2 shows the behaviour indicators used for caries risk assessment among preschool children in Nigeria. Of the 11 studies that assessed the relation between ECC risk and behaviour, eight explored tooth brushing frequency [20–23,26,27,33,35], six explored sugar consumption [20,23,26,28,33,34], five explored breast feeding duration [21,24,28,33,35], five explored night feeding [21,22,24,32,35], four explored forms of breast feeding (exclusive, partially exclusive or non-exclusive) [21,23,24,28], three explored the use of toothpaste [20,22,23], two explored bottle feeding [24,28], dental service utilisation [20,26], two tooth cleaning tools [25,32], and supervised tooth brushing [21,22] each, and one explored tooth cleaning methods [27] and oral rehydration therapy [31].

Table 3 shows the range of social indicators used for ECC risk assessment in Nigeria. Of the 11 studies that assessed the relation between ECC risk and social factors, nine explored age [20–24,27,28,33,35], seven explored sex [22–24,27,28,33,35], four explored socioeconomic status [23,26,27,35], three explored birth rank [23,27,28], two explored residential location [22,35], and one explored maternal psychosocial factors [30], maternal decision-making abilities [30], maternal education, [30], maternal income [30], maternal employment status [30], and maternal knowledge [23], respectively.

Table 1 shows the social factors associated with ECC risk were older age [20–22,26–28], and higher socioeconomic status [26,35]. Age [23,24,33,35], sex [22,24,27,28,33,35], residential location [22,35], socioeconomic status [23,27], birth rank [23,27,28], maternal psychosocial factors [30], maternal decision-making abilities [30], maternal education, [30], maternal income [30], maternal employment status [33], and maternal age [23,24] were not associated with ECC risk. The two protective social factors were being female [23] and maternal oral health knowledge [23].

Table 4 shows the biological indicators used for ECC risk assessment in Nigeria. Of the 12 studies, five explored plaque score [23,25–27,35], three explored anthropometric variables [25,29,33], and one explored enamel defects [24], maternal caries status [30], maternal illness [21], use of medication [21], CD4 count [32], HIV exposure [32], spontaneous membrane rupture during delivery [32], *S. mutans* count [34], and *S. sobrinus* count [34].

Table 1 shows the biological indicators associated with ECC risk were plaque score [22,23,27], wasting [29], overweight [32], birth weight [21], enamel defects [29], maternal caries sta-

tus [30], HIV infected [32], low CD4 count [32], and S. *sobrinus* count [34]. Biological indicators not associated with ECC were plaque [35], stunting [32], underweight [32], wasting [32], medical illness [21], use of medication [21], and *S. mutans* count [34]. In addition, children with fair oral hygiene had lower risk for ECC [24].

Table 5 shows the outcome of the critical appraisal of the quality of studies included in the review. All the studies described the study participants and setting in detail, used objective, standardised criteria to measure ECC, and used appropriate statistical analysis to reach their conclusions. However, only 15 (93.8%) of the 16 studies included information on the eligibility criteria of the study participants, and 15 (93.8%) had information about how the exposure variables were measured validly. In addition, of the 15 epidemiological studies that needed to adjust for confounders, only three (20.0%) studies clearly defined their confounding variables and six (40.0%) identified strategies to deal with confounding variables.

Table 1. Characteristics of included studies.

s/n	Authors, Date (Location)	Study Design	Sample Size	Variable Assessed	Category of Tool	Age Range	ECC Risk Indictors	ECC Protective Indicators	Indicators Not Associated with ECC
1	Folayan et al., 2021 [20] (Ile-Ife)	Cross-sectional Population-based	1549	Cavitated and non-cavitated caries Age Tooth brushing frequency Sugar consumption frequency Use of fluoridated toothpaste Dental service utilisation in 12 months	 Social Behavioural Behavioural Behavioural Behavioural	6–71 months	dmft and dmfs highest among the 24–35-months-olds SiC score highest among the 12–23-months-olds	Tooth brushing frequency (more than once per day)	Sugar consumption frequency Use of fluoridated toothpaste Dental service utilisation in 12 months
2	Olatosi et al., 2015 [21] (Lagos)	Cross-sectional Hospital-based	302	Cavitated caries Sugar consumption Duration of breastfeeding Breastfeeding at night On demand breast feeding Duration of bottle feeding Sleep with bottle Sugarmate drinks Method of tooth cleaning Onset of tooth cleaning Frequency of tooth cleaning Tooth cleaning supervisor Birth weight of child Medical illness Use of medication Socioeconomic status Age, sex	 Behavioural Behavioural Behavioural Behavioural Behavioural Behavioural Behavioural Behavioural Behavioural Behavioural Behavioural Biological Biological Social Social Social	6–71 months	Age Duration of breastfeeding Sleep with bottle Sugarmate drinks Sugar consumption Tooth cleaning supervisor Method of tooth cleaning	NA	Breastfeeding at night On demand breast feeding Duration of bottle feeding Onset of tooth cleaning Tooth cleaning frequency Birth weight of child Medical illness Use of medication Socioeconomic status Age, sex

Table 1. *Cont.*

s/n	Authors, Date (Location)	Study Design	Sample Size	Variable Assessed	Category of Tool	Age Range	ECC Risk Indictors	ECC Protective Indicators	Indicators Not Associated with ECC
3	Adeniyi et al., 2009 [22] (Lagos)	Cross-sectional Population-based	404	Cavitated caries Age Sex Residence (Rural vs. urban) Plaque score Toothpaste (Children vs. adult) Tooth brusher (Child vs. caregiver) Tooth-brushing frequency	 Social Social Social Biological Behavioural Behavioural Behavioural	18–60 months	Age Plaque score	NA	Sex Residence (Rural vs. urban) Toothpaste (Children vs. adult) Tooth brusher (Child vs. caregiver) Tooth-brushing frequency
4	Folayan et al., 2015 [23] (Ile-Ife)	Cross-sectional Population-based	497	Cavitated caries Age, sex, birth rank Socioeconomic status Maternal age at childbirth Maternal knowledge of oral health Tooth brushing frequency Sugar consumption frequency Use of fluoridated toothpaste Night feeding Forms of breastfeeding (exclusive, almost exclusive or mixed) Plaque score	 Social Social Social Social Behavioural Behavioural Behavioural Behavioural Behavioural Biological	6–71 months	Sugar consumption frequency Plaque score	Female Maternal knowledge of oral health	Age Socioeconomic status Use of fluoridated toothpaste Birth rank Night feeding Tooth brushing frequency Forms of breastfeeding (exclusive, almost exclusive, or mixed) Maternal age at childbirth

Table 1. *Cont.*

s/n	Authors, Date (Location)	Study Design	Sample Size	Variable Assessed	Category of Tool	Age Range	ECC Risk Indictors	ECC Protective Indicators	Indicators Not Associated with ECC
5	Folayan et al., 2010 [24] (Lagos)	Cross-sectional Population-based	396	Cavitated caries Age and sex Forms of breastfeeding (exclusive, almost exclusive or mixed) Duration of breastfeeding Night feeding habits Duration and content of bottle feeding	 Social Behavioural Behavioural Behavioural Behavioural	6–71 months	Breastfeeding longer than 18 months Exclusively breastfeeding	NA	Age and sex Night feeding habits Duration and content of bottle feeding
6	Folayan et al., 2020 [25] (Ile-Ife)	Cross-sectional Population-based	1549	Cavitated caries Anthropometric variables (stunting, wasting underweight) Enamel defects	 Biological Biological	0–5 years	*0–2-year-olds* Amelogenesis imperfecta Fluorosis *3–5-year-olds* Enamel hypoplasia Amelogenesis imperfecta Fluorosis *0–5-year-olds* Enamel hypoplasia fluorosis	NA	Anthropometric variables (stunting, wasting underweight)
7	Onyejaka et al., 2015 [26] (Enugu)	Cross-sectional School-based	429	Cavitated caries Socioeconomic status Dental service utilisation Tooth brushing frequency Sugar consumption frequency Plaque score	 Social Behavioural Behavioural Behavioural Biological	3–5 years	Age High socioeconomic status	Fair oral hygiene	Dental service utilisation Tooth brushing frequency Sugar consumption frequency

Table 1. *Cont.*

s/n	Authors, Date (Location)	Study Design	Sample Size	Variable Assessed	Category of Tool	Age Range	ECC Risk Indictors	ECC Protective Indicators	Indicators Not Associated with ECC
8	Sowole et al., 2007 [27] (Lagos)	Cross-sectional Population-based	389	Cavitated caries Socioeconomic status, age, sex, birth rank Tooth cleansing methods Tooth brushing frequency Tooth cleansing tool Plaque score	 Social Behavioural Behavioural Behavioural Biological	6–71 months	Age Plaque score	NA	Socioeconomic status, sex, birth rank Tooth cleansing methods Tooth brushing frequency Tooth cleansing tool
9	Folayan et al., 2012 [28] (Ile-Ife)	Cross-sectional study Hospital-based	205	Cavitated caries Age, sex, birth rank Duration of breast and bottle feeding Forms of breastfeeding (exclusive, almost exclusive or mixed) Frequency of daily sugar consumption Duration of bottle feeding	 Social Behavioural Behavioural Behavioural Behavioural	1–16 years	Age Frequency of daily sugar consumption	NA	Sex Birth rank Duration of breast and bottle feeding Forms of breastfeeding (exclusive, almost exclusive, or mixed)
10	Olatosi et al., 2021 [29] (Lagos)	Cross-sectional School-based	273	Cavitated caries Anthropometric variables (stunting, wasting, underweight, BMI)	 Biological	1–6 years	Wasting	NA	NA

Table 1. *Cont.*

s/n	Authors, Date (Location)	Study Design	Sample Size	Variable Assessed	Category of Tool	Age Range	ECC Risk Indictors	ECC Protective Indicators	Indicators Not Associated with ECC
11	Alade et al., 2021 [30] (Ile-Ife)	Cross-sectional Population-based	1549	Cavitated caries Maternal psychosocial factors (dental anxiety, general anxiety, sense of coherence, parenting stress, fatalism, social support, depressive symptoms, and executive dysfunction), Maternal decision-making abilities Maternal education Maternal income Maternal caries status	 Social Social Social Social Biological	6–71 months	Maternal caries status	NA	Maternal psychosocial factors (dental anxiety, general anxiety, depressive symptoms, sense of coherence, fatalism, parenting stress, social support, and executive dysfunction), Maternal decision-making abilities Maternal education Maternal income
12	Folayan et al., 2023 [31] (Ile-Ife)	Cross-sectional Population-based	1564	Cavitated and non-cavitated caries Oral rehydration therapy	 Behavioural	6 month–5 year	NA	NA	Oral rehydration therapy
13	Folayan et al., 2019 [32] (Ile-Ife)	Cross-sectional Population-based	370	Cavitated caries Anthropometric variables (stunting, wasting, overweight, underweight)	 Biological	6–71 month	Overweight	Stunting Underweight	Wasting

Table 1. *Cont.*

s/n	Authors, Date (Location)	Study Design	Sample Size	Variable Assessed	Category of Tool	Age Range	ECC Risk Indictors	ECC Protective Indicators	Indicators Not Associated with ECC
14	Coker et al., 2018 [33] (Benin)	Cross-sectional Hospital-based	335	Cavitated caries Age and sex Maternal age, education and employment status CD4 count HIV exposure (HIV infected; HIV exposed but uninfected; and HIV unexposed and uninfected) Spontaneous membrane rupture during delivery Duration of breastfeeding Tooth cleaning frequency Sugar consumption Sleeping with bottle or breast	 Social Social Biological Biological Behavioural Behavioural Behavioural Behavioural	6–72 months	HIV infected Low CD4 count Older age Longer duration of breastfeeding Spontaneous membrane rupture during delivery.	NA	Sex Maternal age, education and employment status Tooth cleaning frequency Sugar consumption Sleeping with bottle or breast
15	Oluwo et al., 2021 [34] (Lagos)	Cross-sectional study Hospital-based	80	Cavitated caries *Streptococcus mutans* count *Streptococcus sobrinus* count	 Biological Biological	1–5 years	*S. sobrinus* count	NA	*S. mutans* count
16	Folayan et al., 2012 [35] (Lagos)	Cross-sectional study Population-based	369	Cavitated caries Age, sex Socioeconomic status Residential location Duration of breast feeding Night feeding practice Frequency of tooth cleaning Plaque score	 Social Social Social Behavioural Behavioural Behavioural Biological	6–71 months	Higher with higher socioeconomic status Night feeding practice	NA	Age, sex Residential location Duration of breast feeding Tooth cleaning frequency Plaque score

dmft: decay, missing, filled tooth. dmfs: decay, missing, filled surface; SiC: significant Index of Caries.

Table 2. Behavioural indicators used for early childhood caries risk assessment among preschool children in Nigeria.

s/n	Authors, Date (Location)	Use of Toothpaste	Supervised Tooth Brushing	Tooth Cleaning Method	Tooth Cleaning Tools	Tooth Brushing Frequency	Oral Rehydration Therapy	Sugar Consumption	Breast Feeding Duration	Forms of Breast Feeding	Night Feeding	Bottle Feeding	Dental Service Utilisation
1	Folayan et al., 2021 [20]	X	-	-	-	X	-	X	-	-	-	-	X
2	Olatosi et al., 2015 [21]	-	X	-	X	X	-	X	X	X	X	-	-
3	Adeniyi et al., 2009 [22]	X	X	-	-	X	-	-	-	-	-	-	-
4	Folayan et al., 2015 [23]	X	-	-	-	X	-	X	-	X	X	-	-
5	Folayan et al., 2010 [24]	-	-	-	-	-	-	-	X	X	X	X	-
6	Onyejaka et al., 2015 [26]	-	-	-	-	X	-	X	-	-	-	-	X
7	Sowole et al., 2007 [27]	-	-	X	X	X	-	-	-	-	-	-	-
8	Folayan et al., 2012 [28]	-	-	-	-	-	-	X	X	X	-	X	-
9	Folayan et al., 2023 [31]	-	-	-	-	-	X	-	-	-	-	-	-
10	Coker et al., 2018 [33]	-	-	-	-	X	-	X	X	-	X	-	-
11	Folayan et al., 2012 [35]	-	-	-	-	X	-	-	X	-	X	-	-

Table 3. Social indicators used for ECC risk assessment among preschool children in Nigeria.

s/n	Authors, Date (Location)	Age	Sex	Residential Location	Socioeconomic Status	Birth Rank	Maternal Knowledge of Oral Health	Maternal Psychosocial Factors	Maternal Decision Making	Maternal Education	Maternal Income	Maternal Employment Status
1	Folayan et al., 2021 [20]	X	-	-	-	-	-	-	-	-	-	-
2	Olatosi et al., 2015 [21]	X	-	-	-	-	-	-	-	-	-	-
3	Adeniyi et al., 2009 [22]	X	X	X	-	-	-	-	-	-	-	-
4	Folayan et al., 2015 [23]	X	X	-	X	X	X	-	-	-	-	-
5	Folayan et al., 2010 [24]	X	X	-	-	-	-	-	-	-	-	-
6	Onyejaka et al., 2015 [26]	-	-	-	X	-	-	-	-	-	-	-
7	Sowole et al., 2007 [27]	X	X	-	X	X	-	-	-	-	-	-
8	Folayan et al., 2012 [28]	X	X	-	-	X	-	-	-	-	-	-
9	Folayan et al., 2023 [31]	-	-	-	-	-	-	X	X	X	X	-
10	Coker et al., 2018 [33]	X	X	-	-	-	-	-	-	X	-	X
11	Folayan et al., 2012 [35]	X	X	X	X	-	-	-	-	-	-	-

Table 4. Biological indicators used for ECC risk assessment among preschool children in Nigeria.

s/n	Authors, Date (Location)	Plaque Score	Anthropometry	Enamel Defect	Maternal Caries Status	Medical Illness	Use of Medication	CD4 Count	*S. mutans* Count	*S. sobrinus* Count	HIV Exposure	Spontaneous Membrane Rupture during Delivery
1	Olatosi et al., 2015 [21]	-	-	-	-	X	X	-	-	-	-	-
2	Adeniyi et al., 2009 [22]	X	-	-	-	-	-	-	-	-	-	-
3	Folayan et al., 2015 [23]	X	-	-	-	-	-	-	-	-	-	-
4	Folayan et al., 2020 [25]	-	X	X	-	-	-	-	-	-	-	-
5	Onyejaka et al., 2015 [26]	X	-	-	-	-	-	-	-	-	-	-
6	Sowole et al., 2007 [27]	X	-	-	-	-	-	-	-	-	-	-
7	Olatosi et al., 2021 [29]	-	X	-	-	-	-	-	-	-	-	-
8	Alade et al., 2021 [30]	-	-	-	X	-	-	-	-	-	-	-
9	Folayan et al., 2019 [32]	-	X	-	-	-	-	-	-	-	-	-
10	Coker et al., 2018 [33]	-	-	-	-	-	-	X	-	-	X	X
11	Oluwo et al., 2021 [34]	-	-	-	-	-	-	-	X	X	-	-
12	Folayan et al., 2012 [35]	X	-	-	-	-	-	-	-	-	-	-

Table 5. Critical appraisal of included studies.

s/n	Authors, Date	Were the Criteria for Inclusion in the Sample Clearly Defined?	Were the Study Participants and the Setting Described in Detail?	Was the Exposure Measured in a Valid and Reliable Way?	Were Objective, Standard Criteria Used for Measurement of the Condition?	Were Confounding Factors Identified?	Were Strategies to Deal with Confounding Factors Stated?	Were the Outcomes Measured in a Valid and Reliable Way?	Was Appropriate Statistical Analysis Used?
1	Folayan et al., 2021 [20]	Yes	Yes	Yes	Yes	Unclear	No	Yes	Yes
2	Olatosi et al., 2015 [21]	No	Yes	No	Yes	No	No	Yes	Yes
3	Adeniyi et al., 2009 [22]	Yes	Yes	Yes	Yes	No	No	Yes	Yes
4	Folayan et al., 2015 [23]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
5	Folayan et al., 2010 [24]	No	Yes	Yes	No	No	No	Yes	Yes
6	Folayan et al., 2020 [25]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Onyejaka et al., 2015 [26]	Yes	Yes	Yes	Yes	No	No	Yes	Yes
8	Sowole et al., 2007 [27]	No	Yes	Yes	Yes	No	No	Yes	Yes
9	Folayan et al., 2012 [28]	Yes	Yes	Yes	Yes	No	No	Yes	Yes
10	Olatosi et al., 2021 [29]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11	Alade et al., 2021 [30]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12	Folayan et al., 2023 [31]	Yes	Yes	Yes	Yes	No	No	Yes	Yes
13	Folayan et al., 2019 [32]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
14	Coker et al., 2018 [33]	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
15	Oluwo et al., 2021 [34]	Yes	Yes	Yes	Yes	Not applicable	Not applicable	Yes	Yes
16	Folayan et al., 2012 [35]	Yes	Yes	Yes	Yes	No	No	Yes	Yes

4. Discussion

This scoping review reveals that the assessment of ECC risk was only carried out in two of the six geopolitical zones in Nigeria. These assessments were conducted using cross-sectional studies that were mainly population-based. Various indictors were utilised to assess ECC risk, including behavioural indicators such as snacking habits, frequency of refined carbohydrate consumption between meals, dental service utilisation, tooth brushing frequency, use of fluoridated toothpaste, breastfeeding and bottle-feeding patterns, and duration. Additionally, biological indicators like birth rank, age, sex, dental defects, anthropometric measures, molecular characterisation of isolated organisms, and plaque accumulation were used. Social indicators such as the child's socioeconomic status, mother's education level, maternal income, father's occupation, and maternal decision-making ability were also used, either individually or in combination.

This scoping review showed that there was no consensus on behavioural indicators that were associated with an increased risk of ECC, except brushing more than once a day, which was identified as a protective indictor. Similarly, dental services utilisation was not associated with the risk of ECC in the two studies that included it as a risk indicator. Moreover, no consensus was reached on the social indictors that were risks for ECC, while being female and having maternal knowledge of oral health were found to be protective indicators. On the other hand, biological indicators like HIV exposure, low CD4 count, high *S. sobrinus* count, and enamel defects were identified as risk indicators for ECC. The association between malnutrition, oral hygiene, and ECC risk was not clearly established across most studies. Furthermore, most of the studies lacked clear definitions of their confounding factors, and did not propose strategies to address potential confounding factors, compromising the robustness of the analysis.

One strength of this study is that it highlights a critical gap in ECC management in Nigeria. Despite having a low prevalence of ECC in Nigeria [37,38], the burden of untreated caries remains high [39], especially considering the large population of infants, toddlers, and preschool children in the country [40]. Therefore, there is an urgent need for an effective CRA tool that can be utilised by adjunct dental staff to prevent and diagnose ECC. Countries like Canada [9], the UK [41], India [42], and others [43,44] are promoting the use of context-specific CRA tools by laypersons to ensure early access to oral examinations by the age of one. Early intervention for ECC management is crucial, as the risk significantly increases by the age of 2 and becomes even higher in the 3–5-year age group [38]. This study also highlighted that the risk of ECC increases with age in Nigeria, emphasizing the need for the development of an appropriate CRA tool for the country.

The data generated in Nigeria regarding the indicators associated with ECC contribute to ongoing debates in the public sphere. Like findings from other studies, it was observed that prolonged breastfeeding combined with poor oral hygiene practices can increase the risk of ECC [23,39]. Conversely, effective plaque control disrupts the bacterial biofilm, reduces substrate availability for cariogenic bacteria, minimises acid production, and lowers the risk of ECC [11,22]. An effective CRA tool will consider factors such as diet, fluoride exposure, salivary flow, previous caries experience, and the presence of cariogenic bacteria [11]. However, in Nigeria, there is limited information on the association between fluoride exposure and the risk of ECC, as well as limited information on cariogenic bacteria that are risk indicators for ECC. There are also no studies on the association between ECC and salivary flow. In addition, the evidence for the link between ECC and the frequency of daily sugar consumption is contradictory. While the two studies that showed links between maternal knowledge of oral health, maternal caries status, dental defects, and the risk of ECC are supported by existing evidence [45–47], the non-significant association between *S. mutans* count and ECC is contentious, as prior studies had shown this link [48]. Also contentious is the finding that fair oral hygiene is protective against ECC. These are some of the reasons why robust evidence is needed to objectively identify ECC risk and protective factors in Nigeria.

The development of a CRA tool for Nigeria requires a strong foundation of research-based evidence, like the process followed in the development of the Canadian CRA [9,49]. However, at present, the country-specific evidence needed to support the development of a CRA is limited. The robustness of the studies conducted have been majorly limited by the studies not defining their confounders nor identifying strategies to adjust their study findings for the effect of confounders. It is crucial to strategically address this data analysis gap and facilitate the conduct of research that provides high-quality evidence to support the development of a cost-effective and easy to use CRA tool. Such research should explore the use of digital risk assessment tools and artificial intelligence-based models and algorithms [50,51].

The development of a national CRA for ECC screening should be based on shifting the task of screening for ECC to community healthcare workers working based on the national task shifting and task sharing policy for essential healthcare services in Nigeria [52]; and the need to promote minimum intervention dentistry based on the draft National Policy on Mercury phase down. The successful application of the minimum intervention dentistry strategy to manage ECC relies heavily on caries risk assessment [53–55]. It also contributes to achieving the sustainable development goals (SDG 3) [56].

5. Conclusions

This scoping review demonstrated that ECC risk assessment in Nigeria has been limited to only two regions in the country and assessment has relied on the use of behavioural, biological, and social indicators. No standardised CRA tool was used in any of the studies. In addition, consensus is lacking on the factors that are associated with risk for ECC, though suggestive protective behaviours and social indicators were identified. Additionally, the associations of the frequency of sugar consumption, duration of breastfeeding, forms of breastfeeding, night feeding, malnutrition, and oral hygiene with the risk of ECC were inconclusive. There is the need for studies using more comprehensive, and standardised tools with nationally representative samples and proper consideration of confounding factors to enhance the understanding of risk factors for ECC and improve its preventive strategies.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Search strategy

The search strategy for PubMed, which was altered appropriately using specific terms for the other databases, is as follows:

1. Medline (PUBMED) (940 results)

• #1- (Dental Cavity[Title/Abstract) OR (Dental Decay[Title/Abstract)) OR (Dental Cavities[Title/Abstract)) OR (Cavities, Dental[Title/Abstract)) OR (Cavity, Dental[Title/Abstract)) OR (Carious Lesions[Title/Abstract)) OR (Carious Lesion[Title/Abstract)) OR (Lesion, Carious[Title/Abstract)) OR (Lesions, Carious[Title/Abstract)) OR (Decay, Dental[Title/Abstract)) OR (Carious Dentin[Title/Abstract)) OR (Carious Dentins[Title/Abstract)) OR (Dentin, Carious[Title/Abstract)) OR (Dentins, Carious[Title/Abstract)) OR (Dental White Spot[Title/Abstract)) OR (Spot, Dental White[Title/Abstract)) OR (Spots, Dental White[Title/Abstract)) OR (White Spot, Dental[Title/Abstract)) OR (White Spots, Dental[Title/Abstract)) OR (Dental White Spots[Title/Abstract)

• #2- (risk assess[Title/Abstract] OR risk assessed[Title/Abstract] OR risk assessment[Title/Abstract] OR risk assessing[Title/Abstract] OR risk, assessment[Title/Abstract] OR risk, assessments[Title/Abstract] OR risk, assessments[Title/Abstract] OR risk assessor[Title/Abstract] OR risk assessors[Title/Abstract] OR risk management[Title/Abstract] OR risk managing[Title/Abstract)

• #3- (children[Title/Abstract] OR preschool children[Title/Abstract)

• #4- (Nigeria [Title/Abstract] OR Federal republic of Nigeria[Title/Abstract)

#1 AND #2 AND #3 NOT #4 --- (n = 1040)

2. Cochrane Library (n = 10)

ID Search
#1 caries
#2 carious lesion
#3 dental caries
#4 dental cavities
#5 carious lesions
#6 dental cavity
#7 dental decay
#8 risk
#9 risk assessment
#10 tool
#11 indices
#12 methods
#13 children
#14 Early childhood
#15 Nigeria
#16 #1OR#2OR3OR#4OR#5OR#5OR#6OR#7
#17 #8OR#9
#18 #10OR#11OR#12
#19 #13OR#14
#20 #15AND#16AND#17AND#18AND#19 (n = 10)

3. African Journals Online (AJOL) (n = 74)

Search term: Risk assessment tool for early childhood caries in Nigeria

4. Grey Literature (n = 2)

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