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Prevalence and associated factors of dental caries among primary school children in Ethiopia: A systematic review and meta-analysis.

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Abstract

Background: Dental caries affect all age groups globally; particularly primary school children are affected to a greater magnitude; accounts for 60%-90%. Despite many fragmented studies reported so far in Ethiopia, a study representing the national level of dental caries is lacking and their reports for evidence-based interventions were contradictory and inconclusive for policymakers. Therefore, the aim of this systematic review and meta-analysis was to estimate the overall prevalence of dental caries and its associated factors in Ethiopia among primary school children.
Methods: This review was reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocol (PRISMA-P) guideline. We systematically searched the he international reputable databases (i.e., PubMed/MEDLINE, CINAHL, EMBASE, Google Scholar, and Science Direct) to identify potentially relevant studies. To analyze the data, STATATM Version 14.1 was used. The findings were described in a forest plot using descriptive summaries. To determine heterogeneity and reporting bias, the Cochrane Q and I2 test, and Egger 's test were used respectively. Pooled prevalence and pooled odd ratios were estimated with confidence intervals of 95%. Finally, a random effects meta-analysis model was calculated to estimate the pooled prevalence of dental caries.
Results: From 11 studies with a total of 5179 participants, the overall pooled estimation of the prevalence of dental caries among children in Ethiopia was found to be 41.77% (95% CI: 33.41, 50.13%). Children under 10 years of age (OR: 3.75; 95% CI: 1.16, 16.19), Consumption of tea and coffee with sugar (OR: 2.29; 95%CI: 1.61, 3.26), consumption of sweet foods (OR: 2.96; 95% CI: 2.09, 4.19) consumption of soft drinks (OR:2.27; 95% CI: 1.55, 3.32) and Children who haven't cleaned their teeth (OR: 2.6; 95% CI: 3.22, 5.79) had increased odds of dental caries.
Conclusion: The prevalence of dental caries among children was comparatively high in Ethiopia and considered to be a public health problem. The associated factors of dental caries were found to be age of children, consumption of sugared foods, consumption of sweet foods, consumption of soft drinks and not cleaning teeth. Preventive measures, such as health education on oral hygiene, eating practices and the importance of dental visits, are therefore essential to prevent and control dental caries. Early diagnosis and treatment will also prevent further damage.

Keywords: Prevalence, Associated factors, Dental caries, Children, Ethiopia.

Introduction

In particular in childhood age, dental caries are the most serious and persistent oral health conditions in the world; it affects about 60-90% [1,2]. Dental caries, which are a progressive infectious process with a multifactorial etiology, are the most prevalent oral health problem [3]. Dental caries are currently on the rise to become a major health concern around the world , with an estimated 2.4 billion adults suffering from permanent teeth caries and around 486 million children suffering from primary teeth caries [4].

Although dental caries is not life-threatening, it has detrimental consequences on children's quality of life by inflicting tooth pain, premature tooth loss, eating impairment and finally influences overall growth and development of the children. Furthermore, dental caries has effects on children's concentration in school, and has a high financial burden on the families [5]. Dietary habits, oral microorganisms that ferment sugars, and host susceptibility have to coexist for dental caries to initiate and develop [6]. Dental caries is caused by dental plaque deposits on the tooth surface [7]. After intake of fermentable carbohydrates, Streptococcus mutans undergo fermentation and produce copious amount of acid and lowers the local pH to a level where the minerals of enamel and dentine dissolve. According to the report of different study, risk factors such as gender, age, dietary habits, socioeconomic and oral hygiene status are associated with an increased prevalence and incidence of dental caries in children. Likewise, the frequent intake of sweets, dry mouth, and poor tooth-brushing habits, and low level of awareness about dental caries is some of the factors that increased the levels of dental decay.

On the contrary, frequent tooth brushing was a lower chance of having decayed tooth.

According to WHO guidelines the prevention and control approaches range from changing personal behavior to working with families and caregivers to public health solutions such as building health policies, creating supportive environments and health promotion and orientation of health services towards universal health coverage. Fortunately, it is preventable, with almost all risk factors modifiable, in many countries, access to dental care is not equitable, leaving poor children and families underserved.

The prevalence of dental caries among pre-school children of developed nations has been declining over the past few decades. However, the burden of dental caries is increasing rapidly in low and middle-income nations, and, is particularly severe among children living in deprived communities [6].

Numerous studies have revealed that the prevalence of dental caries was reported as 43.6% in Thailand, 70.4% in china, 63.4% in India, and 73% in Eastern Saudi Arabia. The prevalence of dental caries in Africa was reported to be varied from 12.6% to 24.1% in Nigeria, 43.3% in Kenya, and 30.5% in Sudan. A study done in Ethiopia indicated that dental caries was 21.8% in Bahir Dar, 47.4% in Addis Ababa, 36.3% in Gondar Town, and 48.5% in Finote Selam [8].

Although, the trend is not clear in developing countries, the burden of dental caries has been increasing among children due to the unlimited consumption of sugary substances, poor oral care practices and inadequate health service utilization. To improve dental care by implementing different effective interventions, comprehensive nationwide evidence is vital. In Ethiopia, despite many fragmented studies that have been reported so far, a study representing the national and regional level of dental caries is lacking and their reports were inconsistent and inconclusive across the country for policymakers for evidence-based interventions. As far as our knowledge, no pooled prevalence studies on a nationally representative population have been carried out on the dental caries of children. Herein, the reasons mentioned above triggered us to conduct this comprehensive review to summarize the available evidence on the pooled prevalence of dental caries and its associated factors in Ethiopia. Thus, this systematic review and meta-analysis were aimed to estimate the pooled prevalence of dental caries and its associated factors among children in Ethiopia. The results obtained from this review will help public health decision makers, ministry of health, nongovernmental organizations and other stake holders to design evidence-based public health responses [4].

Materials and Methods

Study design and setting

In order to assess the prevalence of dental caries and associated factors among primary school children in Ethiopia, this systematic review and meta-analysis was carried out. Ethiopia is located in the horn of Africa. It is bounded by Eritrea to the North, Djibouti, and Somalia to the East, Sudan and South Sudan to the West, and Kenya to the South [8].

Data source and searches

This systemic review was prepared in accordance with the PRISMA (Preferred Reporting Iems for Systematic review and Meta-Analysis) guidelines. In this review, to find potentially relevant articles we searched major databases (i.e. PubMed/MEDLINE, Web of Science, EMBASE, CINAHL, Google Scholar, Science Direct and Cochrane Library) without limit to the date of publication. Gray literature and official websites of international and local organizations and universities have also been searched. In addition, the reference lists of eligible studies were reviewed for more articles using the snowball approach. The search was performed independently by two authors (YMA and FA). In order to download, organize, review and cite the articles, EndNote (version X7) reference management software was used. This review included all papers published in peer-reviewed journals that were written in English, provided that the findings of systematic analyses and meta-analysis were not affected by any language restrictions. The search was carried out using Medical Subject Headings (MeSH) terms and keywords, and Boolean operators from the above-mentioned electronic databases. The specific searching detail in PubMed the following keywords were used: "dental"[All Fields] OR "teeth"[All Fields] AND "caries"[All Fields] OR "cavities"[All Fields] AND "children"[All Fields] OR "childhood"[All Fields] AND "prevalence"[All Fields] OR "proportion"[All Fields] OR "epidemiology"[All Fields] OR "magnitude"[All Fields] AND "factors"[All Fields] OR "associated factors"[All Fields] OR "risk factors"[All Fields] OR "determinants"[All Fields] OR "predictors"[All Fields] AND "Ethiopia"[All Fields]. The literature search was carried out from July 1 to September 1, 2020. All articles published up to September 1, 2020 have been considered.

Inclusion criteria

Design: All observational study that contain original data reporting the prevalence of dental caries and associated factors among children Ethiopia were considered.

Study setting: Only studies conducted in Ethiopia.

Population: Primary school children.

Publication status: All published and unpublished articles.

Language: articles written in English.

Publication date: All studies those were published from 2012 to 2020 and unpublished study from the national university repositories were retrieved to assess for the eligibility of inclusion in this review and critical appraisal.

Exclusion criteria

Papers not fully accessed after at least two email contacts of the principal investigator were excluded. The reason for the

exclusion of these articles is that we were unable to assess the quality of each article in the absence of their full texts. Moreover, studies which did not report our outcome of interest were excluded after reviewing their full texts.

Outcome of interests

Primary outcome was the pooled prevalence of dental caries among Ethiopian children. Secondary outcome was the associated factors of dental caries among Ethiopian children.

Data extraction and quality assessment

Data were extracted using a standardized data extraction spreadsheet format in Microsoft Excel. Data were extracted in Microsoft Excel and then exported to STATA version 14 for further analysis. The data abstraction format includes author/s name, year of publication, study region, study design, sample size, the prevalence of dental caries. The data were extracted by two independent authors (YMA and FA). Joanna Briggs Institute (JBI's) critical appraisal checklist for prevalence studies was used to assess the quality of included studies. Additionally, a modified version of the Newcastle-Ottawa Scale (NOS) was used to assess the methodological quality of studies for cross-sectional studies. Newcastle-Ottawa scale criteria include representativeness of the sample, response rate, measurement tool used, comparability of the subject, appropriateness of the statistical test used to analyze the data. Based on the Newcastle-Ottawa scale criteria, two authors independently assessed the quality of each article. Any discrepancy was resolved by discussion and agreement.

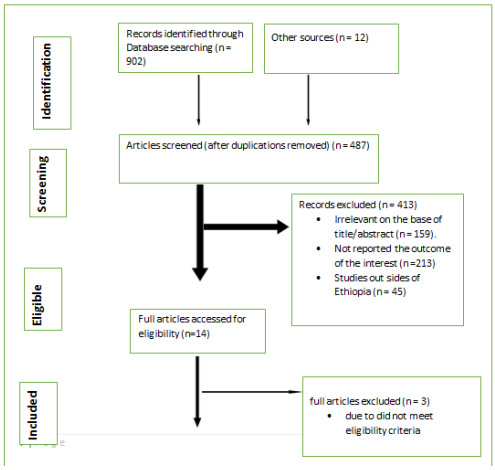
Publication bias, and statistical analysis

For farther analysis, we imported the data to STATA version 14 statistical software after extracting the data using Microsoft Excel format. We identify the heterogeneity between the studies using Cochrane's Q statistics (Chi-square), inverse variance (I2) and p-values. I2 test statistics were used to investigate the heterogeneity across the included studies. The I2 test statistics of 25, 50 and 75% was declared as low, moderate and high heterogeneity respectively and a p-value less than 0.05 was used to declare significant heterogeneity [5]. As the test statistic showed there is significant heterogeneity among the studies as a result a random-effects meta-analysis model was used to estimate the DerSimonian and Laird's pooled effect. In the current meta-analysis, arcsine-transformed proportions were used. The pooled proportion was estimated by using the back-transform of the weighted mean of the transformed proportions, using arcsine variance weights for the fixed-effects model and DerSimonian-Laird weights for the random-effects model. Egger's and Begg's tests, with the p-value, less than 5% was used to declare the presence of publication bias. Forest plot was used to present the combined estimate with 95% Confidence Interval (CI) of the meta-analysis. In this plot, the size of each box indicated the weight of the study, while each crossed line refers to a 95% confidence interval. Subgroup analysis was conducted by regions, sample size and publication year. Besides, a meta-regression model was done based on sample size and year of publication to identify the sources of random variations among included studies. Furthermore, sensitivity analysis using a random effects model was performed to assess the influence of a single study on the overall pooled estimate. At last, results were presented in tables and forest plots. For the second outcome, the effect of selected associated factors was presented using forest plot and Odds Ratio (OR) with its 95% CI.

Results

Search results and study selection

From the online search, there 914 results were identified. Then, after removing duplicates using EndNote 7, studies were screened by title and abstract. Finally, 14 entire texts were accessed and downloaded for review using our eligibility criteria. From these 14 complete texts, three articles were excluded; the reasons for excluding the articles were defined (Figure 1).



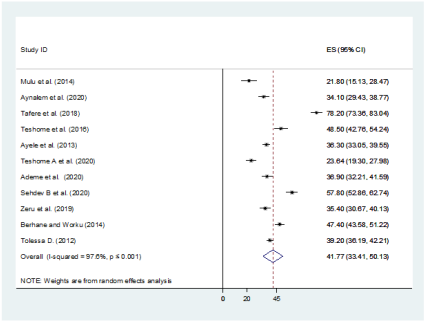


Figure 1. *PRISMA flow diagram which shows the selection of included studies for dental caries among primary school children in Ethiopia, 2020.*

Characteristics of original articles

As presented in Table 1, 11 studies meet the requirements for inclusion criteria. All included papers were cross-sectional and consist with a total of 5179 participants. All included studies were published between January 2012 and November 2020. All studies (100%) were cross-sectional with respect to study design. The smallest (n=147) and largest (n=1013) sample

sizes were reported from studies done in Bahir Dar (Amhara Region) and Addis Ababa. Likewise, the lowest (21.8%) and the highest (78.2%) prevalence of dental caries was reported from Amhara Region [6]. Geographically, six studies were undertaken from Amhara Region two from Tigray Region, two from Addis Ababa and one from Harar Region. However, we did get studies from Benishangul Gumuz Region, Dire-Dawa City Administration, Oromia Region, Southern Region, Afar Region, Ethio-Somali Region, and Gambella Region. This showed that most of the studies were conducted in the Amhara region. The quality score of the included studies ranged from seven to nine. All studies with a quality score of ≥ seven were considered as high quality. Finally, all 11 included articles were categorized as high-quality studies.

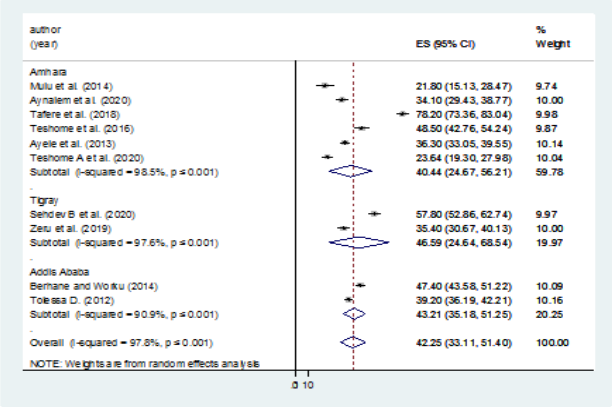


Figure 2. *Random effect estimate of dental caries among children in Ethiopia.*

Table 1. *Descriptive summary of 11 included studies in the systematic review and meta-analysis of dental caries among primary school children in Ethiopia, 2020.*

Year	Study area	Study design	Sample size	Prevalence with 95% CI	Quality score (10 pts)
2014	Bahir Dar	Cross-sectional	147	21.800 (15.125, 28.475)	7
2020	Debre Berhan	Cross-sectional	396	34.100 (29.431, 38.769)	8
2018	Debre Tabor	Cross-sectional	280	78.200 (73.364, 83.036)	7
2016	Finote Selam	Cross-sectional	291	48.500 (42.758, 54.242)	7
2013	Gondar town	Cross-sectional	842	36.300 (33.052, 39.548)	9
2020	Gondar town	Cross-sectional	368	23.640 (19.299, 27.981)	8
2020	Harar town	Cross-sectional	407	36.900 (32.212, 41.588)	7
2020	Mekelle	Cross-sectional	384	57.800 (52.860, 62.740)	7
2019	Axum	Cross-sectional	393	35.400 (30.672, 40.128)	8
2014	Addis Ababa	Cross-sectional	658	47.400 (43.585, 51.215)	9
2012	Addis Ababa	Cross-sectional	1013	39.200 (36.194, 42.206)	9

Pooled prevalence of dental caries among children in Ethiopia

As is shown in the forest plot, Figure 2, it was found that the overall random effect estimate of dental caries among children in Ethiopia was 41.77% (95% CI: 33.41, 50.13%). However, from the analysis, this observed effect size differs considerably and the results show a high heterogeneity in test statistics (I^2=97.6%; p ≤ 0.001). Thus, Random effect analysis was carried out by considering this fact.

Regional subgroup analyses revealed that the highest (46.59%, 95 % CI: 24.64, 68.54%) proportion of dental caries was found in Tigray Region; followed by Addis Ababa (43.21%, 95% CI: 35.18, 51.51.25%), and Amhara Region (40.44%, 95% CI: 24.67, 56.21%) (Figure 3).

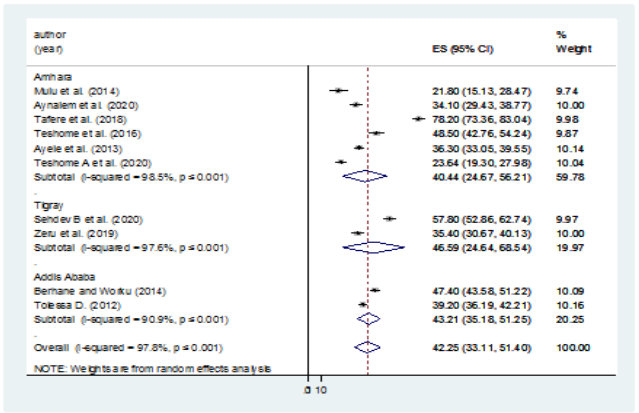


Figure 3. *Subgroup level of dental caries by region among primary school children in Ethiopia, 2020.*

Publication bias and meta regression

Using multiple statistical methods, we investigated potential causes of heterogeneity. Using publication year, sample size and regions as covariates, univariate meta-regression was carried out. None of these factors, however, is statistically significant in clarifying heterogeneity.

As this analysis had a substantial variability, the presence of publishing bias was tested by funnel plot and statistical tests by Eggers and Beggs at a 5% significant level. The funnel plot showed asymmetrical distribution as subjectively described. However, the Beggs'(p=0.640) and Egger (p=0.756) tests showed no significant publication bias; therefore, publication bias is not a problem in this study.

To identify causes of heterogeneity, univariate and categorical meta-regression analysis was carried out in addition to subgroup analysis and publication bias. For each study, sample size, publication year and study regions were considered in the meta-regression analysis. The analysis indicated that heterogeneity was not explained by sample size (p=0.207), publication year (p=0.374) and region. This showed that there was no statistical significance value from the meta-regression analysis.

Sensitivity analysis

A sensitivity analysis was conducted to detect the influence of one study on the overall meta-analysis. However, sensitivity analysis did not show strong evidence on the effect of a single study on the final outcome.

Associated factors of dental caries among primary school children in Ethiopia

Age, consumption of sugared foods, consumption of sweet foods, consumption of soft drinks and not cleaning teeth were found as the factors of dental caries among primary school children in Ethiopia. As shown in Figure 3, the age of children shows strong association with developing the dental caries. Children who were less than ten years old were 3.75 times more likely to develop dental caries than children who were ten and above years old (OR: 3.75; 95% CI: 1.16, 16.19). Likewise, children who consumed sugared tea and coffee were 2.29 times more likely to develop dental caries than their counterparts. On the other hand, children who consumed sweet foods were 2.96 folds (OR: 2.96; 95% CI: 2.09, 4.19) to develop dental caries than those who does no ate sweet foods. Moreover, children who consumed soft drinks were 2.27 times more likely (OR:2.27; 95% CI: 1.55, 3.32) to develop dental caries than those who do not drank sweet drinks. Finally, children who did not clean their teeth were 4.32 times more likely to have dental caries than those who cleaned (OR: 2.6; 95% CI: 3.22, 5.79).

Discussion

The purpose of this systematic review and meta-analysis was to assess the pooled prevalence of dental caries and its associated factors among primary school children in Ethiopia. In this meta-analysis we extensively analyzed the studies reported the prevalence of dental caries and associated factors in Ethiopia. To our knowledge, this systematic review and meta-analysis is the first of its kind to estimate the pooled prevalence of dental caries and its associated factors among children in Ethiopia. The prevalence of dental caries among children in Ethiopia is currently rising, ranging from 21% to 58% across the country. Overall pooled estimate from 11 studies for the prevalence of dental caries among children in Ethiopia was found to be 41.77 % (95% CI: 33.41, 50.13%). According to this study, the prevalence of dental caries among children is higher than studies done in Tanzania (17.6%), Nigeria (35.5%), Sudan (30.3%). The possible reason for the inconsistencies can be due to cultural, geographical, socioeconomic differences. The methodological differences, residency and educational status may be another potential reason for the disparity. However, the prevalence of dental caries among children in this report is lower than that of studies done in Nepal (52%), India (77%), Saudi Arabia (83%). The difference could be due to difference in Knowledge, Attitude and Practices (KAPs) on oral hygiene practice.

In this study, age of children, consumption of sugared foods, consumption of sweet foods, consumption of soft drinks and not cleaning teeth were found as the factors of dental caries among primary school children in Ethiopia.

Dental caries is associated with the age of the children. In this research, it was found that children under 10 years of age are more affected by dental caries than those children above 10 years of age. As the age of the children grows, this could be because the children may be more concerned with his or her oral hygiene. This finding was also supported by similar findings. This may also be explained by the so-called 'infectivity window,' which is characterized as the time between the ages of 16 and 32 months during which children are infected with Streptococcus mutans, although some studies suggest that infection can occur at a younger age, even before the age of 14 months.

Moreover, habit of consumption of sweet foods has significantly associated on the prevalence of dental caries (OR: 2.96; 95% CI: 2.09, 4.19). This is in agreement with studies conducted in Saudi Arabia and Kenya [6]. This may be associated with the abundant production of acid by cariogenic bacteria such as Streptococcus mutans, which are adherent to the teeth as a result of sweet food fermentation. The enamel of the tooth was later introduced into tooth decay.

Based on the current study, dental caries has been significantly associated with poor tooth cleaning habits. A lower prevalence of dental caries was revealed by children who had cleaned their teeth. Generally, it is true that cleaning teeth can remove the oral food debris. Streptococcus mutans can also not get enough nutrients and time for growth and no production of acid that triggers the formation of dental caries.

According to this report, children consuming tea and coffee with sugar were 2.29 times more likely than children consuming tea and coffee without sugar to develop dental caries. This result was supported by other studies. This variation may be attributed to the diverse drinking habits of sugared tea in different areas and most participants did not clean their teeth after drinking sugared tea. Similarly, sugar beverage use may be attributed to the increasing prevalence of problems of oral health. The process for the degradation of teeth due to sugar consumption has been well established; the sugar diet continues to bind to the tooth surface, making it easy for the bacteria to bind. Glucose, fructose, and most often sucrose (table sugar) is then converted by the bacteria into acids. These acids induce the demineralization of the hard tissues of the teeth if left in contact with the tooth.

Conclusion

The prevalence of dental caries was comparatively high among children in Ethiopia and considered to be a public health problem. The associated factors of dental caries were found to be age of children, consumption of sugared foods, consumption of sweet foods, consumption of soft drinks and not cleaning teeth. Preventive measures, such as health education on oral hygiene, eating practices and the importance of dental clinic visits, are therefore essential to prevent and control dental caries. Early diagnosis and treatment will also prevent further damage.

Limitations of the Study

The findings of this systematic review and meta-analysis had limitations: Firstly, a cross-sectional study design was used in all studies of this meta-analysis. Therefore, cause-effect relationships cannot be established in this study. Secondly, studies from the Oromia Region, the Southern Region, the Benishangul Gumuz Region, the Ethio-Somali Region, the Afar Region and the Gambella Region could not be obtained and this has an influence on generalizability.

Conflict of Interest

We have confirmed that we have no competing interests.

Funding

No funding was obtained for this study.

Authors' Contributions

YMA and FA: Developed the study design and protocol, literature review, selection of studies, quality assessment, data extraction, statistical analysis, interpretation of the data and developing drafts of the manuscript. Both authors approved the final manuscript.

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