A Meta-Analysis And Systematic Review Evaluating Cavities And Their Incidence In Indian Permanent Teeth

Nikhil Ajabrao Bomble[1], Sudarshan Pargaonkar[2], Shambhavi Shrivastav[3], Arjun Singh[4], Shivani Donde[5], Ranjeet D. Kavitake[6]

[1]Professor & Head, Department of Public Health Dentistry, YCMM and RDF's Dental College and Hospital Ahilyanagar
[2] Reader, Department of Pedodontics and Preventive Dentistry, YCMM and RDF's Dental College and Hospital Ahilyanagar
[3]Post Graduate Student, Department of Public Health Dentistry, Institute of Dental Sciences, Bareilly
[4]Senior Lecturer, Department of Public Health Dentistry, Institute of Dental Sciences, Bareilly
[5]Post Graduate Student, Department of Oral Medicine and Radiology, DY Patil Dental College and Hospital, Pimpuri, Pune
[6]Post Graduate Student, Department of Public Health Dentistry, Vyas Dental College and Hospital, Jodhpur

KEYWORDS: Dental caries, DMFT, India, prevalence

Abstract

Objectives: To use a systematic review and meta-analysis to assess the combined prevalence of dental caries in the Indian population.

Methodology: To find information about dental caries in the Indian population, a keyword search was done using pertinent keywords in the PubMed, Science Direct, Google Scholar, Cochrane, and Scopus databases. Standard Boolean operators were used in the search criteria, which included English-language manuscripts published between March 2015 and March 2025. Two researchers independently reviewed the studies that satisfied the inclusion criteria, and the Newcastle–Ottawa Scale was used to evaluate their quality.

Results:
Seventy of the 253 articles that were found after screening satisfied the inclusion criteria and were used to create the meta-analysis. The overall dental caries prevalence was 54.16% (CI: 0.4966–0.5866), whereas the age-specific prevalence was 52% among individuals aged 3–18 and 62% among those aged over 18 ($P < 0.0001$).

Conclusions: In addition to an average prevalence of 54.16%, dental caries prevalence rates vary significantly by age, dentition, geographic location, and diagnostic parameters.

Introduction

Dental caries, also known as cavities, are a common problem in children. The age-standardized prevalence worldwide of untreated caries is approximately 8% in deciduous teeth and 29% in permanent teeth. Notable regional variations exist, such as in India and among South Asians, with significant implications for public health.[1,2]

It is a complicated and multifactorial problem resulting from an imbalance between the dynamic processes of constant mineralization and demineralization occurring on the surface of the teeth known as the caries balance.[3,4] In a comprehensive review by Kirthinga et al wherein studies from 1981 to January 2019 were analyzed, 123 risk factors for dental caries were identified. In high-income countries, the primary risk factors include dentinal caries and high levels of Streptococcus mutans bacteria, whereas enamel defects are more prevalent in upper-middle-income countries. Socioeconomic factors

such as low household income, maternal education level, mother's employment status, urban or rural residence, being raised by a single mother, and the birth order of the child can also significantly impact the prevalence of dental caries. Dietary habits, particularly the frequency of sugar consumption, quantity of sugar, and timing of meals, as well as calcium and dairy intake during pregnancy are crucial determinants of caries in children.[5]

The mechanism of the caries process leads eventually to cavitation of the tooth structure. As a result of the fermentation of carbohydrates, organic acids are produced by oral bacteria, including lactic, formic, acetic and propionic acids. These acids are able to penetrate dental tissues and dissolve the enamel forming the outer layer of the tooth, together with the underlying dentin and the cementum which forms the root of the tooth. The erosion of substance can lead, in time, to cavitation (Featherstone, 2004).[6] Usually the examination for dental caries is performed after teeth have been air-dried, under artificial light and with the aid of a dental mirror and an explorer which is used for the removal of plaque. The number of teeth with caries is recorded for each patient. All erupted teeth are evaluated according to the criteria recommended by the World Health Organization (WHO) using the decayed, missing, filled teeth (dmft) index for primary teeth (Pezzementi and Fisher, 2005).[7]

Materials and Methods

To ascertain the rate of dental caries in the Indian population across various ages, an in-depth meta-analysis and review of the literature was carried out. The chosen study protocol complied with the Preferred Reporting Items for PRISMA standards and was registered.

Sources including PubMed, Science Direct, Google Scholar, Cochrane, and Scopus were used to screen research articles published between March 2015 and March 2025. The incidence, dental caries, India, cavitation lesion, non- cavitated lesion, root caries, incisors caries, smooth surface caries, occlusal caries, proximal caries, DMF, early childhood caries, aged-related caries, premolar caries, molar caries, canine caries, coronal caries, pit and fissure caries, linear enamel caries, and age group between 6 and 75 years were among the search strings used to electronically screen databases. English-language full-text publications over the previous ten years were chosen for examination. The submission requirements were observational studies (case-control, cohort, and cross-sectional) on the prevalence of dental caries in patients between the ages of six and seventy-five in India. editorials, letters, case reports, studies with vague data, poorly planned

Following deduplication, two separate investigators reviewed the studies for eligibility to find "potentially eligible" research; disputes were settled by consensus following discussion. Cohen's Kappa was used to evaluate the inter-reliability score (0.00943). The author's name, year of publication, participants, demographic variables (age range and dentition), geographical location, the kind of dental caries, diagnostic criteria for dental caries, and prevalence percentage of tooth decay by age category were all collected from the research that was eligible. The Newcastle–Ottawa Scale (NOS), which consists of three elements (methodology, comparability based on study design, and result), was used to evaluate the quality of the studies that served as the foundation for the meta-analysis. The research's reliability was rated on a 10-point scale depending on this criterion. Low quality in method was defined as an average rating of less than 5, a moderate level as a score of 5 to 7, and high quality as a score of more than 7.

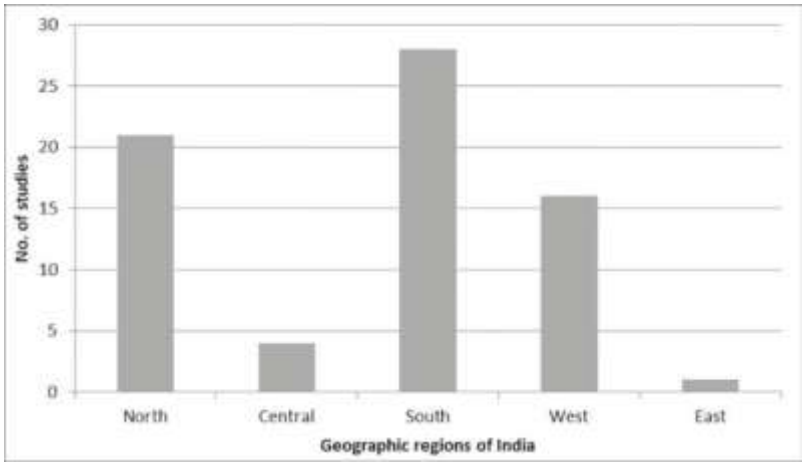
SPSS software, version 23, was used to conduct statistical analyses. Every meta-analysis process used a random effects model. Assuming that the effect size was log-normally distributed, standard errors of its logarithm were computed from the published or inferred confidence intervals. Subgroup analyses were carried out according to dentition, type of dental caries, mean age, geography, and the diagnostic criterion for estimating dental caries (DMFT). Statistical significance was defined as $P < 0.05$.

Results

253 pertinent publications were discovered by electronic screening. Google Scholar produced the greatest number of publications (n = 170) within the databases we examined, followed by PubMed (n = 62), Science Direct (n = 15), Scopus (n = 4), and Cochrane Library (n = 2). Initially, EndNote was

used to eliminate 115 duplicate data, resulting in a distinct list of duplicate references that investigators examined for de-duplication. Following carefully examining the abstracts, an additional 43 papers were eliminated, leaving 95 publications whose entire texts were evaluated for eligibility. When two separate reviewers screened rest information, 70 publications ended up being used in this meta-analysis. Twenty-five articles were excluded because they did not specify the DMFT index, did not contain the prevalence rate of dental caries, or did not meet the inclusion requirements for age. Investigations were found to be widely distributed geographically, with representation found in nearly every region of India with the exception of the northeast. Eight studies documented early childhood caries, and 69 trials found a higher incidence of crown caries. Diagnostic tests were used to assess dental caries, mostly using DMFT and WHO standards.

Figure 1- Geographical distribution pattern of the 70 studies included in the meta-analysis on prevalence of dental caries



The overall prevalence of the dental caries calculated using the random effects model was 54.16% (SD 0.0229, 95% CI: 0.4966–0.5866). The test for heterogeneity produced Tau square of 0.04, Q(P < 0.0001), I^2 =99.57% (95% CI: 99.4121–99.7012), H square = 232.32 (95% CI: 170.1101–334.6652).

Studies were divided into various subgroups such as age, dentition, geographic location, estimation of caries using a diagnostic index and type of dental caries, to check for any possible heterogeneity.

Subgroup analysis by age which was further divided into three categories. The overall prevalence of dental caries observed in the age range of 3–18 years was 52%. The test for heterogeneity produced Tau square of 0.0330, Q(P < 0.0001), I^2 =99.5365% (95% CI: 99.3520–99.6907), H square = 215.7641 (95% CI: 154.3266–323.3308). The maximum and minimum prevalence of dental caries observed in the age range of 3–18 years were 95 and 7%, respectively.

Similarly, the overall prevalence of dental caries observed in the age range of >18 years was 62%. The test for heterogeneity produced Tau square of 0.0519, Q(P < 0.0001), I^2 = 99.5250% (95% CI: 98.8461–99.9014), H square = 210.5069 (95% CI: 86.6651–1014.4179).

META-ANALYSIS FOR DMFT BY SUBGROUP ANALYSIS

The prevalence of the DMFT index as a diagnostic criterion in the estimate of dental caries in the age group of 3–18 years was found to be 57% using a random-effect model. Its utilisation was significantly higher (77%) in individuals over the age of 18. It was found that 62% of cases of crown caries were diagnosed using the DMFT index. At 29%, the DMFT index prevalence in early childhood caries was rather low. In the primary dentition, the DMFT index was 59% prevalent as a diagnostic criterion for dental caries. However, the incidence rates of DMFT for dental caries diagnosis were 43% in permanent dentition and 66% in mixed dentition. Eastern India observed the highest overall prevalence of DMFT as diagnostic criteria for estimating dental caries at 72% followed by western part of India (60%), southern (59%), and north India (58%).

The test for heterogeneity (for age, type of dental caries, dentition, region) produced Tau square of 0.0288, Q($P < 0.0001$), $I^2 = 99.30\%$ (95% CI: 98.9145–99.6016), H square = 143.09 (95% CI: 92.1239–250.9946). The mean real effect's size was unaffected by any of the included subgroups, according to the results of the meta-regression study. The six factors (region, design, caries type, dentition, age, and year of study) account for about 9.62% of the total amount of heterogeneity. Additionally, variables not covered in investigation accounted for the balance of 90.28% of variability. The test for residual heterogeneity was significant (QE = 12340.4190, df = 55, $P < 0.0001$), which may suggest that the prevalence of caries was influenced by additional variables not taken into account in the model, such as gender and sample demographic.

Discussion

As per our review and analysis, the overall prevalence of dental caries in Indian population aged between 3 and 75 years was 54.16%. This finding is in congruence with results of the National Oral Health Survey in India which noted a prevalence of 53.8%.[8]

An ages-specific prevalence of 62% for individuals over the age of 18 and 52% among those aged 3 to 18 ($P < 0.0001$) was noted, despite the fact that the majority of research have concentrated on dental caries in groups under the age of 18. According to Janakiram et al., the mean prevalence was 49% for children aged 5 to 12, and it steadily increased to 60% and 84% for those aged 15 and 65 to 74, correspondingly. Limited time for self-care, drug misuse, the prevalence of multiple illnesses, poor health-seeking behaviours among adults, and the lack of organised programmes aimed at dental caries prevention and reduction in India are all contributing factors to the age-specific increase in dental caries.[9,10,11,12,13]

When the geographic distribution of dental caries prevalence rates in India was evaluated, western India had a particularly high prevalence (72%). This contradicts a meta-analysis by Janakiram et al., which discovered that dental caries was significantly more common in North India across all age groups than in other regions of the country.11 Depending on the socioeconomic characteristics of the locations examined and the local eating customs, this discrepancy in interregional estimations may occur.[10,11,14,15]

Conclusion

Present findings suggest that the prevalence of dental caries is a pressing health concern affecting at least half of the Indian population. Age-specific subgroup analysis highlights the need for better preventive oral care programs and awareness campaigns among adults for pertinent management of dental caries.

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