Introduction

As stated by the World Health Organization in their oral health report of 2003,[1] dental caries and periodontal diseases are pandemic diseases affecting all population irrespective of gender, age, or socioeconomic status. This situation is more alarming in developing countries due to lack of access to oral health care services and preventive measures like fluorides. India is a developing mixed economy country of 1.3 billion. It initiated economic liberalization in late 1991, before that the growth rate of India was 3%–4%, but currently, it is one of the fastest growing and the 5th largest (in terms of the gross domestic product [GDP]) economies in the world.[2] The total expenditure on healthcare as a proportion of GDP in 2014 was 4.7%. India was declared Polio-free in 2014 and maternal and neonatal tetanus free in 2015.[3] It has a dentist population ratio of 1:10,271, but there is a disparity between urban and rural areas as urban centers attracting more dental workforce.[4] Last National Oral Health Survey conducted in 2002–2003 stated that DMFT index score for Indian children was around 2 and caries prevalence was increasing with age from 51.9% to 63.1% in 5–15 years of age group, respectively.[5]

Keeping these facts in mind, a retrospective study was planned with a rationale that as oral health is considered to be an integral part of general health, it is expected that there shall be an improvement in oral diseases morbidity indicators among the children who are born in the era economic liberalization in India. The main purpose of this study was to assess the trend in caries prevalence and mean decayed, missing, filled/Decayed, Missing, Filled (dmf/DMF) index score among Indian children for the past 25 years.

Materials and Methods

Search strategy

An electronic literature search was conducted in PubMed and PubMed Central databases for the following Mesh and free text terms – “child,” “dental caries,” and “India.” The search period was from 1992 to 2016.

Results

The pooled caries prevalence was between 50.84% and 62.41% at 5-year interval. There was a decline in caries prevalence in 2–5 and 11–15 years of age group. The overall weighed mean of 2.4, 2.7, and 1.9 was observed in three different age groups. Significant caries index (SiC) of more than 3 was observed in all the age groups. Conclusion: The present review suggests that more than half of Indian children have been affected by dental caries. High SiC index score suggests a skewed distribution of caries among Indian children. This data may aid in planning further exploratory research and oral health care services for children by the stakeholders.

Keywords: Children, dental caries, DMF/dmf index, India, significant caries index

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January 1, 1992 to December 31, 2016. Articles in English language only were included in this search. Terms searched by PubMed and PMC were: (“dental caries” [MeSH Terms]) OR (“dental” [All Fields] AND “caries” [All Fields]) OR “dental caries” (All Fields) AND (“child” [MeSH Terms] OR “child” [All Fields] OR “children” [All Fields]) AND (“India” [MeSH Terms] OR “India” [All Fields]).

The initial search in databases found 3440 hits. After removal of duplicates, 1468 articles remained for initial screening, out of these 191 articles were selected for detail inspection. Based on the predecided inclusion criteria, 69 studies were found eligible for participation in this study [Flow Chart 1]. Full text of the included studies was retrieved by electronic and manual search from the library.

Inclusion criteria
Studies satisfying the following criteria were included in this review:
1. Studies done on children less than or equal to 15 years of age
2. Studies published between 1992 and 2016 in PubMed and Pubmed central databases
3. Studies mentioned average DMF/dmf score with a measure of variance and/or caries prevalence in percentage.

Exclusion criteria
Studies which were done on children suffering from any systemic conditions such as asthma, leukemia, diabetes, obesity, and physical or mental disabilities were excluded from this review. Comparison or correlation studies, for example, studies done to find an association between diet or obesity or body mass index and dental caries experience or where the assessment of caries risk was done were excluded from this review. Studies done on children of Indian origin living outside India were not included in this review.

Records identified through database searching (n = 3440)
Records after duplicates removed (n = 1468)
Records excluded (n = 1277)
Records screened (n = 191)
Full-text articles assessed for eligibility (n = 69)
Studies included for final analysis (n = 69)
Additional records identified through other sources (n = 0)

Flow Chart 1: The method of extraction of articles

Data extraction
A template was prepared in Excel spreadsheet to extract the following data from the articles-year of the study/publication, age, study region, mean dmf/DMF value with standard deviation (SD), and total prevalence of dental caries. Following groups were prepared for further analysis: different age groups (2–5, 6–10 and 11–15 years), 5-year interval (1992–1996, 1997–2001, 2002–2006, 2007–2011 and 2012–2016) and different regions of India (North, East, West, and South). Those groups in which 2 or <2 articles were present and they were excluded from further analysis. “dmf” index was considered for analysis in 0–5 and 6–10 years group, whereas “DMF” was considered for 11–15-year group. If articles have mentioned the year of a survey conducted, that was used; otherwise, year of publication was considered.

Statistical analysis
Average proportion, standard error (SE), confidence interval, weighted mean, and significant caries index (SIC) value were found for each group using the following formulas:[6]
1. Average proportion = \( p = \frac{\text{Sum of success}}{\text{Total number of trials}} \)
2. Weighted mean = \( W = \frac{\text{Sum of } m_1 \times n \text{ for sample 1}}{\text{Total number of samples}} \)
3. Combined SD = \( SD = \sqrt{\text{Sum of } SD_1^2 \times n_1 + SD_2^2 \times n_2 + \ldots} \)
4. SE calculation in case of mean DMFT/dmft = SD/Square root of n
5. SE calculation in case of prevalence of dental caries = Square root of average proportion (1-average proportion)/total sample
6. C. I = \( \text{Weighted Mean} \pm (1.96 \times SE) \)
7. SIC value = \( m_1 \times n_1 + m_2 \times n_2 + \ldots \times n \text{ samples} \) (1/3rd of the population with a higher DMFT score in each group)[7]

Where \( P \) is proportion, \( m \) is mean, \( SD \) is the standard deviation, \( SE \) is standard error, and \( n \) is the total sample.

Results
In total 69 studies were included in this review. When the number of studies was divided according to 5-year interval group, it was observed that there are 4, 15, 8, 18, and 24 studies in 1992–1996, 1997–2001, 2002–2006, 2007–2011, and 2012–2016 group, respectively [Table 1]. Average pooled caries prevalence was 56.7% with a range of 50.8%–62.4% [Table 2]. Caries prevalence was 48.9%, 69.1%, and 52.1% for 2–5, 6–10, and 11–15 year, of age group, respectively. There was a decline in caries prevalence in the youngest and eldest age group children [Graphs 1 and 2], whereas middle age group (6–10 years) showed an upward trend [Graph 3].
Overall weighed mean caries experience was 2.3. Table 3 describes the weight mean dmf/DMF score in different year groups along with SD, SE and confidence interval. Mean dmf/DMF in different age groups ranged from 1.9 to 2.7 as shown in Table 4. Region-wise distribution of dental caries shows more caries prevalence in the southern and western part of India as compared to the northern and eastern part of India. The weighed mean dmf/DMF was also higher for these two regions [Table 5]. SIC values are showing an overall decline from 3.8 to 2.7 over the past 25 years [Graph 4].

**Discussion**

**Principal findings**

This review shows that pooled prevalence of dental caries in Indian children is more than 50% and average dmf/DMF values are between 2 and 3 in all the age groups. These figures are quite similar to those reported by the World Health Organization,[1] Dental Council of India,[5] Moreira R[76] and Kundu et al.[6] for Indian children. Caries experience was found less in the northern and eastern part of India as compared to southern and western parts, this is contrary to findings by Kundu et al. where they found children of north India having higher caries experience as compared to other parts of the country. India despite being a developing country has less caries experience in comparison to other developing countries.[1,77] High SIC values suggest a skewed distribution of dental caries in Indian children and are comparable to its neighboring countries but less than the developed world.[78]

In India, the magnitude and impact of oral diseases, especially caries and periodontal diseases are unknown. There is no nationwide comprehensive disease surveillance in place, and hence, recent epidemiological data are not available to make a strong case about the oral diseases burden. Moreover, there is no national oral health research agenda to coordinate and prioritize research according to national needs. Thus, the indicators commonly used to assess oral health status do not provide clear or easily

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Table 1: Total number of studies included-year wise

| Year    | Number of studies (with references) |
|---------|-------------------------------------|
| 1992-1996 | 4[8‑11]                             |
| 1997-2001 | 15[12-26]                           |
| 2002-2006 | 18[27-44]                           |
| 2007-2011 | 8[45-51]                             |
| 2012-2016 | 24[52-75]                            |

Table 2: Trend in caries prevalence at 5 year interval

| Year    | Prevalence (%) | SE     | Confidence interval |
|---------|----------------|--------|---------------------|
| 1992-1996 | 56.5           | 0.00011 | 56.56-56.58         |
| 1997-2001 | 62.4           | 0.00004 | 62.4-62.42          |
| 2002-2006 | 50.8           | 0.00005 | 50.83-50.85         |
| 2007-2011 | 51.6           | 0.00003 | 51.66-51.68         |
| 2012-2016 | 58.3           | 0.00004 | 58.2-58.4           |

SE=Standard error

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Table 3: Weighed mean Decayed, Missing, and Filled Teeth/decayed, missing, and filled teeth in 5-year interval group

| Year    | Weighed mean±SD | SE     | CI       |
|---------|-----------------|--------|----------|
| 1992-1996 | 2.9±5.3        | 0.095  | 2.74-3.11|
| 1997-2001 | 2.3±7.1        | 0.083  | 2.2-2.52 |
| 2002-2006 | 2.4±8.5        | 0.134  | 2.18-2.68|
| 2007-2011 | 1.9±6.07       | 0.062  | 1.86-2.1 |
| 2012-2016 | 2.3±6.7        | 0.039  | 2.29-2.44|

SE=Standard error, SD=Standard deviation, CI=Confidence interval

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Graph 1: Dental caries trend in 2–5 years age group

Graph 2: Dental caries trend in 6-10 years age group*. *Less than two studies were eligible for analysis in 2002–2006 group

Graph 3: Dental caries trend in 11–15 years age group
Overall caries prevalence

| Region | Weighted mean dmf/DMF |
|--------|----------------------|
| South  | 58.4 2.47             |
| West   | 58.6 2.48             |
| East   | 48.9 1.78             |
| North  | 50.4 1.95             |

*Less than two studies were eligible for analysis. NC=Not calculated

Table 5: Region wise distribution of caries in India

| Region | Overall caries prevalence (%) | Weighted mean dmf/DMF |
|--------|-------------------------------|----------------------|
| North  | 50.4                          | 1.95                 |
| East   | 48.9                          | 1.78                 |
| West   | 58.6                          | 2.48                 |
| South  | 58.4                          | 2.47                 |

dmf=Decayed, missing and filled, DMF=Decayed, Missing and Filled

International standard must be established in India for surveillance of dental caries.

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Conflicts of interest

There are no conflicts of interest.

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