Review Article

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Dentistry Section

Prevalence of Dental Caries in India among the WHO Index Age Groups: A Meta-Analysis

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ABSTRACT

Introduction: Dental caries is widely prevalent globally but the distribution and severity of dental caries varies across countries and regions. In the absence of surveillance or real time monitoring of dental caries in India, there exist a need to assess the prevalence in the country for planning and implementation of oral health programs.

Aim: To assess the combined prevalence and mean DMFT of dental caries in India among the WHO index age groups (5, 12, 15, 35-44 and 65-74 years).

Materials and Methods: Epidemiological/point prevalence studies conducted (among index age groups) in various parts of India from January 2000 to April 2016 were retrieved from Pubmed central database using 'Dental caries' AND 'India' as MeSH terms and information from the only National Oral Health Survey and Fluoride Mapping (2002-2003) in India were used. The combined mean deft/DMFT and pooled prevalence of the dental caries was assessed region wise for each age group.

Results: The mean deft/DMFT was 2.36, 1.95, 3.31 and 7.01 among 5, 12, 15 and 65-74 years respectively. The SiC index shows steady increase from 3.36 to 8.11 across the groups. The mean prevalence of dental caries is almost similar at 5 years and 12 years at 49% while it shows steady increase from 15 years (60%) to 35-44 years (78%) and peaks at 65-74 year group (84%). In the Eastern and Western regions of India, the 15 year old had higher caries prevalence and mean DMFT compared to the 12-year-old. Across India, the 60-74-year-old had the highest DMFT of 7.01. In North and South India, 65-74-year-old had the highest caries prevalence of 84% and 85% respectively.

Conclusion: Irrespective of age groups, the prevalence of dental caries was found to be high and varied across India. This data could help health policy makers to tailor region specific oral health interventions.

Keywords: Dental caries, Geographical distribution, Oral health data, Prevalence, Significant caries index

INTRODUCTION

Dental caries is a widely prevalent disease world-wide. According to Global Oral Health Data Bank, prevalence varies from 49% to 83% across different countries [1]. Irrespective of age, it has shown to have a negative impact on the health related quality of life. Data suggests that there has been a decline in the prevalence of dental caries worldwide but has been at markedly different rates in high and middle/low income countries. While there has been a greater decline in the high income countries which could majorly be attributed to the use of fluorides and established preventive programs while in some low and middle income countries, there decline has been less or inverse because of the increasing consumption of sugars and refined foods [2].

Delivery of effective patient care, health services management, public health and health policy making are dependent on credible data [3]. The World Health Organization (WHO) has advocated epidemiological surveys to be undertaken every 5 years to monitor the changing patterns of oral diseases and to create a global oral health data bank [4]. The data currently available in the global oral health data bank has been sourced from countries having a robust disease surveillance/reporting system or on the basis of systematically conducted national oral health surveys. Though widely prevalent, the distribution and severity of dental caries varies across countries and among various regions within a country [5]. For global monitoring purposes, the WHO recommends the use of certain index age groups to summarize the burden of dental caries and other oral diseases. The age groups 5 years, 12 years, 15 years, 35-44 years and 65-74 years have been chosen to represent primary dentition, immediately after permanent teeth eruption (except third molars), exposure of teeth to the oral environment for a sufficient period of time, adulthood and geriatric population respectively.

India with its wide ethnic, geographic and cultural diversity is considered as a country of several nations. Quite expectedly disease patterns are also widely diverse within various states/regions of the country. However, with the absence of a robust disease reporting system, there is no real-time monitoring of oral diseases in the country. The lack of credible data fails to convince policy makers to accept oral diseases as public health problems and hence the low priority. India has had only a single National Oral Health Survey conducted in 2002 [6]. However, literature reveals innumerable prevalence studies done across the country on various age and population group. This data, if combined, can be used effectively for planning and implementation of oral health programs. This study thus intends to pool the available data on the region wise dental caries prevalence from January 2000 to April 2016 in the country thereby assessing its trend. For standardization purposes, only studies conducted among the WHO index age groups were included for the present review.

MATERIALS AND METHODS

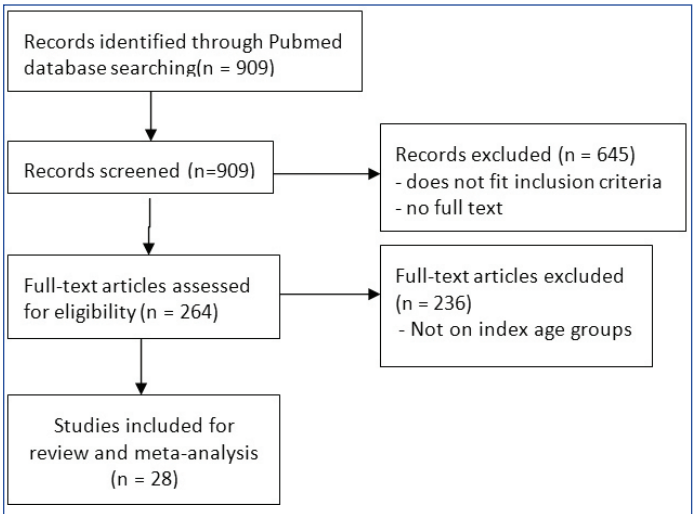
Study Design

It is a review (secondary data analysis) of prevalence studies on dental caries conducted among WHO index age groups.

Data Source and Search Strategy

Studies were retrieved from Pubmed Central database using 'Dental caries' and 'India' as MeSH terms. Data from the National Oral

Health Survey and Fluoride Mapping (2002-03) were also included. The search was conducted in the month of May 2016 and articles



[Table/Fig-1]: Search strategy.

till April 2016 were included. Search strategy and results are given in [Table/Fig-1].

Inclusion Criteria

- Point/period prevalence studies on dental caries prevalence or caries experience using deft/DMFT index done in India from January 2000-April 2016;
- Studies with in the index ages (5, 12, 15, 35-44 and 60-74 years);
- Only English language studies were included.

The search was restricted to articles published in Pubmed database and did not include other sources, government reports or grey literature.

Data Extraction

A proforma was prepared in Microsoft Excel to extract relevant data required for the review. Each article was read by the principal investigator and following variables were recorded; time period during which the study was performed, investigators and year of publication of study, study setting, age group, gender, category of study population, population size, mean deft/DMFT with standard deviation and the prevalence of dental caries. In order to assess the trend of dental caries in different index age groups in different regions, the studies were grouped - age and region wise.

STATISTICAL ANALYSIS

Data was entered in Microsoft Excel sheet and reliability check was done. Data was segregated region wise (north, south, east and west). Caries prevalence and mean deft/DMFT was separated from the master file. Some of the studies did not report either of them.

For mean deft/DMFT, the combined mean and standard deviation was estimated gender wise and region wise among the index age groups:

- Combined mean DMFT, $X = (x_1 * n_1) + (x_2 * n_2) + \ldots\ldots\ldots + (x_n * n_n) / N$
  - Where, x_1, x_2 are mean deft/DMFT and n_1, n_2 are sample size of sample 1 and 2 and N is the total of all sample size.
  - $d_1 = x_1 - X$
  - Combined SD = $SQ.RT\ n_1*(SD_1^2 + d_1^2) + n_2*(SD_2^2 + d_2^2) + \ldots\ldots\ldots + n_n*(SD_n^2 + d_n^2) / N$
- Standard Error was calculated and Confidence Interval were assessed for combined mean
  - Standard Error (SE) = Combined SD / SQ.RT of N
- Confidence Interval, CI = lower limit to upper limit
  - Lower limit = X – 1.96 * SE, Upper limit = X + 1.96 * SE

For prevalence, the combined mean prevalence was estimated gender wise and region wise among the index age groups:

- Combined mean Prevalence, $P = (p_1 * n_1) + (p_2 * n_2) + \ldots\ldots\ldots + (p_n * n_n) / N$
  - Where, p_1 and p_2 are mean prevalence and n_1, n_2 are sample size of sample 1 and 2 and N is the total of all sample size. Standard Error was calculated and Confidence Interval was assessed for combined prevalence.
- $SE = SQ.RT\ P*(1- P) / N$
- Confidence Interval, CI = lower limit to upper limit
  - Lower limit = P – 1.96 * SE, Upper limit = P + 1.96 * SE

Significant Caries Index (SiC):

In order to account for the skewed distribution of caries prevalence, SiC was also calculated [7]. This index was proposed in 2000 to bring attention to those individuals with the highest caries scores in each population [7].

RESULTS

A total of 29 articles including National Oral Health Survey and Fluoride Mapping (2002-03) were included for the final review [Appendix-1]. The studies were grouped under the region of India where it was conducted.

Northern India [6,8–13];

Western India [6,14–20];

Eastern India [6,21,22];

Southern India [6,23–35].

The mean deft/DMFT was 2.36, 1.95, 3.31 and 7.01 among 5, 12, 15 and 65-74 years respectively. Sufficient data was not available for 35-44 year age group. The SiC index shows steady increase from 3.36 to 8.11 across the groups. There is a considerable difference between the mean deft/DMFT of males and females across all age groups [Table/Fig-2].

The mean prevalence of dental caries is almost similar at 5 years and 12 years at 49% while it shows steady increase from 15 years (60%) to 35-44 years (78%) and peaks at 60-74 year group (84%). Males had slightly higher prevalence at 5 and 12 years and females had a higher prevalence in the older age groups [Table/Fig-3].

Region wise data shows that South Indian five-year-old had a higher mean deft compared to their North Indian counterparts. However, among the 12-year-old, the highest mean DMFT was observed among West Indian children followed by North India and others. Studies done in Eastern region of India reported the least DMFT of 0.86 [Table/Fig-4]. The prevalence of the dental caries was consistently higher among all age groups in North India compared to the other regions [Table/Fig-5]. Forest plot of pooled prevalence of dental caries among various age groups in different regions of India is shown in [Table/Fig-6].

DISCUSSION

This study was designed to meta-analyse the mean deft/DMFT and prevalence from all the point prevalence studies in India conducted from January 2000 to April 2016 among the WHO index age groups. The studies were heterogeneous in view of the population group studied but these provided vital information to get a relative estimate of the dental caries burden in different regions of India. Standardization was attempted by incorporating only those studies which used deft/DMFT index for assessment of caries and conducted only among specific age groups.

Sl No	Authors	Title and publication details	Year	Region
1	Bali RK, Mathur VB, Talwar PP, Chanana HB [6].	National Oral Health Survey and Fluoride Mapping 2002-03. Dental Council of India, New Delhi; 2004.	2004	All India
2	Sujlana A, Pannu PK [8].	Family related factors associated with caries prevalence in the primary dentition of five-year-old children. J Indian Soc Pedod Prev Dent. 2015;33(2):83–87.	2015	Northern India
3	Gupta D, Momin RK, Mathur A, Srinivas KT, Jain A, Dommaraju N, et al [9].	Dental caries and their treatment needs in 3-5 year old preschool children in a rural district of India. North Am J Med Sci. 2015;7(4):143–50.	2015	Northern India
4	Das D, Misra J, Mitra M, Bhattacharya B, Bagchi A [10].	Prevalence of dental caries and treatment needs in children in coastal areas of West Bengal. Contemp Clin Dent. 2013;4(4):482–87.	2013	Northern India
5	Mittal M, Chaudhary P, Chopra R, Khattar V [11].	Oral health status of 5 years and 12-year-old school going children in rural Gurgaon, India: an epidemiological study. J Indian Soc Pedod Prev Dent. 2014;32(1):3–8.	2014	Northern India
6	Gambhir RS, Sogi GM, Veeresha KL, Sohi RK, Randhawa A, Kakar H [12].	Dental health status and treatment needs of transport workers of a northern Indian city: A cross-sectional study. J Nat Sci Biol Med. 2013;4(2):451–56.	2013	Northern India
7	Agrawal R, Gautam NR, Kumar PM, Kadhiresan R, Saxena V, Jain S [13].	Assessment of dental caries and periodontal disease status among elderly residing in old age Homes of Madhya Pradesh. J Int Oral Health JIOH. 2015;7(8):57–64.	2015	Northern India
8	Gaur A, Sujan SG, Katna V [14].	The oral health status of institutionalized children that is, Juvenile home and orphanage home run by Gujarat state Government, in Vadodara city with that of normal school children. J Indian Soc Pedod Prev Dent. 2014;32(3):231–37.	2014	Northern India
9	Joshi N, Sujan S, Joshi K, Parekh H, Dave B [15].	Prevalence, severity and related factors of dental caries in school going children of vadodara city - an epidemiological study. J Int Oral Health JIOH. 2013;5(4):35–39.	2013	Western India
10	Ingle NA, Dubey HV, Kaur N, Gupta R [16].	Prevalence of dental caries among school children of Bharatpur city, India. J Int Soc Prev Community Dent. 2014;4(1):52–55.	2014	Western India
11	Prabhu P, Rajajee KTSS, Sudheer KA, Jesudass G [17].	Assessment of caries prevalence among children below 5-year-old. J Int Soc Prev Community Dent. 2014;4(1):40–43.	2014	Western India
12	Gupta P, Gupta N, Singh HP [18].	Prevalence of dental caries in relation to body mass index, daily sugar intake, and oral hygiene status in 12-year-old school children in Mathura City: A Pilot Study. Int J Pediatr. 2014;2014:921823.	2014	Western India
13	Prakasha Shrutha S, Vinit GBG, Giri KY, Alam S [19].	Feeding practices and early childhood caries: a cross-sectional study of preschool children in kanpur district, India. ISRN Dent. 2013;2013:275193.	2013	Western India
14	Simratvir M, Moghe GA, Thomas AM, Singh N, Chopra S [20].	Evaluation of caries experience in 3-6-year-old children, and dental attitudes amongst the caregivers in the Ludhiana city. J Indian Soc Pedod Prev Dent. 2009;27(3):164–69.	2009	Western India
15	Shailee F, Girish MS, Kapil RS, Nidhi P [21].	Oral health status and treatment needs among 12- and 15-year-old government and private school children in Shimla city, Himachal Pradesh, India. J Int Soc Prev Community Dent. 2013;3(1):44–50.	2013	Eastern India
16	Kundu H, Patthi B, Singla A, Jankiram C, Jain S, Singh K [22].	Dental Caries Scenario Among 5, 12 and 15-year-old Children in India- a retrospective analysis. J Clin Diagn Res JCDR. 2015;9(7):ZE01-05.	2015	All India
17	Suprabha BS, Rao A, Shenoy R, Khanal S [23].	Utility of knowledge, attitude, and practice survey, and prevalence of dental caries among 11- to 13-year-old children in an urban community in India. Glob Health Action. 2013;6:20750.	2013	Southern India
18	Beena JP [24].	Dental subscale of children's fear survey schedule and dental caries prevalence. Eur J Dent. 2013;7(2):181–85.	2013	Southern India
19	Das UM, Beena JP, Azher U [25].	Oral health status of 6- and 12-year-old school going children in Bangalore city: an epidemiological study. J Indian Soc Pedod Prev Dent. 2009;27(1):6–8.	2009	Southern India
20	Havaldar KS, Bhat SS, Hegde SK [26].	Oral health status of Tibetan and local school children of Kushalnagar, Mysore district, India: a comparative study. J Indian Soc Pedod Prev Dent. 2014;32(2):125–29.	2014	Southern India
21	John JB, Asokan S, Aswanth KP, Priya PRG, Shanmugaavel AK [27].	Dental caries and the associated factors influencing it in tribal, suburban and urban school children of Tamil Nadu, India: a cross sectional study. J Public Health Res. 2015;4(1):361.	2015	Southern India
22	Baskaradoss JK, Geevarghese A, Roger C, Thaliath A [28].	Prevalence of malocclusion and its relationship with caries among school children aged 11-15 years in southern India. Korean J Orthod. 2013;43(1):35–41.	2013	Southern India
23	Bharateesh JV, Kokila G [29].	Association of root caries with oral habits in older individuals attending a rural health centre of a dental hospital in India. J Clin Diagn Res: JCDR. 2014;8(11):ZC80-82.	2014	Southern India
24	Jain M, Singh A, Sharma A [30].	Relationship of Perceived Stress and Dental Caries among Pre University Students in Bangalore City. J Clin Diagn Res: JCDR. 2014;8(11):ZC131-34.	2014	Southern India
25	Karunakaran R, Somasundaram S, Gawthaman M, Vinodh S, Manikandan S, Gokulnathan S [31].	Prevalence of dental caries among school-going children in Namakkal district: A cross-sectional study. J Pharm Bioallied Sci. 2014 Jul;6(Suppl 1):S160-161.	2014	Southern India
26	Basha S, Swamy HS [32].	Dental caries experience, tooth surface distribution and associated factors in 6- and 13-year-old school children from Davangere, India. J Clin Exp Dent. 2012;4(4):e210-16.	2012	Southern India
27	Sarumathi T, Saravana Kumar B, Manjula Datta, Hemalatha VT, Aarthi Nisha V [33].	Prevalence, severity and associated factors of dental caries in 3-6 year old children. J Clin Diagn Res JCDR. 2013;7(8):1789–92.	2013	Southern India
28	Sukhabogi Jr null, Shekar C, Hameed I, Ramana I, Sandhu G [34].	Oral health status among 12- and 15-year-old children from government and private schools in hyderabad, Andhra Pradesh, India. Ann Med Health Sci Res. 2014;4(Suppl 3):S272-77.	2014	Southern India
29	Sukhabogi J, Parthasarathi P, Anjum S, Shekar B, Padma C, Rani A[35].	Dental fluorosis and dental caries prevalence among 12 and 15-year-old school children in Nalgonda District, Andhra Pradesh, India. Ann Med Health Sci Res. 2014;4(Suppl 3):S245–52.	2014	Southern India

[Appendix 1]: List of included studies for review.

The study found that five-year-old children had mean deft of 2.36 (95% CI 2.3 - 2.42). Since deft is the past caries experience, its presence means the caries experience would have started at least two years prior. Early Childhood Caries (ECC) interferes with speech, self-esteem, daily routine activities, normal nutrition intake and results in underweight and abnormal cognitive development among children [21]. It also affects the overall oral health related quality of life [36]. Also, young children with dental caries have a higher probability of having dental caries in their permanent dentition [37]. The presence of dental caries in deciduous dentition is a predictor of future caries in the permanent dentition. Having deft 2.3 at 5-6 years is high considering the proportion of the children affected which is nearly 50%. Moreover

Index age groups	Males		Females		Overall		
	Mean DMFT(CI)	No. of Studies	Mean DMFT(CI)	No. of Studies	Mean DMFT(CI)	SiC	No. of Studies
5 years	2.05 (1.99-2.11)	4	1.95 (1.89-1.99)	4	2.36 (2.3-2.42)	3.36	16
12 years	1.16 (1.08-1.24)	5	1.18 (1.1-1.26)	5	1.95 (1.91-1.99)	3.52	31
15 years	0.96 (0.79-1.13)	3	1.14 (0.89-1.37)	3	3.31 (3.21-3.41)	5.14	13
35-44 years	No data available	-	No data available	-	No data available	-	-
65-74 years	No data available	-	No data available	-	7.01 (6.64-7.38)	8.11	2

[Table/Fig-2]: Mean deft/DMFT among different age groups in India.
*SiC: Significant caries index

Index age groups	Males		Females		Overall	
	Mean Prevalence (%) (CI)	No. of Studies	Mean Prevalence (%) (CI)	No. of Studies	Mean Prevalence (%) (CI)	No. of Studies
5 years	52 (51.03-52.97)	19	49 (47.98-50.02)	19	49 (48.46-49.54)	32
12 years	51 (48.95-51.05)	17	50 (48.93-51.07)	17	49 (48.43-49.57)	46
15 years	59 (57.97-60.03)	17	61 (59.94-62.06)	17	60 (59.35-60.65)	26
35-44 years	76 (75.11-76.89)	15	80 (79.13-80.87)	15	78 (77.38-78.62)	15
65-74 years	84 (83.2-84.8)	15	85 (84.19-85.81)	15	84 (83.43-84.57)	16

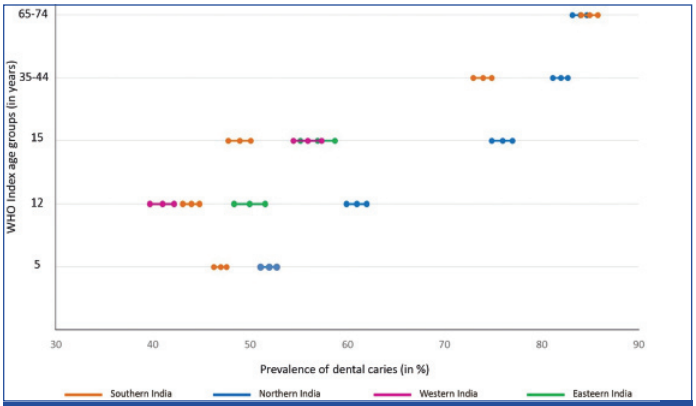
[Table/Fig-3]: Prevalence of dental caries among different age groups in India.

Index age groups	North India			South India			East India			West India		
	MeanDMFT(CI)	SiC	No. of Studies	Mean DMFT(CI)	SiC	No. of Studies	Mean DMFT(CI)	SiC	No.of Studies	Mean DMFT (CI)	SiC	No.of Studies
5 years	2.07 (1.74-2.98)	2.6	6	2.74 (2.61-2.87)	3.6	10	No data			No data		
12 years	2.17 (2.09-2.25)	3	6	1.28 (1.23-1.33)	2.6	18	0.86 (0.78-0.94)	1	3	4.70 (4.44-4.96)	8	4
15 years	4.10 (3.95-4.25)	4.2	2	1.17 (0.98-1.36)	2.1	6	1.38 (1.22-.54)	2.06	3	6.18 (5.82-6.54)	8	2
35-44 years	No data	-	-	No data	-	-	No data			No data		
65-74 years	7.01 (6.64-7.38)	8.11	2	No data	-	-	No data			No data		

[Table/Fig-4]: Mean deft/DMFT among different age groups in different regions of India.
SiC: Significant caries index

Index age groups	North India		South India		East India		West India	
	Mean Prevalence in % (CI)	No of studies	Mean Prevalence in % (CI)	No of studies	Mean Prevalence (%) (CI)	No of studies	Mean Prevalence (%) (CI)	No of studies
5 years	52 (51.1-52.8)	14	47 (46.3-47.7)	18	No data	-	No data	-
12 years	61 (59.9-62.)	12	44 (43.5-44.8)	23	50 (48.4-51.6)	4	41 (39.7-42.29)	8
15 years	76 (74.9-77.2)	8	49 (47.9-50.1)	9	57 (55.2-58.73)	4	56 (54.5-57.4)	5
35-44 years	82 (81.2-82.7)	9	74 (7.01-74.9)	6	No data	-	No data	-
65-74 years	84 (83.2-84.7)	9	85 (84.2-85.8)	7	No data	-	No data	-

[Table/Fig-5]: Mean Prevalence of dental caries among different age groups in different regions of India.



[Table/Fig-6]: Forest plot showing Mean Prevalence of dental caries among different age groups in different regions of India.

the SiC is 3.36 for 5 years which is significantly higher for the age. This implies that nearly four teeth are affected by dental caries, out of which one or two may progress to involve the dental pulp.

In 2011, the total number of children in the age-group 0-6 years were reported as 158.79 million [38]. Nearly half of them, that is, around 79.4 million are affected by ECC in India. Five to six year old males had more dental caries experience than females. There was a slight difference in caries experience in southern and northern Indian studies. This difference may be attributed to socioeconomic indicators in southern states when compared to northern states as dental caries occurrence is largely related to degrees of industrialization.

The Global Oral Health Data Bank reports a mean DMFT of 2.97 among 12-year-old for the South East Asian countries. Though India comparatively reports better mean DMFT of 1.95, it is still higher compared to developed countries in the African, European and Eastern Mediterranean and Western Pacific regions of World Health Organization who report a mean DMFT of 1.06, 1.64, 1.81 and 1.05 respectively. This could probably be attributed to the absence of any organized programs for dental caries reduction/prevention in India. At this rate, there is a need to monitor and ensure the surveillance of oral diseases and its risk factors. Though DMFT, among 12-year-

old was found to be 1.9 which falls under 'low' category according to the WHO, nearly half of the population was affected by caries. The mean DMFT of countries in the Americas is 2.08; higher than in India. This observation could possibly be attributed to the varied dietary patterns like candy culture and processed food intake being higher among the Americans. However, it has also been found that the dental caries rate is lower among the Mongoloid and the Afroamericans and the Caucasians and similar to that of countries like Thailand. It is relevant to note that SiC index for the same group (3.52) falls under the 'moderate' category.

In Northern India, 15 year olds had the highest mean DMFT of 4.10 compared to the 5 and 12 year age groups. Similar findings were observed in a systematic review which also reported that northern regions of India has more dental caries as compared to the southern regions [21].

The highest prevalence of dental caries was found among the 65-74-year-old and the proportion affected was almost 85%. This could possibly include a large number of Missing (M) components in DMFT; an indicator to assess the tooth lost due to caries in DMFT. However, there was a paucity of this data due to inadequate reporting in most of the studies. The tooth mortality and lack of prosthetic care contributed to unmet dental needs among the elderly population which is a growing global concern.

It is well documented that the best predictor of future caries is past caries, which means that children affected by severe caries are likely to have more caries in the future. Hence, this population could be identified for inclusion in caries prevention programs [39]. It is helpful to address the factors that influence children's oral health in order to develop and implement complementary public health actions focused on children and parental behaviours, in an endeavour to provide them with good oral health and better quality of life [40].

LIMITATION

By limiting studies to index age groups and caries assessment methods, standardization was ensured. The use of statistical estimates like weight mean and combined prevalence resulted in meta-analysing the results of numerous studies.

One of the limitations of this review was the inability to calculate mean deft/DMFT and weighted prevalence for every age group in each region of India due to the lack of availability of data. Full texts of few articles could not be accessed leading to its exclusion.

CONCLUSION

The data from this study provide actionable health information to guide public health policy and programs, aimed at improving oral health services in India. Centers for Disease Control and Prevention (CDC) guidelines for evaluating public health surveillance systems around the globe recommends that the health related events (in this case oral diseases and conditions) be considered for surveillance if they affected many people, require large expenditures of resources, are largely preventable, and are of public health importance. Based on these criteria, oral health outcomes, associated health behaviours, and other factors linked to oral health should be included in public health surveillance systems [41]. Oral diseases and its risk factors need to be incorporated into the non-communicable disease surveillance in India.

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