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Oral health behavior: Prevalence and pattern of dental caries in 11–16-year-old children of various socioeconomic strata

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ABSTRACT

Objectives: To evaluate the oral health behavior, prevalence and pattern of dental caries in 11–16-year-old children of various socioeconomic strata in a north-western Indian city were determined.

Methods: A cross-sectional survey was conducted on 2294 children across two age groups—11–13 and 14–16 years—using a WHO oral health questionnaire and a WHO oral health assessment form-2013 to record the oral health behavior and dental caries, respectively. The revised Kuppuswamy socioeconomic scale determined the socioeconomic status.

Results: Dental caries was observed in 60% children of the upper socioeconomic strata (mean DMFT of 2.00 ± 2.35), 68% in the upper middle strata (mean DMFT 2.40 ± 2.54), 73.3% in the lower middle strata (mean DMFT 2.75 ± 2.81), and 83.7% in the lower strata (mean DMFT 3.93 ± 3.07). DMFT was significantly more (a) in girls than in boys and also (b) in the older 14–16-year age group compared to the 11–13-year age group.

Conclusions: The study has shown a 73.2% prevalence of dental caries (mean DMFT 2.93 ± 2.86), an inverse corelation of caries with socioeconomic status, and higher DMFT in girls and in the older age group. Implementation of regular school dental health programs, promotion of healthy dietary habits, and a proactive regular involvement of parents, teachers, and community will promote good oral health.

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Abbreviations: DMFT, decayed, missing, filled teeth; WHO, World Health Organization; SES, socioeconomic status.

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1. Introduction

Dental caries is defined as "the localized destruction of susceptible dental hard tissues by acidic by-products from bacterial fermentation of dietary carbohydrates."[1] Though preventable, there is an upward trend of dental caries observed worldwide,[2] more so in the developing countries.[3] A National Health Survey conducted in India has observed a prevalence of 53.8% in 12-year-old and 63.1% in 15-year-old adolescents.[4] An increase in dental caries worldwide is attributed to frequent consumption of fermentable carbohydrates, low fluorides, paucity of time, resources, and possibly, lethargy to undergo periodic oral health checkups, socioeconomic factors,[2] and influx of immigrants.[2] The occurrence of dental caries thus, involves an interplay of host, bacterial, dietary, and socioeconomic factors.

Many studies have shown that people of lower SES are at a higher risk for cardiovascular disease,[5] diabetes,[5] high caries,[6] oral cancers,[6] and periodontal disease.[6] On the contrary, Wang et al.[7] observed high caries in Chinese urban adolescents and young adults (12, 15, and 18 years), attributing it to different dietary patterns and living conditions in different provinces. In India, the SES of a family is assessed by using the validated Kuppuswamy's socioeconomic scale, involving three important parameters—education, income, and occupation—and is widely advocated for hospital and community-based research.[8] Ever since its introduction in 1976, the scale has required updates due to steady inflation and a change in the consumer price index.[9]

Few studies have evaluated dietary and behavioral patterns as causative factors for dental caries.[10] The present study aims to study such factors along with the prevalence and pattern of dental caries among 11–16-year-old children of various socioeconomic strata.

2. Materials and methods

A cross-sectional survey was designed to assess dental caries, oral health-related behavior, and the association with SES in children of two age groups—11–13 and 14–16 years. Schools were selected, taking care to include all the different areas/phases of the city. A priori, the sample size was calculated as 2095 subjects at a confidence interval of 95% and a margin of error of 2.0%. A written permission and approval was sought from the District Education Officer, Chandigarh Administration and the Principals of various schools to conduct the survey in government and private schools, respectively. The study was approved by the ethical committee of the Institute, vide letter number PUIEC/10/235 dated 14/10/2010.

A written informed consent filled by the parents was obtained prior to the start of the survey. A Kuppuswamy socioeconomic scale with a revised version for the year 2013 was used to calculate the monthly family income.[11] The socioeconomic status was determined according to the calculated Kuppuswamy score [upper SES 26–29 ($n = 360$), upper middle SES 16–25 ($n = 685$), lower middle SES 11–15 ($n = 460$), upper lower SES 5–10 ($n = 768$), and lower SES <5 ($n = 21$)]. However, for the purpose of the study, the upper lower SES and the lower SES were combined and included under the category of lower SES ($n = 789$) as the latter included only 21 students.

The WHO oral health questionnaire was used to record the oral health behavior of each student and the WHO oral health assessment form for children-version 2013, using the prescribed criteria and methodology, to record dental caries.[12] The children filled the forms in the supervision of a trained instructor. To prevent any interexaminer variability, examination of dental caries was done by a single trained examiner. The children were examined in the schools on a chair with the head reclined. The examination was conducted using a plane dental mirror and a Hu-Friedy dental probe under a portable battery-operated artificial lighting source (blue-white spectrum), with the subjects facing away from the natural light source.

Discrete categorical data were presented as n (%), and continuous data presented as mean ± standard deviation, range, median, and interquartile range. The Normality of quantitative data was checked by measures of Kolmogorov–Smirnov tests of Normality. As the data of the present study was skewed, nonparametric Mann–Whitney U-test was used for statistical analysis of the two groups. For categorical data, comparison was made by Pearson Chi-square test or Fisher's exact test as appropriate. All the statistical tests were two-sided and were performed at a significance level of $\alpha = .05$. Analysis was conducted using IBM SPSS STATISTICS (version 22.0).

3. Results

Among all the examined 11–16-year-old children of the city, dental caries was observed in 60% children of the upper SES, 68% of upper middle SES, 73.3% of lower middle SES, and 83.7% of the lower SES. The individual decayed, missing components, and the cumulative DMFT increased and the filled component decreased from upper to the lower strata (Table 1). Dental caries was 73.4% in the older 14–16-year age group compared to 73.0% in the 11–13-year age group with a significantly high individual and cumulative DMFT scores in the former group (Table 2).

The girls had a slightly higher prevalence of caries (75.8%) than boys (70.8%), and a significantly higher mean DMFT than boys (Table 3). Among boys, the prevalence of caries was 56.6% in the upper SES, 67.6% in the upper middle SES, 72.2% in the lower middle SES, and 81.1% in the lower SES. Likewise, the prevalence of caries among girls was 64.9% in upper SES, 68.5% in upper middle SES, 74.4% in lower middle SES, and 86% in the lower SES. The girls also had a higher decayed component, less missing component, and a higher filled component than boys (Table 3).

A comparison of the consumption of food/beverages once a day and several times a day by children of all socioeconomic strata is presented in Tables 4 and 5, respectively. With regard to the dietary pattern, boys consumed more of fresh fruit several times a day (20.1% vs 13.2%; p-value <0.001), milk with sugar several times a day (30.7% vs 20.8%; p-value <0.001), and coke, lemonade everyday (11.9% vs 7.1%; p-value <0.001) to several times a day (1.7% vs 0.3%; p-value <0.001).

Table 1 – A comparison of DMFT scores with socioeconomic status SES (mean ± SD with a range in brackets).

	SES 26–29 (Upper) $n = 360$	SES 16–25 (Upper middle) $n = 685$	SES 11–15 (Lower middle) $n = 460$	SES <10 (Lower) $n = 789$	p-Value (using ANOVA between groups)
Decayed component D 2.87 ± 2.83 (0–17)	1.93 ± 2.32 (0–11)	2.34 ± 2.51 (0–14)	2.69 ± 2.78 (0–17)	3.87 ± 3.04 (0–15)	<.001**
Missing component M .010 ± .143 (0–5)	.006 ± .074 (0–1)	.007 ± .101 (0–2)	.004 ± .066 (0–1)	.018 ± .213 (0–5)	.304
Filled component F .051 ± .279 (0–4)	.07 ± .331 (0–3)	.053 ± .286 (0–3)	.052 ± .298 (0–4)	.041 ± .233 (0–2)	.440
DMFT 2.93 ± 2.86 (0–17)	2.00 ± 2.35 (0–11)	2.40 ± 2.54 (0–14)	2.75 ± 2.81 (0–17)	3.93 ± 3.07 (0–15)	<.001**

** Highly significant.

In comparison to the upper SES, children of the lower SES reported more conditions of pain/trouble with the teeth (51.5% vs 35.2%; p-value 0.003), and reported less children for follow-up (18.7% vs 22.8%; p-value 0.354) and routine checkup (27.5% vs 41.4%; p-value 0.007), with no visits ever for dental care (50.2% vs 21.4%; p-value <0.001).

Tooth brushing (99.2–100%) with toothpaste (98.7–100%) was performed once a day (42.9–54.8%) and ≥2 times a day (44.8–56.5%) and was comparable and nonsignificant among children of all SES. It was also observed that 83.7–87.8% children were unaware of the presence of fluoride in the toothpaste they used. Only 11.7% children of upper SES, 6.9% of upper middle SES, 7.4% of lower middle SES, and 3.8% of lower SES were aware of and confirmed the use of fluoridated toothpaste.

Table 2 – A comparison of DMFT scores with age.

	11–13 years ($n = 1228$) Mean ± SD	14–16 years ($n = 1066$) Mean ± SD	p-Value
D	2.43 ± 2.44	3.38 ± 3.15	<.001**
M	.004 ± .075	.0170 ± .193	.032*
F	.037 ± .220	.068 ± .334	.008**
DMFT	2.47 ± 2.46	3.47 ± 3.19	<.001**

* Significant.
** Highly significant.

Table 3 – A comparison of DMFT scores with gender.

	Boys ($n = 1206$) Mean ± SD	Girls ($n = 1088$) Mean ± SD	p-Value
D	2.69 ± 2.79	3.08 ± 2.86	.001**
M	.013 ± .182	.006 ± .080	.253
F	.041 ± .256	.063 ± .303	.061
DMFT	2.74 ± 2.83	3.15 ± 2.88	.001**

** Highly significant.

4. Discussion

Census of India states that the total population is 121 crores.[13] Chandigarh, a north-western city of India, has a population of 1,055,450 and a literacy rate ranking eighth in the country at 86.05%.[14] Although the city is known for its affluence with a per capita income of Rs. 142,869 in 2011–12,[15] and ranks first in terms of quality of life, yet it lags behind in oral health. Goyal et al.[16] in 2007 observed 80–87% dental caries among 12- and 15-year-old children with a mean DMFT of 3.03 ± 2.52 and 3.82 ± 2.85, respectively.

WHO has declared 12-year and 15-year age groups as the global index ages, for international comparisons of dental diseases, to be used in population surveys.[12] It is at the age of 12 years that students leave primary school and possess a complete permanent dentition except the third molars. The age of 15 years would have allowed an exposure of permanent teeth to the oral environment for at least 3–9 years and so permits assessment of caries and periodontal disease. Data analyzed by the WHO (188 countries) reported 200,335,280 decayed, missing, or filled teeth in just the 12-year age group.[17] The highest priority risk group for dental caries is 11–16 years that also constituted the target population for our study.

The WHO has analyzed DMFT index of 190 countries representing WHO regions, from the years 1973 to 2008, and reported an average DMFT of 2.11 ± 1.32 (range 0.2–7.8) among 12-year-old children in the world.[18] Studies from the South east Asia SEARO region (1984–2008) reported a mean DMFT of 1.95 ± 1.24 (median of 1.65) in the 12-year age group.[18] An Indian study has shown a high risk (Population Attributable Risk or an average of 101.84%) for caries compared to the regional average.[18] Even the RR (Relative Risk or deviation from the mean with a value of >1 representing an excess) for the highest DMFT in Indian children is >1.00.[18] This is despite the fact that the dentist-population ratio in India is increasing rapidly with 30,000 dentists graduating annually.[19]

The present study has observed an increase in dental caries with a decrease in SES, thus being in agreement with most studies worldwide.[6,10] A similar study in Mangalore, India observed a higher prevalence of dental caries in 5–13-year-old children of lower SES (96.2%) compared to the upper SES

Table 4 – A comparison of the consumption of food/beverages once a day by children of all SES.

	SES 26–29 (Upper) $n = 360$	SES 16–25 (Upper middle) $n = 685$	SES 11–15 (Lower middle) $n = 460$	SES <10 (Lower) $n = 789$	p-Value
Fresh fruit	46.7%	45.1%	33.5%	25.3%	<0.001**
Biscuits, cakes, cream cakes, sweet pies, buns, etc.	24.2%	27.9%	26.3%	22.3%	.085
Lemonade, Coca cola, or other soft drinks	10.3%	10.4%	10.4%	8.2%	.441
Jam/honey	7.8%	8.5%	10.4%	9.6%	.506
Chewing gum containing sugar	14.7%	12.7%	10.9%	16.1%	.051
Sweets/candies	12.2%	14.0%	17.2%	22.6%	<0.001**
Milk with sugar	40.3%	47.3%	54.3%	45.4%	.001**
Tea with sugar	15.8%	20.0%	32.6%	50.2%	<0.001**
Coffee with sugar	12.5%	8.0%	6.1%	4.2%	<0.001**

** Highly significant.

Table 5 – A comparison of the consumption of food/beverages ≥ 2 times a day by children of all SES.

	SES 26–29 (Upper) $n = 360$	SES 16–25 (Upper middle) $n = 685$	SES 11–15 (Lower middle) $n = 460$	SES <10 (Lower) $n = 789$	p-Value
Fresh fruit	31.9%	23.6%	15.4%	4.8%	<.001**
Biscuits, cakes, cream cakes, sweet pies, buns, etc.	7.5%	7.0%	3.7%	3.7%	.003**
Lemonade, Coca cola, or other soft drinks	1.1%	1.2%	.9%	1.0%	.968
Jam/honey	1.1%	1.3%	1.5%	.4%	.169
Chewing gum containing sugar	3.1%	3.5%	3.0%	2.7%	.831
Sweets/candies	5.0%	5.1%	5.4%	3.5%	.356
Milk with sugar	50.0%	39.7%	22.2%	5.3%	<.001**
Tea with sugar	1.4%	2.9%	4.6%	14.2%	<.001**
Coffee with sugar	1.1%	.6%	.7%	.3%	.343

** Highly significant.

(77.1%).[20] Likewise, Chandra and Reddy[21] ($n = 1187$) also reported a higher caries occurrence in lower SES aged 19–57 years. Probable reasons could be a lack of awareness, lack of motivation or willingness, monetary reasons, inadequate dentist-population ratio, overcrowded government hospitals and dispensaries, longer waiting times, extended intertreatment appointments, and eventually, failure of follow-up visits. In our study, most parents of lower SES were daily wagers, and loss of wages could have resulted in irregular dental follow-ups and missed appointments.

Another important observation in the present study was the presence of less filled and more missing teeth in the lower compared to the upper SES. This is attributable to expensive dental treatment, in particular, the restorative, endodontic, and subsequent prosthetic rehabilitation. On the other hand, extractions are cheaper and require minimal visits.

The use of fluoride in toothpastes as a preventative measure for dental caries has been researched intensively for decades. Marinho et al.[22] in a Cochrane review selected 74 randomized and quasirandomised controlled clinical trials in children aged ≤16 years and compared the effects of fluoride toothpaste and placebo. They confirmed the beneficial effects of fluoride in toothpaste in preventing dental caries. The current study observed that most children were unaware of the benefits and the presence of fluoride in the toothpaste they used.

Also observed in the present study was that children of lower SES reported more conditions of pain/trouble with the teeth, and reported less children for follow-up and for routine checkup. The fact is in concurrence with the study by Machry et al.[23] in Brazil ($n = 478$), in one- to five-year-old children, where the children of lower SES visited a dentist for treatment rather than preventive measures. Also, Machry et al.[23] observed that visit to the dentist was less in younger children, with less maternal education, and in those who brushed less. Hamasha et al.[10] in a longitudinal study over nine years reported relatively fewer dental visits by the lower SES compared to the upper SES at age 48–108 months. In our study, significantly more children of lower SES had never visited for dental care compared to the upper (p-value < 001) SES. In a city known for its high literacy and high per capita income, 37.1% of all the examined children had never visited a dentist.

Dental caries has been linked to frequent consumption of fermentable carbohydrates or dietary sugars, particularly in cases of poor oral hygiene and inadequate use of fluoridated toothpaste. A dietary assessment of the children of lower SES revealed frequent consumption of sweetened tea daily coupled with a less frequent fresh fruit intake. Additionally, the consumption of readily available and affordable sweets/candies was higher. The dietary pattern of daily increased sugar exposures with a decreased consumption of fresh fruit could be responsible for more caries in this SES. Increased fruit consumption by the children of upper strata, because of the inherent fibrous nature of food, promotes oral cleansing by encouraging salivary flow.[24] The children of the upper SES also

have better awareness and knowledge of oral healthcare through parental guidance, accessibility to social media, schools, and affordability of oral care.

Additionally, with the mushrooming of multiple restaurants, fast food outlets, and roadside vendors, eating out has become common among children of the city.[25] This is more so because of the accessibility, convenience (both working parents with paucity of time and energy to cook food at home), and the affordability factors.[26] The frequent consumption of calorie-dense, high-fat, high-sugar, less fibrous, and low-nutrient foods may also be responsible for a high prevalence of dental caries in the city (73.2%).

The prevalence of dental caries, generally reported to be more in girls, differs widely in literature with regard to gender.[27,28] The present study also observed a higher prevalence of dental caries in girls, which could be attributed to less consumption of fruit, hormonal changes of puberty, particularly estrogen affecting the salivary flow rate and composition,[29] early eruption and an early exposure of teeth to oral environment,[29] role in food preparation with frequent snacking,[29] and genetic alterations.[27] On the contrary, another Indian study on 12–15-year old children showed that boys (61%) had a slightly higher prevalence than girls (59.4%), which was attributed to longer feeding time of male children by all strata.[28] In the present study, boys were more likely to report pain/trouble with the teeth than girls (48.7% vs 39.6%; *p*-value 0.016) and were less likely to report for routine checkups (27.4% vs 35.3%; *p*-value .024). This fact could be attributable to a lower pain tolerance exhibited by boys compared to girls. On the other hand, boys usually being more boisterous and careless are less likely to maintain follow-up appointments.

The 2000 Surgeon General's Report on Oral Health observed an increased prevalence of dental caries with age, ranging from 51.6% in 5–9 year olds to 77.9% in 12 year olds and 84.7% for those over 18 years.[6] A higher prevalence of dental caries in the older age group of 14–16 years compared to 11–13-year age group was also observed in our study. The reasons could be frequent snacking, more academic pressures, career aspirations generating more stress, increased appetite because of rapid growth and development, hormonal influences, and rapid physiological changes of puberty, which may alter salivary flow and composition.

Other findings from this survey revealed that among the teeth, permanent first molars were most affected followed by permanent second molars and premolars in that order. This is in agreement with the study by Goyal et al.[16] The permanent first molars are most affected because of an early eruption, early exposure to oral environment, and the presence of more pits and fissures. In the present case, canines and mandibular anterior teeth were least affected. These teeth, because of a smoother surface, are less plaque retentive. In addition, mandibular incisors, being in proximity to the salivary gland ducts, possess benefits of salivary flow, calcium and phosphorus, enzymes, and anticaries elements in saliva.

Even though Chandigarh ranks high in terms of literacy and per capita income, yet there is a high prevalence of dental caries among 11–16-year-old children (73.2% with a mean DMFT of 2.93 $\pm$ 2.86; range of 0–17) with a significant number never having reported for dental care (37.1%). This is despite the fact that the city has[30] limited supporting staff, increased patient waiting times, and extended intertreatment appointments, which lead to a delay in seeking and continuing with dental care.[30] The dental treatment at private clinics is expensive and out of reach of the common man. Additionally, unless there is an esthetic concern, dental caries in its incipient or chronic stage is usually painless, seldom debilitating, and hence, is likely to remain undetected and often neglected.

The study evaluated the prevalence and pattern of dental caries and assessed the oral health-related behavior of 11–16-year-old children in the city. However, there are certain limitations of the study. First, the parents, particularly of the upper strata, were reluctant and often unwilling to disclose their income. Second, the data is scant on the actual use of fluoridated toothpaste by most children. Third, the study, in order to be representative of a country with great cultural diversity, different dietary habits, and oral hygiene practices, needs to be done on a wider scale involving multiple states.

4.1. *Conclusion*

The observations in the present study were a high prevalence of dental caries among 11–16-year-old children of the city, an inverse corelation of caries with socioeconomic status, higher DMFT in girls, and a higher DMFT in the 14–16-year age group. The probable reasons include frequent consumption of fermentable carbohydrates, lack of knowledge and awareness of dental benefits of fluorides, socioeconomic factors, and an inadequate knowledge and motivation for oral healthcare. Dental education provided at an early age, through periodic school dental health programs, with regular involvement of teachers and parents, will promote better oral and general health. Also, incentives for 'best smile', 'caries-free dentition', or accolades for children who have been regular with dental treatment/follow-up would be motivating factors. Knowledge, awareness, and encouragement of better dietary habits including fresh fruit consumption, accessibility and affordability of health foods, and use of fluoridated toothpastes should be encouraged through media, at home and at school. Adoption of areas/schools by the institutes/dispensaries/health clinics will also go a long way in improving oral health.

The study evaluated the prevalence and pattern of dental caries and assessed the oral health-related behavior of 11–16-year-old children in the city. However, there are certain limitations of the study. First, the parents, particularly of the upper strata, were reluctant and often unwilling to disclose their income. Second, the data is scant on the actual use of fluoridated toothpaste by most children. Third, the study, in order to be representative of a country with great cultural diversity, different dietary habits, and oral hygiene practices, needs to be done on a wider scale involving multiple states.

Authors' contribution

US, NG, RA, and IS contributed to data collection. US, NG, and AG assisted with data processing and data interpretation, and US for writing the manuscript as well. US and KG contributed to the study conception/design and the rest for reviewing the final draft of the article.

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Ethics approval

The study was approved by the ethical committee of the Institute, Panjab University, Chandigarh, India, vide letter number PUIEC/10/235 dated 14/10/2010.

Conflicts of interest

The authors have none to declare.

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