original article

# Prevalence of periodontitis in high school children in Saudi Arabia: a national study

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**BACKGROUND:** The occurrence of periodontitis is rather infrequent in children and adolescence and increases with age. We conducted this study because there have been few epidemiological studies on prevalence of periodontitis in children in Saudi Arabia.

**OBJECTIVE:** Determine the prevalence of periodontitis in high school children in Saudi Arabia.

**DESIGN:** Cross-sectional, using cluster and multistage sampling.

**SETTING:** High school children in Saudi Arabia.

**PARTICIPANTS AND METHODS:** Periodontal examinations were conducted on a randomized sample of high school children between the ages 15 to 19 in Saudi Arabia. The study spanned from September 2012 to January 2016. Clinical examinations included measurements of the probing depth (PD) percentage of PD ≥4 mm per patient.

**MAIN OUTCOME MEASURES:** The prevalence of periodontitis (PD ≥4 mm and CAL ≥1 mm), the mean percentage PD ≥4 mm, the mean percentage CAL ≥1 mm, plaque index (PI) and gingival index (GI).

**SAMPLE SIZE:** 2435 high school students.

**RESULTS:** Of 2435 high school children in the sample, 209 students (8.6%) had periodontitis. The mean (standard deviation) for the PD was 0.59 (0.17) mm. Differences in percentage PD ≥4 mm and CAL ≥1 mm were greater in students with periodontitis ($P<.001$). The prevalence of periodontitis was higher among non-Saudis, students who did not brush their teeth and did not visit their dentist regularly. In the bivariate analysis, periodontitis was positively associated with GI, PI, number of teeth extracted, mean percentage PD ≥4 mm, and mean PD. However, in the multivariate analysis, tooth brushing was the main factor protective against periodontitis (odds ratio: 0.62, 95% CI 0.42-0.92, $P=.017$).

**CONCLUSION:** Periodontitis prevalence was high compared with Western countries in a nationally representative sample of high school students in Saudi Arabia.

**LIMITATIONS:** Partial mouth study design, which may underestimate the disease prevalence.

**CONFLICT OF INTEREST:** None.

Periodontal diseases are universal among children, adolescents, and adults. For many years, clinicians have attempted to classify the evident differences in the forms of these diseases.[1] Since 1999, periodontitis was classified as aggressive, chronic, necrotizing and as a manifestation of systemic disease.[2] In 2017, periodontal diseases were re-defined as interdental clinical attachment loss (CAL) detectable at ≥2 non-adjacent teeth, or as buccal or oral CAL ≥3 mm with pocketing >3 mm detectable in ≥2 teeth.3 Periodontitis is rather infrequent in childhood, and tends to increase during adolescence, with a steady increase in adulthood.[4] Due to the prevalence and severity of periodontitis being low in children compared to older age groups,[5] few epidemiological studies on the prevalence of periodontitis in children in Saudi Arabia have been reported. Prior to 2005, very few studies exist that attempt to estimate the rates of periodontitis in Saudi population.[6] Recent prevalence studies focused only on clinical populations, not on general population rates.[7,8]

Implementation of community-based oral health promotion programs is an important duty of public health organizations to detect periodontitis early in the younger age groups to prevent progression to more severe forms and to allocate different resources for treatment. Therefore, the primary objective of this cross-sectional study was to evaluate the prevalence of periodontitis in high school children in Saudi Arabia using national representative data. A secondary objective was to examine the relationship between periodontitis and other study variables.

## PARTICIPANTS AND METHODS

This was a cross-sectional descriptive study to determine the prevalence of periodontitis among high school children in all of Saudi Arabia. The country has a vast area of 2 250 000 sq km and occupies over four-fifths of the Arab Peninsula. Each of five regions (central, eastern, northern, western, and southern) has specific demographic patterns and sociocultural practices, which may influence the pattern of dental health in the population. Saudi Arabia has an estimated population of 33.9 million (77% urban, 23% rural mix). The study aimed at selecting a randomly selected sample of healthy school children and school children with medical conditions not correlated with periodontitis. The sample included grades 10 to 12 (15-19 years old) of both genders. Students or parents who refused to sign the consent form or who rejected the periodontal examination, and students with medical conditions that have been reported to have a relationship with periodontitis were excluded from the study. We followed a multistage clustered sampling design to guarantee an adequate representation of all children in the country within the specified school grades. The study focused mainly on a large city in each region. The relative number of subjects from each city was based on the size of the population in the region where the city was located. Within each chosen city a group of schools were randomly selected, using computer generated numbers, from various geographic regions to guarantee a mixture of various social and economic backgrounds. Within each selected school all children grades 10th to 12th were included in the sample. The total number of students in the selected cities were: Riyadh (n=713), Jeddah (n=657), Dammam (n=506), Abha (n=297) and Tabuk (n=262).

The study was approved by the Research Ethics Committee of the Faculty of Dentistry, King Abdulaziz University (073-09-12). Subject name, gender, age, marital status, address, contact information, and socioeconomic status were recorded. At the examination visit, the examiners reviewed the medical history with the subjects and recorded the information. A dental history questionnaire was completed by each subject and revised as necessary with the examiner.

All clinical examinations were performed by four dentists, who were calibrated to the exact procedures for disease diagnosis, the proper use of Williams probes, probe angulation, force and position for each tooth, and other examination criteria was prepared and made available to each in a diagnostic manual. Sufficient training and evaluation of the examiners was conducted to document that the examiners were scoring diseases accurately and consistently. Examiners were given didactic sessions to explain the proper use of the periodontal probe including force, site and angulation of the probe. After the didactic sessions, all examiners were given hands-on physical training sessions to fill the examination forms accurately. The intra- and inter-examiner reliability for the gingival index, probing depth and clinical attachment level were tested using intraclass correlation coefficients (ICC). The value of the ICC's were >0.7 for all variables, which corresponded to an excellent reliability as reported by Landis and Koch.[9] The examination was on permanent teeth only; primary and partially erupted teeth were excluded from the examination. The number of missing teeth were also recorded.

The gingival and periodontal examination consisted of measurement of the gingival and periodontal supporting tissue including attachment loss and probing pocket depth using a Williams probe and furcation involvement. The examination also included an assessment of tooth mobility, gingival bleeding, dental

plaque, dental calculus, and gingival recession.[10] We randomly selected one maxillary and one mandibular quadrant using computerized simple random sampling. The disease was evaluated on the mesiobuccal, midbuccal and distolingual (MB-B-DL) portion of all teeth excluding third molars following the three site half-mouth partial recording protocol.[11] For the assessment of oral hygiene and gingivitis severity, we used the Silness and Loe plaque index, and the Loe and Silness gingival index, respectively.

Probing depth (PD) was measured from the free gingival margin to the bottom of the sulcus. The distance from the cemento-enamel junction to the free gingival margin was recorded in millimeters. Loss of attachment (CAL) is the distance (in millimeters) from the cemento-enamel junction to the bottom of the gingival sulcus. The dependent variable (periodontitis) was defined as a finding of at least one site with P D≥4 mm and CAL ≥1 mm at the same site. The probing depth and clinical attachment loss percentage are the proportions of PD ≥4 mm and CAL ≥1 mm per patient. For each patient, 3 sites per each tooth in two randomly assigned quadrants were examined.

This study was analyzed using IBM SPSS version 22 (IBM SPSS, Armonk, NY: IBM Corp). Simple descriptive statistics were used to define the characteristics of the study variables by counts and percentages for the categorical and nominal variables while continuous variables are presented as mean and standard deviation. To test the bivariate relationship between periodontitis and categorical and continuous variables, the chi-square and independent *t* test were used, respectively. To test the multivariate association between periodontitis and the study variables, logistic regression analysis was used. The dependent variable was defined as a binary outcome. A conventional *P* value <.05 was the criteria to reject the null hypothesis.

## RESULTS

The study included 2435 male and female high school students. The minimum age was 15 years, the maximum was 19 years and the mean (SD) was 17.3 (1) **(Table 1a)**. The mean (SD) PD was 0.59 (0.17). Only about one-fifth (18.7%) reported that they visit the dentist regularly **(Table 1b)**. Most (88.5%) reported brushing their teeth while slightly more than one-tenth (11.5%) admitted to not brushing. When comparing subjects from different cities, the mean CAL was significantly higher in Abha city in comparison to other cities, although no significant difference was found in the prevalence of periodontitis. No significant difference was found in any of the other study parameters between different cities.

As to periodontal status, 209 students (8.6%) had periodontitis, and 769 students (34.5%) had a healthy periodontal status, which is defined as a "state free from inflammatory periodontal disease that allows an individual to function normally and not suffer any consequences (mental or physical) as a result of past disease".[12]

The PD ≥4 mm (%) and CAL≥1 mm (%) was greater in students with periodontitis **(Figure 1a, 1b)**. **Tables 2a and b** show the bivariate association between periodontitis and characteristics (categorical and continuous) of the total sample (n=2435) relative to periodontitis. Nationality, brushing, previous permanent teeth extracted, plaque index, gingival index, the mean number of missing teeth, mean probing depth, and mean percentage PD ≥ 4mm had a significant relationship to the presence of periodontitis. Non-Saudis, students who did not brush, who had a previous permanent tooth extraction, and those who had a larger plaque index, gingival index, number of missing teeth, probing depth, and percentage PD ≥4 mm were more likely to have periodontitis.

**Table 3** shows results from a multivariate binary logistic regression model to test the significant predictors of the presence of periodontal disease. Of all demographic and most oral hygiene factors, only brushing had a statistical significant association with periodontitis (*P* value <.017) after adjustment for oral hygiene factors.

## DISCUSSION

This study evaluated the prevalence of periodontitis and the influence of different demographic factors on its prevalence among high school children. To our knowledge, this is the first report on the prevalence of periodontitis amongst this age group, evaluated on a large scale for all five regions of Saudi Arabia. The results showed that 209 (8.6%) of the school students had some degree of periodontitis (mild chronic periodontitis) (1) which is equivalent to stage 1 periodontitis in 2017 classification.[13] Several parameters were significantly related to periodontitis. Nationality, brushing, previous permanent teeth extracted, plaque index, gingival index, the mean number of missing teeth, mean probing depth, and percentage PD ≥4 mm had a significant relationship to the presence of periodontitis. Non-Saudis, those who do not brush their teeth, those who had previous permanent tooth extraction, and those who had a greater means of plaque index, gingival index, number of missing teeth, probing depth, and percentage PD ≥4 mm are more likely to have periodontitis. In addition, the results showed that brushing decreases the chance of having periodontitis.

Of the population examined, 196 students (8%) were

**Table 1a.** Demographic and clinical characteristics of participant population (continuous variables).

| | |
|---|---|
| Age (years) | 17.3 (1.0), 15-19 |
| Mean PD (mm) | 0.59 (0.17), 0-1.80 |
| PD ≥4 mm (%) | 1.85, 0-66.7 |
| Mean CAL (mm) | 0.1 (0.2), 0-2.2 |
| CAL ≥1 mm (%) | 2.54, 0-100 |
| Plaque index | 1.3 (0.8), 0-3 |
| Gingival index | 1.0 (0.8), 0-3 |

Data are mean (SD) and/or range. PD: probing depth, CAL: clinical attachment loss.

**Table 1b.** Demographic and clinical characteristics of participant population (categorical variables).

| | |
|---|---|
| **Nationality** | |
| Non-Saudi | 196 (8.0) |
| Saudi | 2239 (92.0) |
| **Gender** | |
| Male | 1329 (54.6) |
| Female | 1106 (45.4) |
| **Do you smoke?** | |
| Yes | 201 (8.3) |
| No | 2234 (91.7) |
| **Medical history** | |
| No | 2022 (83) |
| Yes | 413 (17) |
| **Do you visit a dentist regularly?** | |
| Yes | 455 (18.7) |
| No | 1980 (81.3) |
| **Do you brush your teeth?** | |
| Yes | 2156 (88.5) |
| No | 279 (11.5) |
| **Brushing frequency** | |
| Once | 922 (42.8) |
| Twice | 922 (42.8) |
| More than 2 times | 356 (16.5) |
| Missing | 279 |

Data are number (%).

**Table 1b. (cont.)** Demographic and clinical characteristics of participant population (categorical variables).

| | |
|---|---|
| **Do you floss your teeth?** | |
| Yes | 255 (10.5) |
| No | 2180 (89.5) |
| **Do you brush your tongue?** | |
| Yes | 871 (35.8) |
| No | 1564 (64.2) |
| **Previous dental treatment** | |
| Yes | 1657 (68.0) |
| No | 778 (32.0) |
| **Previous permanent teeth extracted** | |
| Yes | 585 (24.0) |
| No | 1850 (76.0) |

Data are number (%).

non-Saudis. Of those, 28 students (14.3%) presented with periodontitis compared to 181 students (8.1%) of the Saudi population. When the characteristics of the population were studied based on nationality, non-Saudis had a significantly higher mean CAL, percentages of PD ≥4 mm and percentage of CAL ≥1 mm. Interestingly, there was no difference between Saudis and non-Saudis for previous dental treatments, oral hygiene measures or plaque index. This might suggest that the discrepancy between the two populations is due to cultural and differences in socioeconomic status. It is well accepted that the level of attachment loss is influenced by race/ethnicity, although the role of this factor is not fully explained. Certain racial/ethnic groups, particularly subjects of African and Latin background, have a higher risk of developing periodontal tissue loss than other groups.[10,14-16] There is also evidence that this increased risk may also be partly related to genetic predispositions.[17] For example, in the USA, the prevalence was 2.3% for chronic periodontitis and 0.4% for aggressive periodontitis among children aged 13-15 years.[18] Similarly, in Italy, it was 0.5% for aggressive periodontitis and 2% for chronic periodontitis in children aged 6-14 years.[19] In south Brazil, the prevalence of chronic periodontitis was 18.2% among 14-19 year old children.[20] On the other hand, the prevalence of the aggressive form of the disease is higher in African and Asian countries. A study in Uganda

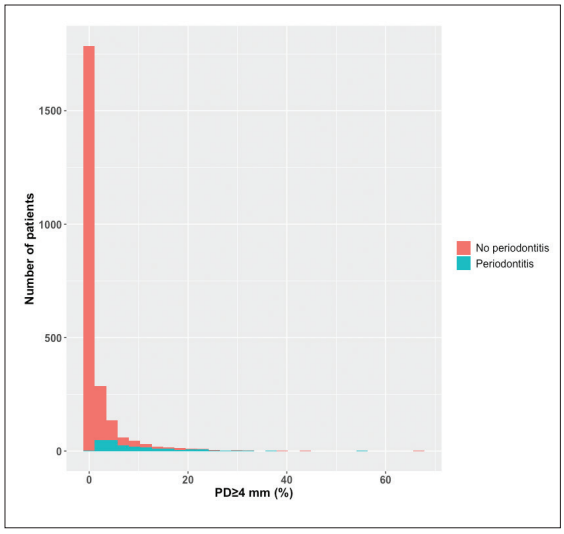


**Figure 1a.** Distribution of percentage of sites per patient with probing depth ≥4 mm by the presence of periodontitis (*P*<.001).

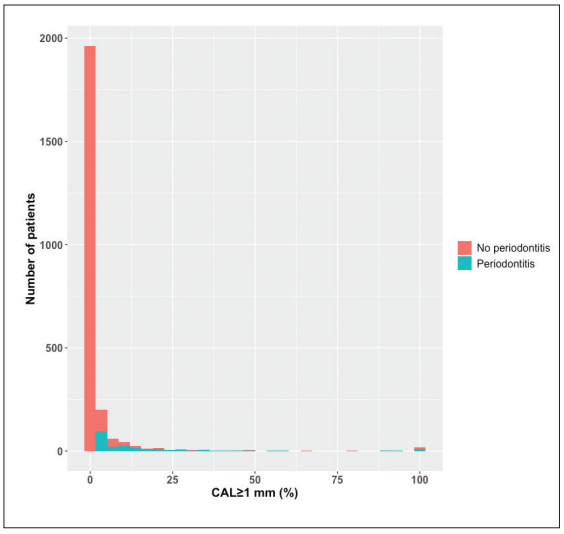


**Figure 1b.** Distribution of percentage of sites per patient with clinical attachment loss ≥1 mm by the presence of periodontitis (*P*<.001).

on school children aged 12-16 years revealed that the prevalence of aggressive and chronic periodontitis was 6.5% and 22.3% respectively.[21] In Morocco, it was 4.9% for aggressive and 6.4% for chronic periodontitis among 12- 25 year old school students.[22] The rate of prevalence of aggressive periodontitis in Asia ranged from 0.13% to 0.86%.[23,24]

Oral hygiene, specifically regular tooth brushing with fluoridated toothpaste, was associated with not having periodontitis,[25] and twice daily tooth brushing was significantly more effective than brushing once a day.[26] Among the study variables, our study showed that only brushing decreases the chance of presence of periodontitis in our national study population. These results are consistent with a Korean national study that showed brushing after lunch and before bedtime as well as the use of floss and a powered toothbrush may be considered independent risk indicators of periodontitis among a Korean sample.[27]

There is a marked decrease in prevalence in periodontal disease in developed countries when compared to developing countries. This lower prevalence may be due to differences in the availability of dental care and community-based health care delivery systems.

In the current study, 8.3% of the population admitted to being smokers. Interestingly, there was no significant relationship between smoking and periodontal or gingival status in this population. These results are consistent with a study published in 2013 where they could not find an association between caries and periodontal disease and smokeless tobacco in Saudi adolescents; however 9 out of 10 in their sample had intra-oral mucosal lesion.[28] This is probably because the harmful effects of smoking are not yet evident in this young population. An epidemiological study from the United States reported a sharp decline in teenage smoking in 2002 following a peak of adolescence smoking observed in the mid 1990's. This has been related to a number of successful educational programs to decrease smoking among adolescents.[29] It is generally agreed that most people will never start smoking if kept tobacco free in youth.

Periodontitis was also significantly associated with deeper periodontal pockets. Subjects with periodontal disease had significantly deeper pockets and higher percentage of pockets ≥4 mm. Periodontal parameters

**Table 2a.** Bivariate association between continuous variables and periodontitis (n=2435).

| Variables | Periodontal disease | | *P* value |
|---|---|---|---|
| | Yes | No | |
| Age (years) | 17.3 (1.0) | 17.3 (1.0) | .741 |
| Plaque index | 1.56 (0.8) | 1.24 (0.8) | <.001[b] |
| Gingival index | 1.33 (0.8) | 1.00 (0.8) | 0.001[c] |
| Missing teeth | 0.59 (1.1) | 0.38 (0.9) | .009[c] |
| Mean PD | 0.75 (0.2) | 0.58 (0.2) | <.001[c] |
| PD ≥4 mm (%) | 7.1 (4.8-11.9) | 0 | <.001[c] |

Data are mean (SD).PD: probing depth. [a]Independent *t* test; [b]Welch's test; [c]Mann-Whitney U test

**Table 2b.** Bivariate association between study characteristics (categorical) and periodontitis (n=2435).

| Characteristics | Periodontitis | | *P* value |
|---|---|---|---|
| | Yes | No | |
| **Gender** | | | |
| Male | 109 (8.2) | 1220 (91.8) | .461 |
| Female | 100 (9.0) | 1006 (91.0) | |
| **Nationality** | | | |
| Saudi | 181 (8.1) | 2058 (91.9) | .003 |
| Non-Saudi | 28 (14.3) | 168 (85.7) | |
| **Smoker** | | | |
| Yes | 22 (10.9) | 179 (89.1) | .212 |
| No | 187 (8.4) | 2047 (91.6) | |
| **Medical history** | | | |
| No | 172 (8.5) | 1850 (91.5) | .765 |
| Yes | 37 (9.0) | 376 (91.0) | |
| **Regular dental visits** | | | |
| Yes | 44 (9.7) | 411 (90.3) | .359 |
| No | 165 (8.3) | 1815 (91.7) | |
| **Brushing** | | | |
| Yes | 172 (8.0) | 1984 (92.0) | .003 |
| No | 37 (13.3) | 242 (86.7) | |
| **Brushing frequency** | | | |
| Once | 64 (7.3) | 814 (92.7) | .562 |
| Twice | 76 (8.2) | 846 (91.8) | |
| More than 2 times | 32 (9.0) | 324 (91.0) | |
| **Flossing** | | | |
| Yes | 17 (6.7) | 238 (93.3) | .248 |
| No | 192 (8.8) | 1988 (91.2) | |
| **Tongue brushing** | | | |
| Yes | 63 (7.2) | 808 (92.8) | .076 |
| No | 146 (9.3) | 1418 (90.7) | |
| **Previous dental treatment** | | | |
| Yes | 153 (9.2) | 1504 (90.8) | .095 |
| No | 56 (7.2) | 722 (92.8) | |
| **Previous permanent teeth extracted** | | | |
| Yes | 63 (10.8) | 522 (89.2) | .030 |
| No | 146 (7.9) | 1704 (92.1) | |

Data are number (%).. Numbers do not add up for brushing and brushing frequency due to missing data (n=297). Medical history means systemic disease associated with periodontitis (diabetes, anemia, genetic disorders).

examined in this study included PD, CAL, plaque index and gingival index. The mean PD was 0.59 mm and the mean percentage of PD ≥4 mm was 1.85%. This is relatively low compared to other studies. In a Georgian population of 15-year-old adolescents, the mean probing depth was 3.34 mm and 34% of the population had at least one site with more the 5 mm PD.[30] One explanation could be related to the study methodology. For example, the Georgia study used Ramfjord index teeth, while this study used half mouth design. The variation between the two studies might also be due to the difference of ethnic background and genetic variation between the two populations. Other studies reported relatively closer numbers. A survey of Armenian region school children showed a tendency for an increase in periodontal indices. Periodontal pocket depths of 4–5 mm among these juveniles were reported in 2.04% of the cases.[31] Ericsson and associates conducted an epidemiological survey aimed at analyzing the periodontal conditions of 19-year-old individuals in two rural counties in Sweden. This study revealed a mean prevalence of sites with PD of ≥4 mm to be approximately 8%.[32] In Jordan, Taani reported that 5.32% of the adolescent population had shallow pockets and 0.29% had deep pockets.[33]

The mean CAL was 0.05 mm and the percentage of CAL ≥1 mm is 23.5%. There is a lot of variation in reports of prevalence of attachment loss. In an American population of 14 to 17-year-old adolescents, Bhat reported that the average periodontal attachment loss is 0.33 mm.[34] Another study on 12 to 22-year-old students reported that CAL ≥1 mm was seen in 69.2% of the students; ≥2 mm in 16% of the students; and ≥3 mm in 4.5%.[35] In France, Bourgeois and his colleagues reported that loss of attachment ≥5 mm was 46.68% and PD >5 mm is 10.21%. However, CAL of ≥5 mm occurred in only 0.88 sites in an individual.[36] This variation can be attributed to differences in study design (diagnostic criteria, examination method, and way of disease classification), disparities in examiners, their training and calibrations undoubtedly influence the reported differences in disease occurrence in different countries.[21] Although the partial mouth design employed in the present study is cost effective and consumes less time during the periodontal examination, it might underestimate the disease severity. Hunt examined the efficiency of half-mouth periodontal examinations in estimating the prevalence of periodontal disease among older U.S. adults and found that the half-mouth method resulted in some underestimation of the extent of the more severe periodontal conditions and disease prevalence was underestimated by up to 13%.[37,38]

**Table 3.** Multivariate logistic regression model of factors associated with periodontitis (n=2435).

| Predictor | Estimate | SE | Z | *P* | Odds ratio | 95% Confidence interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower | Upper |
| Intercept | –3.0057 | 0.2570 | –11.70 | <.001 | 0.0495 | 0.0299 | 0.0819 |
| P index | 0.2919 | 0.1117 | 2.61 | .009 | 1.3389 | 1.0757 | 1.6667 |
| G index | 0.3651 | 0.1156 | 3.16 | .002 | 1.4406 | 1.1486 | 1.8069 |
| DMFT | 0.0595 | 0.0168 | 3.55 | <.001 | 1.0613 | 1.0270 | 1.0967 |
| **Tooth brushing** | | | | | | | |
| Yes - No | –0.4781 | 0.2007 | –2.38 | .017 | 0.6199 | 0.4183 | 0.9188 |

Model fit measures. Deviance: 1354, AIC: 1364, $R^2$ (McFadden): 0.0423, $R^2$ (Nagelkerke): 0.0552. DMFT: Decayed/missing/filled teeth.

In conclusion, periodontitis was high in a nationally representative sample of high school students in Saudi Arabia compared with Western countries. in the multivariate analysis, there was a significant association between periodontitis and tooth brushing, independent of other variables. Surprisingly, smoking was not related to periodontal disease, which might be explained by the fact that since the population is so young, the harmful effect of smoking is not yet evident. This study also emphasizes the need for patient education, parental counseling and regular dental examination and prophylaxis for maintaining a healthy and hygienic oral cavity in childhood.

Based on the data presented, the following recommendations can be made to improve periodontal health and reduce periodontitis: Well-structured oral health education programs for school children to create a positive attitude toward dental care, reinforcement of knowledge by incorporating oral health and oral hygiene in school curricula and involving teachers through training programs, execution of preventive school dental health programs focusing on plaque control and prophylaxis, and comprehensive screening programs to assess the oral health and treatment needs of school children. These preventive services should be given high priority and needs to be started at an early age. Dental care services, both preventive and therapeutic, should be widely available for everybody.

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