*Journal of Oral Health & Community Dentistry*

ORIGINAL ARTICLE

# Prevalence and Relationship Between Dental Caries, Diet and Nutrition, Socioeconomic Status and Oral Hygiene Habits in Children Using Laser Fluorescence Device (Diagnodent)

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**ABSTRACT**

**Aim:** The study assessed the incidence of dental caries in first permanent molars, evaluate and compare caries activity between upper and lower first permanent molar and evaluates the effect of various variables on the incidence.

**Materials and Methods:** Caries were detected using DIAGNOdent as a valuable adjunct to clinical examination. The visual appearance of the site recorded using the criteria proposed by Ekstrand et al.

**Results:** Out of total teeth examined, 50.17% were affected by dental caries and 49.90% teeth had no carious lesion. Out of affected teeth enamel caries consisted of 108 (20.69%) teeth, outer half dentin caries affected 101(19.35%) teeth and 53(10.15%) teeth showed dentin caries extended to inner half of teeth. Further significant associations were noted in between different variables.

**Conclusions:** An early preventive program at the age of 6-7 years reduced caries incidence in permanent molars.

**Keywords:** Dental caries, DIAGNOdent, First permanent molar.

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J Oral Health Comm Dent 2014;**8**(1)16-23

## INTRODUCTION

Dental caries is an important dental public health problem and is one of the most prevalent dental diseases in developed and underdeveloped countries particularly among children (1). The prevalence of dental caries was of great interest for long and is a principal subject of many epidemiological researches being carried out all over the world. The disease not only causes damage to the tooth, but is also responsible for several morbid conditions of the oral cavity and other systems of the body (WHO 1981) (2).

The prevalence pattern of dental caries varies with age, sex, socio economic status, race, geographical location, food habits and oral hygiene practices(3). These events develop by the interaction between bacteria and food particles, especially refined carbohydrates (sugar). Progression of decays to the surrounding tissue can cause inflammation and abscess formation which may subsequently act as a nidus for infection of other organs (4). Changes of diet and/or oral hygiene habits in combination with optimal fluoridation may stop the progression of a lesion and even allow its remineralization(5).The onset of caries is characterized by only microscopically visible surface demineralization on dental hard tissues.

Non- cavitated occlusal caries diagnosis is generally considered problematic since there may be carious lesions involving dentin beneath seemingly intact occlusal surfaces (6,7). Traditionally used diagnostic methods for fissure caries detection exhibits high specificity but low sensitivity (8). The regular use of explorer has been questioned due to its lower efficiency, production of deleterious effects of transmission of microorganisms of one fissure to another and hence increasing susceptibility to caries progression (8). Recently, a new diagnostic method and device for intact (occlusal) surfaces was presented. It is based on fluorescent measurement. Clinical studies(6,7) have shown sensitivity of > 92 % and specificity 69 % for occlusal caries detection. Laser Fluorescence device (DIAGNOdent, 2095, KaVo, Biberach, Germany) is able to capture the fluorescence emitted from bacterial porphyrin and other chromophores when the teeth are stimulated by its diode laser with a wavelength of 655nm. The change in the fluorescence intensity are numerically quantified and translated to values ranging from 0 to 99 (9). The caries process alters the amount of fluorescence which can be seen as an elevated reading (6). The accuracy of DIAGNOdent has been studied both in vitro (10,11) and in vivo (7,12).

In a clinical study among children, Sheehy (12) et al (2001) have found that visual examination and DIAGNOdent measurements are suitable for caries detection and considered DIAGNOdent to be a valuable adjunct to clinical examination. Further studies(6,7,12) showed DIAGNOdent to be an accurate method for diagnosis of occlusal caries, mainly if employed simultaneously with visual inspection. The clinical performance of DIAGNOdent is related to cut off limits used in the clinical practice. Several cut off limits have been suggested, not only by the manufacturer but also by in vivo (6,7,9,12) and in vitro (10,13) studies. In the present clinical study new cut off limits for the Laser Fluorescence device proposed by Diniz M.B et al (9) was used and these limits were not considered as fixed and carefully interpreted with visual examination criteria proposed by Ekstrand et al.1997 (14). Since laboratory and clinical studies showed promise for both the visual system (Ekstrand et al. 1997) and the DIAGNOdent for the non invasive diagnosis of occlusal caries, the aim of this study is to find the prevalence of dental caries in first permanent molars specifically within 3-4 years of eruption i.e in children of 6-10 years of age attending OPD of Pedodontics and Preventive Dentistry from areas in and around Rohtak, to evaluate and compare caries activity between upper and lower first permanent molars and to evaluate the effect of various variables on the incidence of caries in first permanent molars.

## MATERIALS AND METHODS

A total of 132 healthy subjects (522 occlusal surfaces) age ranged 6-10 years (mean age 8.25 + 0.11), out of which males were n = 69 (52.27 %) and females were n= 63 (47.72 %) selected randomly. 262 (50.19%) maxillary and 260 (49.80%) mandibular first permanent molars were examined. One occlusal site per tooth was selected with macroscopically intact surfaces, varying from sound to different degrees of non-cavitated carious lesions. Teeth with carious lesion on approximal surfaces, fissures sealant (opaque), occlusal restorations (composite), hypoplasia, obvious fissure stains and with advanced degree of fluorosis were excluded. All the children volunteered and their parents gave consent after receiving verbal and written information. Patient history was taken and a pretested structured questionnaire consisted of demographic information on each child was filled. Information collected included the age, gender, socioeconomic status, dietary habits and oral hygiene status. The socioeconomic status was obtained through an index of mother's level of education and father's occupation. Child was also being asked to provide information on the type of oral hygiene tool or methods used and the frequency of tooth cleaning each day.

**Table 1: Visual examination and Clinical Interpretation (Ekstrand et al 1997) (14)**

| Score | Interpretation | Visual examination |
|---|---|---|
| 0 | Sound | No or slight change in enamel after prolonged air – drying ( > 5 s) |
| 1 | Caries lesion in enamel | Opacity or discoloration hardly visible on wet surface but distinctly visible after air drying; |
| 2 | Caries lesion in the outer half of the dentin | opacity or discoloration distinctly visible without air drying<br>Localized enamel breakdown in opaque or discolored enamel and/or grayish discoloration frvom the underlying dentin |
| 3 | Caries lesion in the inner half of the dentin | Cavitation in opaque or discolored enamel exposing dentin |

**Table 2: Optimal cut off limits of the LF device to detect in vivo occlusal carious lesion (Diniz MB et al ) (9)**

| New cut off limits | Clinical lesion depth |
|---|---|
| 0-14 | Sound |
| 15 - 21 | Enamel caries |
| 22 - 37 | Carious lesion in the outer half of the dentin |
| > 38 | Carious lesion in the inner half of the dentin |

Visual examination of all First Permanent Molars with the patient positioned in the dental chair was performed, after thorough cleaning of teeth. A 2 in 1 air syringe, a halogen bulb, a plain mouth mirror were used to assist this visual examination. The visual appearance of the site was then being recorded using the criteria proposed by Ekstrand et al (1997) as shown in Table 1. After visual examination the patients were subjected to DIAGNOdent measurement of all First Permanent Molars.

The laser fluorescence assessment of the occlusal surface was performed using the DIAGNOdent (2095, KaVo, Biberach, Germany) after calibration on a ceramic standard using a fiber optical conical tip (Tip A), which has been specifically designed by the manufacturer for the detection of occlusal caries. The fluorescence of a sound spot on the cuspal area of the buccal surface was recorded for each tooth (zero substraction value) in order to provide a baseline value for that tooth. The occlusal surface of First Permanent molar was cleaned with pumice slurry and extensively washed with water for 10 seconds. A site on the occlusal surface was chosen for investigation which was either the central fissure of Mandibular First Permanent Molar or the central fossa of the mesial pit of the Maxillary First Permanent Molar. Site was assessed under cotton roll isolation and after briefly being air dried with 2 in 1 syringe. The tip was positioned perpendicular to the test site and rotated (pendulous movement) around its long axis, to ensure the fluorescence from slopes of the fissure walls, where the carious process often begins. The highest LF reading (table 2) was recorded and the zero subtraction value was subtracted from this value. For each site, 3 measurements were performed and averaged for statistical purposes.

The data collected was subjected to statistical analysis using SPSS software, version 17 (SPSS Inc., Chicago, III., USA). The relationship between variables was calculated using chi-square test. The level of significance was set to 5% ($p < 0.05$). The kappa coefficient of correlation was used as the measurement of agreement between laser fluorescence values and the visual scoring criteria.

**Table 3: Prevalence of dental caries in first permanent molars among children age ranged 6-10 years.**

| New cut off limits | | Clinical lesion depth | | |
|---|---|---|---|---|
| Teeth examined 522 | No Caries 260 (49.90 %) | Dental Caries 262 (50.17 %) | | |
| | | Enamel Caries 108 (20.69 %) | Dentin (Outer half) 101 (19.35 %) | Dentin (Inner half) 53 (10.15 %) |

## RESULTS

Out of 522 teeth examined, 262 (50.17%) were affected by dental caries and 260 (49.90%) teeth had no carious lesion. Out of affected teeth enamel caries consisted of 108 (20.69%) teeth, outer half dentin caries affected 101(19.35%) teeth and 53(10.15%) teeth showed dentin caries extended to inner half of teeth. Results were shown in table 3.

Table 4 shows the prevalence of dental caries in first permanent molars in each quadrant respectively. Prevalence of enamel caries was 31(28.70%) and 29(26.85%) in maxillary, 27(25.00%) and 21(19.44%) in mandibular right and left first permanent molars respectively. Similarly, caries extending to outer and inner half of dentin were 14(13.86%) and 3(5.66%) in maxillary right, 12(11.88%) and 2(3.77%) in maxillary left, 40(39.60%) and 23(43.39%) in mandibular right and 35(34.65%)

**Table 4: Prevalence of dental caries in first permanent molars**

| Teeth examined | Maxillary first permanent molars (N=262) Right (n=130) | Maxillary first permanent molars (N=262) Left (n=132) | Mandibular first permanent molars (N=260) Right (n=131) | Mandibular first permanent molars (N=260) Left (n=129) |
|---|---|---|---|---|
| No Caries | 82 (31.54%) | 89 (34.23%) | 41* (15.77%) | 48* (18.46%) |
| Enamel Caries | 31 (28.70%) | 29 (26.85%) | 27 (25.00%) | 21 (19.44%) |
| Dentin Caries (outer half) | 14 (13.86%) | 12 (11.88%) | 40* (39.60%) | 35* (34.65%) |
| Dentin Caries (inner half) | 3 (5.66%) | 2 (3.77%) | 23* (43.39%) | 25* (47.17%) |

* p <0.001 when caries in mandibular teeth compared to maxillary teeth (chi square test)

**Table 5: Association of dental caries with different variables/factors in 132 children 6-10**

| Tyears of age: Variables/Factors | Chi-square test | p value |
|---|---|---|
| Dental Caries with: | | |
| 1. Age | No association | — |
| 2. Gender | $\chi 2$ =3.958 | p<0.05 |
| 3. Geographic location | $\chi 2$=4.273 | p<0.05 |
| 4. Type of employment of parents (professional, labourer, unemployed/ housewife) | No association | — |
| 5. Education level of father | $\chi 2$ =6.516 | p<0.05 |
| 6. Education level of mother | No association | — |
| 7. Income of parents | No association | — |
| 8. Number of rooms per family | No association | — |
| 9. Number of family members living together | No association | — |
| 10. Miscellaneous factors | | |
| a. Parents having habit of smoking | $\chi 2$ =3.957 | p<0.05 |
| b. Magazines taken | No association | — |
| c. Domestic help employed | No association | — |
| 11. Method of cleaning teeth | $\chi 2$ =9.153 | p<0.05 |
| 12. Frequency of oral hygiene aids (tooth brush, datun, finger etc used) | $\chi 2$ =9.939 | p<0.05 |
| 13. Different types of toothpaste used (Fluoridated/Non-Fluoridated) | $\chi 2$ =11.044 | p<0.05 |
| 14. Source of drinking water (Pipe water or Ground water) | No association | — |
| 15. Access to dental services | | |
| a. Ever visited dentist | No association | — |
| b. Consulted in last 12 months | $\chi 2$ =5.953 | p<0.05 |
| c. Regular visit | $\chi 2$ =6.022 | p<0.05 |
| d. Habit of flossing | $\chi 2$ =6.349 | p<0.05 |
| 16. Pocket money of children | No association | — |
| 17. Dietary habits | | |
| a. In between meals | No association | — |
| b. Number of times sugar containing (sweets, chocolates/ toffees, biscuits, sweet drinks, tea, milk and dairy products) taken per day | No association | — |
| c. Number of times per day fresh fruits was consumed | No association | — |

and 25(47.17%) in mandibular left molars respectively. On applying the chi-square test it was found that dental caries in first permanent molars in children aged 6-10 years is highly statistically significant in mandibular teeth as compared to maxillary teeth ($\chi^2$=10.89, p <0.001).

Relationship between dental caries with regard to demographic variables, dietary habits of the subjects, socioeconomic status and oral hygiene aids used were shown in table 5.

The kappa value recording the measurement of agreement between laser fluorescence values and the visual scoring criteria (Ekstrand's) was 0.886 indicating a very good agreement between two system (Tb= 32.126) as shown in table 6.

**Table 6: Measurement of agreement between laser fluorescence (LF) and visual examination (VE)**

| Count | | VE score | | | | Total |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | | |
| LF score | 0 | 255 | 5 | 0 | 0 | 260 |
| | 1 | 12 | 93 | 0 | 0 | 108 |
| | 2 | 3 | 9 | 88 | 1 | 101 |
| | 3 | 0 | 1 | 5 | 47 | 53 |
| **Total** | **270** | **108** | **96** | **48** | **522** | |

Kappa coefficient of correlation = 0.886 (Tb= 32.126)

## DISCUSSION

The occlusal surfaces are the most caries susceptible sites in children, young adolescents and adults (22). Additionally, as dentinal caries can occur under a macroscopically intact surface, the detection of occlusal caries lesions by conventional methods, such as visual examination and radiography, is insufficient (23). There is thus a need for an objective quantitative method for occlusal caries detection and to support restorative treatment decisions. DIAGNOdent is a recently developed laser fluorescence device, which has been investigated for diagnostic performance of occlusal caries detection in several studies (7,10-12).

An ideal diagnostic method should offer high sensitivity and high specificity. Bader et al (18) reported that LF device was more sensitive and less specific than the visual examination. Attrill and Ashley (19) compared LF, visual examination, and intraoral radiography, and they found that LF was the most accurate system as compared to intraoral radiography which was the worst system for occlusal caries detection. However, Burin et al (24) evaluated the efficiency of LF, visual examination, and bitewing radiography, and they reported that visual examination was as valid as LF device, which should be considered a better adjunct than bitewing radiography for occlusal caries diagnosis.

McDonald (1992) (26) pointed out a high frequency of occlusal caries on the permanent first molar for all age groups, concluding that occlusal surface of first permanent molar remains the most common site for caries within a short period following its eruption. Furthermore, the first permanent

molar was the earliest erupting teeth of the permanent dentition in most cases and has control over the teeth erupting later behind and in front of them. They have the maximum root surface area they are considered to be best source of anchorage for moving the tooth, support the main masticatory duty, and influence the vertical distance of upper and lower jaws, the occlusal height, and esthetic proportions (25). Furthermore, the health of this tooth in particular can form a good basis to assess the oral health status of these children, since this tooth is more vulnerable to caries than others because of its functional and morphological (deep pits and fissures on the occlusal surface) characteristics as well as to the surrounding conditions the newly erupted permanent molars have to face. This is the reason why occlusal surface of first permanent molars in children aged 6-10 years were taken in this study.

The findings of our study showed that 50.19% of first permanent molars were affected by dental caries and 49.81% were caries free. The proportion varies from 40.57%, 43.62%, 65.04% and 53.08% for 6-7, 7-8, 8-9 and 9-10 years old children respectively. The findings obtained in the present study were in accordance with that of Luca et al (2002) (20) who reported 53.97% carious and 46.03% caries free first permanent molars in a study group consisting of 126 children (62 boys and 64 girls) aged 6 to 9 years. The proportion varied from 36.12% for the 6-7 years old to 61.12% for the 8-9 years old. Similar results were reported by Kuhnisch et al (1997) (31) and Hescot and Roland (1987) (30). In contrast, Stempler et al (1997) (32) reported lower prevalence of dental caries in first permanent molars i.e 40.63% in an urban population consisting of 5-9 years old children from Argentina whereas Noronha et al (1999) (44) reported a relatively higher caries prevalence i.e 87.3% in occlusal surface of first permanent molars.

One important finding of the present study was that mandibular first permanent molars (65.77%) exhibited statistically highly significant caries prevalence than their maxillary counterpart (34.74%). The findings were in concordance with that of Serban, Maxim and Balan (27). The reason for mandibular first permanent molar exhibiting higher caries could be attributed to their morphology and eruption time. Mandibular first permanent molar has more number of pits and supplementary grooves which can act as food retentive areas promoting caries. Further, in majority of children mandibular first permanent molar erupts slightly earlier than its maxillary counterpart, hence mandibular first permanent molar being exposed to the oral environment for a longer period of time, making it more susceptible to caries than maxillary first permanent molar.

Findings of our investigation clearly show that caries prevalence for age 9-10 years (53.08%) was higher than that for age 6-7 years (40.57%) and highest at 8-9 years (65.04%) of age. This may be due to the fact that dental caries increases with age and this comes in agreement with previous studies by Al-Sayyab et al (28) and others.

Most research (20) supports the findings of our study that girls (57.02%) demonstrate a higher level of dental caries as compared to boys (43.95%). In contrast, Venugopal et al (15), Shetty and Tandon (33) found no significant difference in caries prevalence between male (36.15%) and female (34.93%) children.

Moreover in the present study rural children (57.87%) exhibited higher caries prevalence than the urban children (41.36%). Similar findings have been reported by Luca et al (20) and Stempler et al (32). Probable reason for this could be lack of access to health education, preventive dental programs and school dental services for the urban children.

In the present study considering the socioeconomic status no statistically significant difference in the distribution of dental caries was found. These findings were in accordance with Ghandour (34) who classified children into three socio-economic groups – low, middle and high, but did not find any statistically significant difference between the caries prevalence within these groups. This can be explained by the fact that grouping of subjects according to the socioeconomic status encompasses the influence of education (35), income (36) and social environment. Further, determination of social class is complicated especially in developing countries like India, where there are no specifically accepted criteria for the same.

Christensen et al (21) found that the mother's educational level seemed to be the main determinant of the children caries level. Low educational level often means lack of skills and social benefits. Such lack of skills may include a lack of ability to process certain information and a lack of ability to interact with health professionals. It can also mean a lack of ability to adapt to health promotion behavior. Al-Shammery et al (37) reported a higher prevalence of caries amongst molars in primary school children whose parents had a primary level of education or were illiterate. However, in the present study such association was not statistically significant.

Our study had not revealed much influence of parental income on caries prevalence. Venugopal et al (15) and Khan et al (38) also reported similar observation. High income group differs significantly from others by their knowledge of reduction of sugar intake to prevent dental caries.

Regarding others variables the prevalence of dental caries was found to be statistically significant in children of parents having a habit of smoking (58.96%) as compared to those do not smoke (45.86%).

In the present study statistically significant low prevalence of dental caries was noted in children cleaning their teeth using tooth brush (41.87%), with a finger (65.63%) or neem stick (71.15%) compared to children who do not clean (74.60%) their teeth. Similarly low caries prevalence was found for children using oral hygiene aids daily (52.47%) or more than daily (26.13%) compared to those using once a week (79.48%), twice a week (76.74%) and never used (74.60%). Our results were in agreement with Venugopal et al (15), Khan et al (38) and Verma et al (39) reported lower caries prevalence among those with regular brushing habits. Venugopal et al (15) showed a relationship between frequency of rinsing mouth and caries prevalence, it was low in those who used to regularly rinse their mouth with water after food. Bellini et al (40) reported that the relationship between caries and the amount of plaque on teeth or frequency of self-reported oral hygiene measure is vague. High sucrose consumption and poor oral hygiene are often found in the same individual, and the effect of one of these factors may vary.

Considering dental caries according to access to dental health, in our study prevalence of caries were found to be low in children visiting a dentist regularly, had visited in the last 12 months and having a habit of flossing. Many other studies reported that a regular visit to a dentist lead to a better oral health and condition of permanent teeth as compared to those who never visited.

In the present study no significant difference was found between caries prevalence according to source of drinking i.e Pipe water or Municipal supply (48.31%) and Ground water (52.16%). Further dental caries was comparable in children using fluoridated (42.42%) and non-fluoridated toothpaste (43.33%). However, there was a significant difference from those not using tooth pastes (71.85%) i.e using neem stick, ash etc.

Both positive correlation and lack of correlation between the intake of sucrose containing foods and caries have been reported. In the present study with increasing number of sugar exposure difference in distribution of dental caries were found to be statistically non significant. The strongest correlation between sugar consumption and caries development was seen when international data was compared. A study by Sreebny (41) using data on sugar supplied in various countries and data on caries prevalence obtained from WHO for 6 year old children in 23 nations and 12 year olds in 47 nations, showed that the availability of less than 50 grams sugar per person per day in a country was always associated with dmfs or DMFT scores of less than three. Similar findings were reported by Gustaffson et al (42) and Shetty and Tandon (33) in their studies.

However, Mc Donald (29) found no significant relationship between sugar consumption and caries prevalence. Our study is in agreement to his study. Most of the cross-sectional epidemiological studies showed a weaker correlation between sugar intake and caries than might be expected from theoretical considerations. It is evident that dietary data obtained through questionnaires, or diet history interviews, covered a period ranging from 1 day to some months, while caries data included the total caries experience accumulated over the years. Further, sugar clearance is another important factor, which must be taken into consideration while studying the effect of sugar consumption on incidence of dental caries.

In the present study correlation obtained statistically between visual and DIAGNOdent were found to be very good i.e 0.886 (kappa coefficient of correlation). These results were in accordance to the study by Sridhar and Tandon (16). But in cases of stained occlusal surfaces if the diagnosis and treatment decision is solely based on DIAGNOdent reading there will be a tendency to overestimate the lesion stage and a higher risk of overtreatment. In such cases, visual examination is more appropriate to the clinician or at least the dentist using the laser fluorescence system must be aware of its limitations before reaching a treatment decision.

The fundamental basis for the detection and quantification of carious lesion by DIAGNOdent method is registration of altered physical characteristics of carious hard tissues relative to surrounding sound surfaces. It has also been reported by Li et al (43) that mean values for laser fluorescence in the first permanent molars were significantly higher for caries active than for caries inactive 6 to 7 year old children. The principal limitation of the method is that an increased reading could reveal change in the physical properties of the tooth structure, such as caries, disturbed tooth development or mineralization as well as deposits of calculus or organic material. Therefore the clinician experience is a fundamental prerequisite for using the instrument as an aid to detection of clinical caries. As mentioned before in this study (Table 6) DIAGNOdent has over scored 12 teeth for which visual inspection revealed no visible carious lesion.

Several reports assessing the conventional fluorescence device pointed out that plaque, toothpastes, prophylaxis pastes, and stains (e.g. brownish pigments) could give false-positive readings (10,17). Therefore, in the present study, professional cleaning of tooth surfaces was performed using a rubber cup and plain water spray, as this cleaning procedure is recommended prior to laser fluorescence measurements in teeth with visible plaque.

An early preventive program at the age of 6-7 years reduced caries prevalence

in permanent molars. Restorative and preventive regimens for teeth must be based on frequent recall examinations of not more than 6 monthly intervals to reduce dental decay and further caries progress in the first permanent molars among children. First permanent molars are very important teeth in the mouth for maintaining the integrity of the dental arches and therefore they need special attention during dental examination.

## CONCLUSION AND SUMMARY

The results of the present study can be used as a powerful aid for planning a proper health care system at early ages. Such plans may include improving parents' knowledge about the importance of these teeth, especially because most parents are unaware that these teeth are the first permanent teeth.

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