Article published online: 2021-11-01

ORIGINAL ARTICLE

Malocclusion and deleterious oral habits in a north Indian adolescent population: A correlational study

Nidhi Pruthi, Girish M. Sogi[1], Shailee Fotedar[2]

Departments of Public Health Dentistry, Rama Dental College, Hospital and Research Centre, Kanpur, Uttar Pradesh, [1]KLE Institute of Dental Sciences, Belgaum, Karnataka, [2]Government Dental College and Hospital, Shimla, Himachal Pradesh, India

Address for correspondence:
Dr. Nidhi Pruthi,
Department of Public Health Dentistry,
Rama Dental College, Hospital and
Research Centre, Kanpur,
Uttar Pradesh, India.
E-mail: drnidhi_21@yahoo.in

ABSTRACT

Objective: To assess the prevalence of malocclusion and deleterious oral habits among 12 and 15-year-old school children in Shimla city, India and to find, if any correlation exists between the two. **Design:** Correlational study design. **Setting:** Twelve schools in Shimla city, India. **Materials and Methods:** Prevalence of malocclusion and orthodontic treatment need was assessed using the Dental Aesthetic Index (DAI) among a sample of 961, 12 and 15-year-old school children in Shimla city, who received no orthodontic treatment before or during the study. Subjects were also assessed for deleterious oral habits. **Statistical Analysis:** Chi-square and Mann-Whitney U tests were used. Multivariate regression analysis was used to test the correlation of habits with mean DAI score and malocclusion traits. **Results:** Mean DAI score was 26.81±5.25. Nearly 53% of the study sample presented with malocclusion, ranging from 'definite' to 'handicapping' based on the DAI scores. The prevalence of various deleterious oral habits was 25.9%. About 29% of children with any oral habit developed malocclusion as compared to those without any habit (*P* value=0.023). Tongue thrusting, mouth breathing and thumb sucking habits had a significant impact on malocclusion. **Conclusion:** There was high prevalence of malocclusion (52.7%). Abnormal oral habits, particularly mouth breathing and tongue thrusting had a significant impact on malocclusion, resulting in higher frequency of crowding in anterior teeth, open bite, and spacing.

Key words
Adolescents, deleterious oral habits, Dental Aesthetic Index, malocclusion

INTRODUCTION

A number of epidemiological studies on malocclusion and orthodontic treatment need have been performed worldwide which have reported wide variations in the incidence of malocclusion. The lack of suitable universal methods for recording and grading malocclusion and the different criteria used to define malocclusion have been a considerable factor that has influenced such extreme of variation.[1] The World Health Organization (WHO) in order to address this has accepted the Dental Aesthetic Index (DAI) as an international cross-cultural index in the assessment of orthodontic treatment need.[2]

Development of malocclusion is determined by a combination of genetic and environmental influences. In recent years, the etiological importance of genetic factors has been reduced, considering that many malocclusions recognize a post-natal origin.[3] Oral habits, especially if they persist beyond the preschool age, have been implicated as an important environmental factor associated with the development of malocclusion.[4] The role of prolonged digital sucking habit on the development of malocclusion has been investigated by many researchers. Similarly the effect of abnormal swallowing pattern has been notably documented in the literature.[5-7]

The knowledge of prevalence and causes of malocclusion can help formulate strategies for prevention, interception, and corrective treatment. In view of fiscal restraints due to high costs of orthodontic services and lack of publicly funded dental treatment programs in developing countries, such as India, it becomes increasingly important to recognize orthodontic treatment need according to severity and to identify modifiable factors that can be targeted through preventive and interceptive orthodontics.

The present study was initiated in urban Shimla,

Access this article online	
Quick Response Code:	Website: www.ejgd.org
	DOI: 10.4103/2278-9626.116013

including 12 and 15-year-old school-going children. The aims of the study were to (1) assess the prevalence of malocclusion and deleterious oral habits, and (2) to find, if any correlation exists between the presence of deleterious oral habits and the malocclusion status.

MATERIALS AND METHODS

The present cross-sectional study was carried out among a sample of 12 and 15-year-old school going children in Shimla city. Shimla is the largest town and capital city of the Northern hill state of Himachal Pradesh, India. For the purpose of sampling, Shimla city was arbitrarily divided into four geographical regions (quadrants), which correspond to the four varying demographic areas of the city: Shimla municipal and 3 Shimla Planning Areas (Dhalli, Tutu, and New Shimla). Employing the cluster sampling technique, schools from each region were randomly selected such that there was a proportionate representation from each of the four zones. For obtaining the required sample size, seven government and five private schools were selected randomly and all children aged 12 and 15 years in the selected schools were surveyed.

The sample size was computed on the basis of prevalence rate of malocclusion in the region available from the National oral health survey and Fluoride Mapping, 2002-2003,[8] Himachal Pradesh and computed using the Epi Info version 6 at 95% confidence interval (CI). The calculated sample size was 925.

Children who were attending the school, and who had attained their 12th and 15th birthday on the day of examination were considered eligible for inclusion in the study. Children with any history of orthodontic treatment or undergoing orthodontic treatment at the time of examination were excluded from the study.

List of schools in Shimla city and prior permission to visit the schools for the survey was obtained from the Directorate, Department of Elementary Education, Shimla and Principal/Headmaster of the participating schools signed the consent for participation of the children in the study. The Institutional Review Board of H.P. Govt. Dental College and Hospital (HPGDC), Shimla gave the ethical approval for the study.

A single trained examiner carried out all the examinations in the respective schools to avoid inter-examiner variations. Training and calibration of the examiner was done to standardize the recording criteria in the Department of Public Health Dentistry, HPGDC, prior to the field survey.

Intra-examiner reproducibility was determined using Kappa-statistic by randomly selecting five students on each examination day from among those examined the previous day and re-examining the next day. A pilot study was conducted to test the proposed proforma for its feasibility and the format was finalized.

Data regarding general information including name, age, gender, type of school the child attended (i.e. government or private), and history of orthodontic treatment was obtained through an interview with the participating subjects.

Deleterious oral habits were assessed by self-reporting of the subjects through a face-to-face interview. The subjects were assessed for thumb sucking, lip biting, grinding of teeth, tongue thrusting, mouth breathing, and other habits including pen/pencil or nail biting. Clinical examination was done for the presence or absence of abnormal tongue thrust while swallowing and mouth breathing was confirmed using the butterfly and mouth mirror test.[9]

Malocclusion and Orthodontic Treatment Need was assessed using the Dental Aesthetic Index (DAI) according to the method recommended by WHO.[10] All examinations were conducted at the respective schools under natural day light illumination, using mouth mirror and the WHO standard periodontal probe (CPI probe).

The data was analyzed using Statistical Package for Social Sciences (SPSS) package, version 15. Statistical tests used were Chi-square test for comparing categorical variables and Mann-Whitney U test for comparing quantitative variables. Multivariate logistic regression analysis was used to identify the effect of independent variables (i.e. age, sex, presence of any deleterious oral habit) on the dependent variable, i.e. DAI score, and further to test the effect of habits on DAI score and malocclusion traits. A P value of ≤ 0.05 was considered statistically significant.

RESULTS

Following the exclusions, which accounted for 4.7% of the study population (50 students), the study sample comprised 961 subjects. The main demographic and clinical characteristics of the study population are depicted in Table 1.

Intra-examiner reproducibility assessed by Kappa-statistic was found to be 0.81 and 0.77 for prevalence of malocclusion and deleterious oral habits, respectively.

Frequency distribution of malocclusion traits according to DAI components for 12 and 15 year-old subjects is shown in Table 2.

The mean DAI score of this study group was 26.81±5.25 [Table 3].

Prevalence of malocclusion and treatment need according

Table 1: Selected characteristics of the study sample

Variable	Number	Percent
Age (years)		
12	476	49.5
15	485	50.5
Total	961	100
Gender		
Male	598	62.2
Female	363	37.8
Total	961	100
Type of school attended		
Government	476	49.5
Private	485	50.5
Total	961	100
Deleterious oral habits		
Any habit present	249	25.9
No habit present	712	74.1
Total	961	100
Type of oral habit present*		
Thumb sucking	22	2.3
Lip biting	19	2.0
Grinding of teeth	19	2.0
Tongue thrusting	61	6.3
Mouth breathing	55	5.7
Other habits (pen/pencil/nail biting)	116	12.1
Orthodontic treatment taken§		
Government schools	3	0.62
Private schools	47	8.83
Total	50	4.94

*Some children presented with more than one oral habit, thereby this total does not match with the above total of 'any habit present', Percentage is calculated for total of 961 subjects, §Orthodontic treatment taken was assessed for all subjects examined before exclusions; thereby this total was 1011 subjects, Percentages are calculated for number of children studying in government schools (479), private schools (532) and total number of children (1011), respectively, before exclusion

Table 2: Frequency distribution of malocclusion traits according to Dental Aesthetic Index components and age

DAI component	12 years (*N*=476)		15 years (*N*=485)		Total (*N*=961)		*P* value*
	%	No.	%	No.	%	No.	
Missing teeth ≥1	2.3	11	3.9	19	2.1	20	0.152
Crowding (incisal segments) 1-2	73.0	348	75.9	369	74.5	717	0.291
Spacing (incisal segments) 1-2	30.6	146	26.5	129	28.5	275	0.163
Diastema (mm) ≥1	17.0	81	11.3	55	14.1	136	0.012**
Anterior maxillary irregularity ≥1 (mm)	77.0	367	75.2	365	76.0	732	0.505
Anterior mandibular irregularity ≥1 (mm)	68.1	325	64.9	315	66.5	640	0.275
Maxillary overjet (mm) ≥4	48.2	230	36.8	179	42.5	409	0.000**
Mandibular overjet (mm) ≥1	3.6	17	3.9	19	3.7	36	0.777
Open-bite (mm) ≥1	2.7	13	7.8	38	5.2	51	0.000**
Molar relation ≥1/2 unit cusp	27.5	131	32.8	159	30.1	290	0.079

N – Number of subjects; **P* values from Chi-square test, *P* value≤0.05 is considered statistically significant, **Statistically significant, DAI – Dental Aesthetic Index

to the severity levels as measured by the DAI was 52.7%. Among these 28.3% had definite malocclusion (DAI score 26-30), 14.7% had severe malocclusion (DAI score 31-35), and 9.7% had handicapping malocclusion (DAI score≥36). Age and gender-wise distribution of malocclusion severity is shown in Figure 1.

The frequency distribution of deleterious oral habits among children having some kind of malocclusion was found to be 28.8% compared to 22.3% in children having no malocclusion (*P*=0.023). Figure 2 depicts the presence of malocclusion among subjects with deleterious oral habits.

Results of the multivariate logistic regression analysis revealed that the presence of any deleterious oral habit significantly affected the DAI score (*P*=0.037, 95% C.I.=0.080-2.601, regression model, Table 4). In order to analyze which deleterious oral habit affected the DAI and its severity, all oral habits were entered into a regression model to predict the effect on DAI score. Results of the regression model are shown in Table 5.

Further, in the present study, the effects of habits on individual malocclusion traits were analysed in detail. All oral habits were entered into separate regression

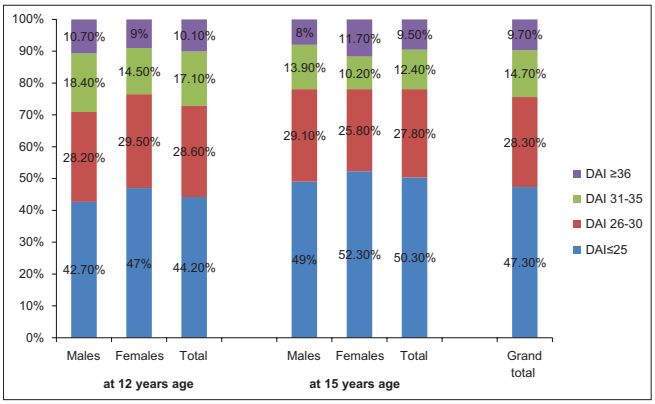

Figure 1: Age and gender-wise distribution of malocclusion severity according to DAI scores

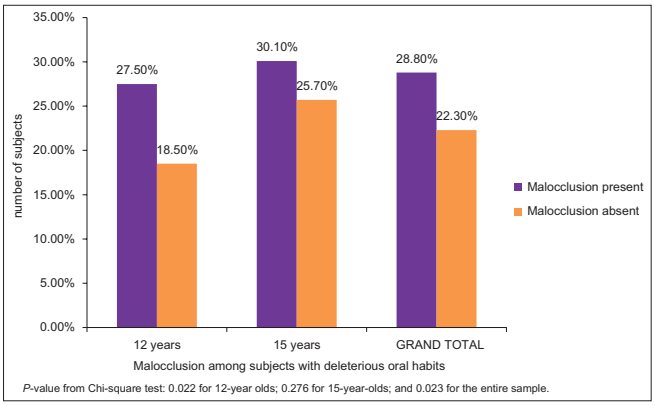

Figure 2: Age and gender-wise distribution of malocclusion among subjects with deleterious oral habits

models for each malocclusion trait. Results revealed that mouth breathing habit significantly affected presence of crowding in incisal segments (*P*=0.022, 95% C.I=-0.465 to -0.037), largest anterior maxillary irregularity (*P*=0.003, 95% C.I=-0.953 to -0.196), largest anterior mandibular irregularity (*P*=0.001, 95% C.I=-0.717 to -0.185) and increased maxillary overjet (*P*<0.001, 95% C.I=-1.871 to -0.831). Tongue-thrusting habit was significantly associated with spacing in the incisal segments (*P*=0.014, 95% C.I=-0.350 to -0.040), midline diastema (*P*=0.010, 95% C.I=-0.328 to -0.044), reverse overjet (*P*<0.001, 95% C.I=-0.288 to -0.120), anterior open bite (*P*<0.001, 95% C.I=-0.608 to -0.420) and deviation from normal molar relation (*P*<0.001, 95% C.I=-0.538 to -0.212). Thumb suckers significantly associated with increased maxillary overjet (*P*=0.015, 95% C.I=-1.809 to -0.195) and midline diastema (*P*=0.025, 95% C.I=-0.494 to -0.033).

Table 3: Age and gender-wise distribution of subjects according to mean Dental Aesthetic Index score

Age	Gender	*N*	Mean DAI score	Standard deviation	*P* value
12 years	Males	310	27.3	5.47	0.287
	Females	166	26.57	4.86	
	Total	476	27.04	5.27	
15 years	Males	288	26.62	5.07	0.569
	Females	197	26.52	5.46	
	Total	485	26.58	5.23	
Grand	Total	961	26.81	5.25	

N – Number of subjects; **P* values from Mann-Whitney U test, *P* value≤0.05 is considered statistically significant, DAI – Dental Aesthetic Index

DISCUSSION

The present study determined the prevalence of malocclusion, orthodontic treatment need, and the relationship of malocclusion with associated factors, such as deleterious oral habits, in a North Indian school going population of 12 and 15-year-old children in Shimla city. Malocclusion is established close to its full expression in an individual with the eruption of all permanent teeth, thereby young adolescents at the late mixed dentition and early permanent dentition stage provide a much clear prevalence of malocclusion and orthodontic treatment needs than younger children.[11,12]

Children with present or past history of orthodontic treatment were excluded from the study. In the present study, it was found that 50 subjects had seeked orthodontic treatment, which constituted 4.7% of the study group, similar to that reported by some other authors.[3,13-15] This clearly indicates underutilization of orthodontic services, and also a significant disparity was noted between the government and private school students in the utilization of orthodontic services. This could be because of low awareness of oral health problems and less importance of dental aesthetics among the children belonging to government schools and their parents, as well as the unaffordability of orthodontic services by the majority.

Prevalence of oral habits was found to be 25.9%. This is similar to that reported by Kharbanda, Sidhu and

Table 4: Regression model showing relationship of age, sex, and presence of any deleterious oral habit with Dental Aesthetic Index score

	Unstandardized coefficients		Standardized coefficients	Sig.	95% confidence interval (C.I.) for B
	B	Standard error	Beta		
Coefficients (a)					
(Constant)	29.180	3.936		0.000	21.455-36.905
Age	−0.127	0.235	−0.017	0.589	−0.587-0.333
Sex	−0.895	0.736	−0.039	0.225	−2.3400-0.551
Any oral habit	1.340	0.642	0.068	0.037*	0.080-2.601

[a]Dependent variable – DAI score, *Statistically significant, DAI – Dental Aesthetic Index

Table 5: Regression model showing relationship of various deleterious oral habits with Dental Aesthetic Index score

	Unstandardized coefficients		Standardized coefficients	*T*	Sig.	95% confidence interval (C.I) for B	
	B	Standard error	Beta			Lower bound	Upper bound
Coefficients (a)							
(Constant)	44.324	9.371		4.730	0.000	25.935	62.714
Thumb sucking	−2.262	2.382	−0.031	−0.950	0.343	−6.936	2.413
Lip biting	0.144	2.568	0.002	0.056	0.955	−4.895	5.184
Grinding of teeth	−0.774	2.554	−0.010	−0.303	0.762	−5.786	4.238
Tongue thrusting	−3.324	1.471	−0.073	−2.259	0.024*	−6.211	−0.436
Mouth breathing	−3.797	1.534	−0.080	−2.476	0.013*	−6.807	−0.787
Other habits	1.216	1.076	0.037	1.130	0.259	−0.895	3.327

[a]Dependent variable – DAI score; *Statistically significant, DAI – Dental Aesthetic Index

Sundram (25.5%) in Delhi children,[4] and Shetty and Munshi (29.7%) in Mangalore children.[16] However, Gauba *et al.*, in their study on rural children in Haryana found a low prevalence of only 3.0%.[17] Among the various habits it was found that other habits which included habit of pen/pencil/nail biting were most prevalent (12.0%), followed by tongue thrusting affecting 6.3% of the population. This is consistent with the findings of National Oral Health Survey, which reported highest prevalence of "habit of biting nails, lips or objects like pencil" among all habits at both 12 (32%) and 15-years age (21%) in the two regions of Himachal Pradesh.[8] Shetty and Munshi have also reported high prevalence of pencil biting (9.8%) and nail biting (12.7%), they found a comparatively low prevalence of tongue thrust among Mangalore children in the age range of 3-16 years.[16]

Similar to other studies,[14,15,18-20] the malocclusion traits as assessed by the DAI components showed that the population studied in this research had more problems with crowding distribution than with extra space. Crowding of teeth and dental irregularities in the anterior maxillary and mandibular segments were the most frequent traits observed. Crowding between the teeth and presence of rotations and displacements has been reported at a high frequency among few other Indian studies as well.[21] In a study by Katoh *et al.*, malocclusion in three ethnic groups of Asian origin was worse for crowding in the incisal segments, maxillary and mandibular largest anterior irregularity and antero-posterior molar relation compared to those in white Americans.[18] Jenny *et al.*, have suggested that inherited differences in tooth size and arch size may be one reason for differences because the DAI includes measurements of the most relevant orthodontic traits that affect dental aesthetics, such as crowding.[22] These differences reflect racial differences in skeletal growth and dental measures in the maxillae and mandible.[15] Another significant finding was that increased maxillary overjet (>4 mm) decreased over age, other studies have also reported that maxillary overjet decreased with age.[23,24] Moyers has stated that both overbite and overjet decrease throughout the second decade of life, probably due to the relatively forward growth in the mandible.[9] In the present study, a significant increase was observed in the frequency of open bite from 2.7% to 7.8% and from 12 to 15 years age. This is similar to that reported by Thilander *et al.*,[24] and Sidlauskas *et al.*[23] Since overbite is not assessed by the DAI, this finding needs further investigation, as there is a tendency of decrease in overbite with age due to forward growth in the mandible. One explanation could be that full eruption of the premolars and second molars takes place after 12 years of age and gets completed by 15 years.[24] A normal antero-posterior molar relation was observed in 70% subjects, and a deviation from normal molar relation was seen in 30%, including a half-cusp or full-cusp deviation is in agreement with other studies.[23-26] A higher prevalence of normal molar relation has been reported in studies on North Indian children by Gauba *et al.*,[17] and Kharbanda *et al.*,[4] with 85.2% and 81% distribution of normal molar relation in their respective studies. These differences could be because of error in distinguishing Class I molar relation and half-cusp deviation from the natural situation.

The mean DAI score for the evaluated young adults (26.81) lies within the range reported by other authors from other parts of the world.[14,18,20,22,25] No significant difference was observed for the mean DAI score between boys and girls, though girls had a slightly lower score at 12 years age as compared to boys. This is comparable with the reports of Otuyemi *et al.*,[13] and Onyeaso and Sanu[27] which did not find any significant sex differences in the mean DAI score of Nigerian children.

The prevalence of malocclusion requiring orthodontic treatment was 52.7%. Elective need for orthodontic treatment with definite malocclusion was reported among 28.3% individuals, as also reported by Chi *et al.*,[28] among the 13-years old children in New Zealand. Highly desirable orthodontic treatment need was assessed among 14.7% individuals. This is comparable with the findings of Jenny and Cons,[29] van Wyk and Drummond,[30] and Bernarbe E.[20] Mandatory orthodontic treatment need was found in 9.7% of the study subjects. Similar findings were reported by Jenny and Cons,[29] and Esa *et al.*[25]

Different studies have also shown that Asian populations generally have dental appearances that require more orthodontic treatment.[13,18,25]

A higher proportion of female students than male students were rated as having normal or minor malocclusion at both ages, whereas a lower proportion of them scored as having definite, severe, or very severe malocclusion. This is consistent with the findings of Danei *et al.*, in Iranian students.[15] The proportion of subjects requiring orthodontic treatment decreased at 15 years as compared to that at 12 years. This is in accordance with the results of Chestnutt *et al.*,[31] and Manzanera *et al.*[32] Both studies reported lower treatment need among the 15-year-old than the 12-year-old.

Analysis of prevalence of deleterious oral habits with malocclusion revealed that 28.8% of the children with oral habits had malocclusion. This is consistent with the findings of Shetty and Munshi,[16] and Sinn J. Minor[33] who reported 28.95% and 23% of malocclusion were caused by habits in their respective studies. Results of the regression models revealed that mouth breathing and thumb-sucking habits had a significant impact on malocclusion, significantly affecting the presence of crowding and irregularities in anterior segments, and increased maxillary overjet. Also, tongue thrusters

significantly developed a reverse overjet, spacing in incisal segments, and anterior open-bite. Abundant reports in the literature have stated that malocclusion in relation to these traits is observed with a higher prevalence amongst those with habits than without. Shetty and Munshi[16] found that when tongue thrusting, mouth breathing, and thumb sucking were taken into consideration, about 28.95% had malocclusion with a higher prevalence in relation to anterior maxillary protrusion. Melson *et al.*,[6] stated that both tongue-thrust swallow and teeth apart swallow favor development of disto-occlusion, extreme maxillary overjet, and open bite. Popovich and Thompson[34] found that in the age range of 3-12 years, with increase of age the percentage of Class II malocclusion increased from 21.5 to 41.9% in children with sucking habit. Singh *et al.*,[5] reported a statistically significant relationship between thumb sucking and Class II malocclusion, open bite, and extreme overjet.

The present study offers a detailed picture of the prevalence and severity of malocclusion and orthodontic treatment need among the 12 and 15-year-old school children in Shimla city, using standardized criteria according to the DAI. It is one of the few studies in India giving a comprehensive outline of the malocclusion status and its traits, using the DAI, and therefore it can serve as a source of comparison for future studies.

Nevertheless, the DAI has some drawbacks wherein it fails to record about certain features that may have major aesthetic and functional impact, and may be a strong indication of treatment need such as midline discrepancy, deep bites, or posterior cross-bites. Also as Class I molar relationship, distal or mesial deviation are not registered in the DAI components, the results could not be compared with other studies in which the relations of Angle's Classes II and III were examined separately. The significance of the association between oral habits and malocclusion as a causative factor should be interpreted cautiously as this study did not take into consideration the effect of genetic factors and environmental factors other than abnormal habits, such as, trauma, birth injuries, abnormal shedding, and eruption patterns. Future studies can be planned taking into consideration all these factors.

CONCLUSIONS

- Overall, there is high prevalence of malocclusion and unmet orthodontic treatment need (52.7%) among the adolescent population in the present study. The need for orthodontic treatment was higher among boys, and higher among the 12-year-olds than the 15-year olds
- Malocclusion was characterized by a relatively high frequency of crowding and irregularity of teeth in the incisal segments
- Abnormal oral habits were prevalent in about 26% of the study participants, and 28.8% of children with malocclusion presented with one or more deleterious oral habits
- Mouth breathing, tongue thrusting, and thumb sucking have a significant impact on malocclusion, resulting in higher frequency of crowding in anterior teeth, open bite, and spacing.

ACKNOWLEDGMENT

We would like to extend our heartfelt thanks to the Department of Elementary Education, Himachal Pradesh, India, and the school teachers for extending their support and co-operation in organizing the survey. We are also much thankful to our statistician, Mrs. Kusum Chopra, without whose valuable input this work would not have been possible to compile in its present form.

REFERENCES

1. Kharbanda OP, Sidhu SS. Prevalence studies on malocclusion in India-Retrospect and prospect. J Indian Orthod Soc 1993;24:115-8.
2. World Health Organization. International Collaborative study of Oral health outcomes (ICSII), Document 2: Oral Data Collection Instrument and Evaluative Criteria. Geneva: World Health Organization; 1989.
3. Nobile CG, Pavia M, Fortunato L, Angelillo IF. Prevalence and factors related to malocclusion and orthodontic treatment need in children and adolescents in Italy. Eur J Public Health 2007;17:637-41.
4. Kharbanda OP, Sidhu SS, Sundaram K, Shukla DK. Oral habits in school going children of Delhi: A prevalence study. J Indian Soc Pedod Prev Dent 2003;21:120-4.
5. Singh SP, Utreja A, Chawla HS. Distribution of malocclusion types among thumb suckers seeking orthodontic treatment. J Indian Soc Pedod Prev Dent 2008;26:114-7.
6. Melsen B, Stensgaard K, Pedersen J. Sucking habits and their influence on swallowing pattern and prevalence of malocclusion. Eur J Orthod 1979;1:271-80.
7. Tewari A. Abnormal oral habits: relationship with malocclusion and their influence on anterior teeth. J Indian Dent Assoc 1970;42:81-4.
8. Bali RK, Mathur VB, Talwar PP, Chanana HB. National Oral Health Survey and Fluoride Mapping; 2002-2003, Himachal Pradesh, Dental Council of India, New Delhi. 2004.
9. Burdi AR, Moyers RE. Development of the dentition and the occlusion. *In* Handbook of Orthodontics, Moyers RE. 4th ed. Year Book Medical Publishers, 1988, pp. 99-146.
10. World Health Organization. Malocclusion and Orthodontic Treatment Need. In: Oral Health Surveys Basic Methods, 4th ed. Geneva: World Health Organization; 1997
11. Jenny J, Cons NC, Kohout FJ, Jakobsen J. Predicting handicapping malocclusion using the Dental Aesthetic Index (DAI). Int Dent J 1993;43:128-32.
12. Proffit WR, Fields HW. Orthodontic treatment planning: From Problem list to specific plan. *In* Contemporary Orthodontics, Proffit WR. 3rd ed. Elsevier, New Delhi, 2001, pp. 196-239.
13. Otuyemi OD, Ogunyinka A, Dosumu O, Cons NC, Jenny J. Malocclusion and orthodontic treatment need of secondary school students in Nigeria according to the Dental Aesthetic Index (DAI). Int Dent J 1999;49:203-10.
14. Baca-Garcia A, Bravo M, Baca P, Baca A, Junco P. Malocclusions and orthodontic treatment needs in a group of Spanish adolescents using the Dental Aesthetic Index. Int Dent J 2004;54:138-42.
15. Danaei SM, Amirrad F, Salehi P. Orthodontic treatment needs of

12-15-year-old students in Shiraz, Islamic Republic of Iran. East Mediterr Health J 2007;13:326-34.
16. Shetty SR, Munshi AK. Oral habits in children: A prevalence study. J Indian Soc Pedod Prev Dent 1998;16:61-6.
17. Guaba K, Ashima G, Tewari A, Utreja A. Prevalence of malocclusion and abnormal oral habits in North Indian rural children. J Indian Soc Pedod Prev Dent 1998;16:26-30.
18. Katoh Y, Ansai T, Takehara T, Yamashita Y, Miyazaki H, Jenny J, *et al.* A comparison of DAI scores and characteristics of occlusal traits in three ethnic groups of Asian origin. Int Dent J 1998;48:405-11.
19. Silva RG, Kang DS. Prevalence of malocclusion among Latino adolescents. Am J Orthod Dentofacial Orthop 2001;119:313-5.
20. Bernabe E, Flores-Mir C. Orthodontic treatment need in Peruvian young adults evaluated through Dental Aesthetic Index. Angle Orthod 2006;76:417-21.
21. Singh AA, Singh B, Kharbanda OP, Shukla DK, Goswami K, Gupta S. Malocclusion and its traits in rural school children. J Indian Orthod Soc 1998;31:76-80.
22. Jenny J, Cons NC, Kohout FJ, Jakobsen J. Differences in need for orthodontic treatment between Native Americans and the general population based on DAI scores. J Public Health Dent 1991;51:234-8.
23. Sidlauskas A, Lopatiene K. The prevalence of malocclusion among 7–15-year-old Lithuanian schoolchildren. Medicina (Kaunas) 2009;45:147-52.
24. Thilander B, Pena L, Infante C, Parada SS, de Mayorga C. Prevalence of malocclusion and orthodontic treatment need in children and adolescents in Bogota, Colombia. An epidemiological study related to different stages of dental development. Eur J Orthod 2001;23:153-67.
25. Esa R, Razak IA, Allister JH. Epidemiology of malocclusion and orthodontic treatment need of 12-13-year-old Malaysian schoolchildren. Community Dent Health 2001;18:31-6.
26. Shaikh HS, Desai DH. Varieties of malocclusion among orthodontic patients. J Indian Dent Assoc 1966;38:201-3.
27. Onyeaso CO. Prevalence of malocclusion among adolescents in Ibadan, Nigeria. Am J Orthod Dentofacial Orthop 2004;126:604-7.
28. Chi J, Johnson M, Harkness M. Age changes in orthodontic treatment need: A longitudinal study of 10- and 13-year-old children, using the Dental Aesthetic Index. Aust Orthod J 2000;16:150-6.
29. Jenny J, Cons NC. Establishing malocclusion severity levels on the Dental Aesthetic Index (DAI) scale. Aust Dent J 1996;41:43-6.
30. van Wyk PJ, Drummond RJ. Orthodontic status and treatment need of 12-year-old children in South Africa using the Dental Aesthetic Index. SADJ 2005;60:334-6.
31. Chestnutt IG, Burden DJ, Steele JG, Pitts NB, Nuttall NM, Morris AJ. The orthodontic condition of children in the United Kingdom, 2003. Br Dent J 2006;200:609-12.
32. Manzanera D, Montiel-Company JM, Almerich-Silla JM, Gandía JL. Orthodontic treatment need in Spanish schoolchildren: An epidemiological study using the Index of Orthodontic Treatment Need. Eur J Orthod 2009;31:180-3.
33. Sinn JM. Tooth movement in children, 2nd ed. St. Louis: C.V. Mosby and Co; 1977. p. 243-71. Sims JM. Minor tooth movement in children. 2nd ed. Saint Louis: C.V. Mosby and Co.; 1977. 243-71.
34. Popovich F, Thompson GW. Analysis of factors associated with persisting maxillary diastema. J Dent Res 1974;53:272.

How to cite this article: Pruthi N, Sogi GM, Fotedar S. Malocclusion and deleterious oral habits in a north Indian adolescent population: A correlational study. Eur J Gen Dent 2013;2:257-63.

Source of Support: Nil, **Conflict of Interest:** None declared.

Author Help: Online submission of the manuscripts

Articles can be submitted online from http://www.journalonweb.com. For online submission, the articles should be prepared in two files (first page file and article file). Images should be submitted separately.

1) **First Page File:**
Prepare the title page, covering letter, acknowledgement etc. using a word processor program. All information related to your identity should be included here. Use text/rtf/doc/pdf files. Do not zip the files.
2) **Article File:**
The main text of the article, beginning with the Abstract to References (including tables) should be in this file. Do not include any information (such as acknowledgement, your names in page headers etc.) in this file. Use text/rtf/doc/pdf files. Do not zip the files. Limit the file size to 1 MB. Do not incorporate images in the file. If file size is large, graphs can be submitted separately as images, without their being incorporated in the article file. This will reduce the size of the file.
3) **Images:**
Submit good quality color images. Each image should be less than 4096 kb (4 MB) in size. The size of the image can be reduced by decreasing the actual height and width of the images (keep up to about 6 inches and up to about 1800 x 1200 pixels). JPEG is the most suitable file format. The image quality should be good enough to judge the scientific value of the image. For the purpose of printing, always retain a good quality, high resolution image. This high resolution image should be sent to the editorial office at the time of sending a revised article.
4) **Legends:**
Legends for the figures/images should be included at the end of the article file.