

Assessment of Impact of Malocclusion on Oral Health Status and Oral Health-related Quality of Life among School and College Students of Chennai, Tamil Nadu, India: A Cross-sectional Study

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ABSTRACT

Introduction: Malocclusion is multifactorial in origin, caused by the interaction of various general and local factors. The consequences of malocclusion include dental caries, periodontitis, impaction of teeth, and compromised chewing abilities. Thus, if left untreated, malocclusion can not only lead to oral health problems like periodontal problems and dental caries but also psychological problems, causing a loss of self-esteem and confidence in the individual.

Aim: To assess the potential relationship between malocclusion with orthodontic treatment needs and dental caries, periodontal diseases, dental traumatic injuries, oral hygiene, and Oral Health-related Quality of Life (OHRQoL).

Materials and Methods: A cross-sectional study was conducted among 1800 school-going and college students at their respective Institutions in Chennai, Tamil Nadu, India from December 2021 to June 2022 with and without orthodontic treatment needs, to identify malocclusion and various oral conditions/diseases associated with it, in addition to the effect of malocclusion on OHRQoL. Oral health

status was assessed using the World Health Organisation (WHO) Basic Oral Health Survey (2013); malocclusion was assessed using the Index of Orthodontic Treatment Needs (IOTN) index, and OHRQoL was measured using OHIP-14. Data were analysed using Statistical Packages for Social Sciences (SPSS) version 23.0 software, and statistical significance was assessed using Pearson's Chi-square test and Mann-Whitney U Test.

Results: The study was conducted among 1800 subjects aged between 14 and 21 years (mean 17.47±1.58 years) from various schools and colleges in Chennai. Among the study subjects, 1066 (59.2%) were males, and 734 (40.8%) were females. About 46.7% of the study subjects had malocclusion. The binomial logistic regression analysis suggested that study subjects with orthodontic treatment needs had greater odds of experiencing dental caries, gingival bleeding, and traumatic dental injuries compared to study subjects without orthodontic treatment needs.

Conclusion: There is a definite relationship between malocclusion, orthodontic treatment needs, dental caries, periodontal diseases, dental traumatic injuries, oral hygiene, and OHRQoL.

Keywords: Dental caries, Index of orthodontic treatment need, Oral hygiene, Periodontal diseases, Tooth fractures

INTRODUCTION

Malocclusion is multifactorial in origin. According to Graber TM et al., malocclusion is caused by the interaction of various general factors and local factors [1]. The consequences of malocclusion include dental caries, periodontal problems, impaction of teeth, compromise in chewing abilities, aesthetics, and the Oral Health-Related Quality of Life (OHRQoL) [2-4]. Thus, if left untreated, malocclusion can lead to oral health problems affecting not only soft tissue like periodontal problems and hard tissue like dental caries but also psychological problems causing a loss of self-esteem and confidence in the individual. Furthermore, if that particular individual remains untreated for malocclusion during the growth phase of their life, it serves as an indicator for missed treatment at an earlier age [3].

Dental appearance plays a very important role in the general presentation of any individual. A beautiful smile boosts confidence, self-esteem, socialising, and interpersonal relationships of an individual [4,5]. Previous studies have suggested an inverse association between the severity of malocclusion and QoL [6,7]. Research has shown that treatment of malocclusion not only improves the occlusion but also the psychological and social well-being of the individual and thus OHRQoL [8,9]. However, Taylor KR

et al., argued that though treatment of malocclusion did improve appearance, it failed to affect QoL in measurable terms [10].

Studies in the past have reported the effect of malocclusion on dental caries, periodontal diseases, oral hygiene, and QoL either independently or in association with two factors [2, 11-13]. However, the impact of malocclusion has not been associated with dental caries, periodontal diseases, oral hygiene, and QoL in coalescence. The current paper discusses the potential relationship between malocclusion with orthodontic treatment needs and a few oral health parameters along with OHRQoL. The present study was a part of a larger project that assessed the prevalence of various oral diseases and compared orthodontic treatment needs for malocclusion with several demographic features, oral health status, oral hygiene status, and OHRQoL. The null hypothesis was that there was no association between orthodontic treatment needs and study subjects' oral health status, oral hygiene status, and OHRQoL, and the alternative hypothesis was that there was an association between orthodontic treatment needs and study subjects' oral health status, oral hygiene status, and OHRQoL.

MATERIALS AND METHODS

A cross-sectional study was conducted in Chennai, Tamil Nadu, India from December 2021 to June 2022 among school-going and college

students at their respective Institutions to identify malocclusion and various oral conditions/diseases associated with it and the effect of malocclusion on OHRQoL. Ethical clearance was obtained from the Institutional Ethical Committee in accordance with the Helsinki Declaration of 1975 as revised in 2013 (Dr. MGRDU/TMDCH/2015-16/2412012). Chennai is divided into three zones: North, South, and Central zones [14]. The list of schools in Chennai was obtained from the Directorate of School Education, Chennai. The list of Arts and Science Colleges was obtained from the Directorate of Collegiate Education, Chennai.

Inclusion and Exclusion criteria: The subjects who were present on the day of examination, agreed to participate, and were 14 years and above were included in the study. Subjects with a previous history of orthodontic treatment or undergoing orthodontic treatment, systemic illnesses such as Type I diabetes, neurological disorders like epilepsy, any type of chronic illnesses, cleft lip or palate, and syndromes were excluded from the present study.

Sample size calculation: The sample size was determined by conducting a pilot study among 342 subjects. The mean Oral Health Index Profile-14 (OHIP-14) score among the orthodontic treatment needed and not needed groups was 2.09 ± 4.31 and 1.10 ± 3.97 , respectively. The sample size was calculated using the formula for the difference between two independent means with α 0.05, power of the study 90%, design effect two, and non-response 15%. The estimated sample size was 1741, which was rounded off to 1800.

A multistage stratified random sampling methodology and randomised cluster sampling were used in the selection of schools and colleges and study subjects, respectively. Two schools and two colleges were randomly selected from each zone, and 100 students from each school and 200 students from each college who satisfied the inclusion and exclusion criteria were randomly selected. Approximately 30 study subjects were examined each day. Prior permission was obtained from the authorities after explaining the objective and procedure of the study. Students who qualified for the study were also informed about the purpose of the research, and informed consent was obtained from their parents.

Study Procedure

The subjects were interviewed for demographic characteristics and their OHRQoL with respect to malocclusion using OHIP-14 [15]. The modified WHO 2013 Basic Oral Health Assessment form was used to assess their dentition status, periodontal disease, and traumatic dental injuries, and the Oral Hygiene Index-Simplified (OHI-S) was used to assess their oral hygiene status [16,17]. The orthodontic treatment needs for malocclusion were assessed using IOTN [18]. The examiner used appropriate measures to prevent cross-infection. All necessary instruments were individually packed and sterilised in sufficient quantity for each working day. The Type III clinical examination was carried out with the study subjects seated on a chair under adequate natural light on school and college premises as recommended by the American Dental Association [19].

Once the research instrument was formulated, an expert panel was constituted to evaluate its content validity. They assessed whether the items adequately measured the intended construct and whether all items were adequate to measure the area of interest {Item-level Content Validity Index (I-CVI)}=0.78). This was followed by face validity assessment among a few samples from the study population. The training and calibration of the examiner were carried out in the department on outpatients aged 14-21 years under expert guidance. For the pilot study, a group of 10 students was examined on successive days to assess intra-examiner reproducibility. Intra-examiner reproducibility was assessed by measuring internal consistency (Cronbach's α =0.75) and test-retest reliability, which was evaluated using Pearson's product-moment correlation coefficient (Pearson's r =0.80).

The study subjects were dichotomised based on the IOTN scores into treatment not needed and treatment needed groups. The oral health status, oral hygiene status, and OHRQoL were compared between the orthodontic treatment not needed and treatment needed groups. The study subjects were divided into subjects with good, moderate, and poor OHRQoL based on the total score of OHIP-14, i.e., good=0-18, moderate=19-37, severe=38-56 [20]. The higher the value, the poorer the OHRQoL.

STATISTICAL ANALYSIS

To analyse the data, IBM SPSS Statistics for Windows, version 23.0, Armonk, NY: IBM Corp. Released 2015, was used. The significance level was set at 5% (α =0.05). Frequencies and percentages were calculated for demographic variables and oral health status parameters, such as subjects with bleeding gums, dental trauma, and IOTN grades. Mean and standard deviation were calculated for oral health status parameters, including decay, missing, filled, Decayed, Missing, and Filled primary Teeth (DMFT), Debris Index-Score (DI-S), Calculus Index-Score (CI-S), OHI-S, and the number of teeth with bleeding gums. To compare the percentages, the Pearson's Chi-square test was used, and the Mann-Whitney test was used to compare mean scores. A binomial logistic regression was performed to predict the effect of the requirement of orthodontic treatment needs on dental caries, gingival bleeding, and traumatic dental injuries. A linear regression analysis was conducted to predict the OHRQoL based on IOTN scores.

RESULTS

The study was conducted among 1800 subjects from various schools and colleges in Chennai with an age range of 14 to 21 years (mean age 17.47 ± 1.58 years). The study subjects were assessed for malocclusion based on the IOTN index. The majority, 1066 (59.2%), were males, and 734 (40.8%) were females. It was observed that 960 (53.3%) of the study subjects were without malocclusion and did not need any orthodontic treatment, while the remaining 840 (46.7%) of the study subjects had malocclusion and needed orthodontic treatment that ranged from little need to very great need [Table/Fig-1].

IOTN grade	Frequency	Percentage (%)	Group
Grade-1 (No need)	960	53.3	Treatment not needed group
Grade-2 (Little need)	468	26.0	Treatment needed group
Grade-3 (Borderline need)	265	14.7	
Grade-4 (Great need)	98	5.4	
Grade-5 (Very great need)	9	0.5	
Total	1800	100.0	

[Table/Fig-1]: Distribution of orthodontic treatment needs of the study subjects according to IOTN.

Among the study subjects, 882 (49%) were caries-free, and 918 (51%) had decayed, missing, or filled teeth, and 1585 (88.1%) did not have any dental trauma. The subjects with orthodontic treatment needs had significantly higher mean decayed teeth ($p=0.002$), mean DMFT ($p=0.001$), mean number of teeth with gingival bleeding ($p=0.015$), dental trauma ($p=0.025$), higher DI-S ($p=0.001$), CI-S ($p<0.001$), and OHI score ($p<0.001$) than the study subjects without orthodontic treatment needs [Table/Fig-2-4].

Oral health status parameters	Treatment			p-value*
	Not needed	Needed	Total	
No. of permanent teeth	29.10 ± 1.57	29.14 ± 1.65	29.12 ± 1.60	0.785
Decayed teeth	1.31 ± 1.99	1.62 ± 2.18	1.46 ± 2.09	0.002
Missing teeth	0.02 ± 0.16	0.04 ± 0.40	0.03 ± 0.30	0.216
Filled teeth	0.05 ± 0.38	0.07 ± 0.42	0.06 ± 0.40	0.287

DMFT	1.39±2.04	1.73±2.27	1.55±2.16	0.001
No. of teeth with gingival bleeding	1.88±4.25	2.49±5.35	2.16±4.80	0.015

[Table/Fig-2]: Comparison of mean oral health status among the study subjects without and with orthodontic treatment needs.
*Mann-Whitney U test

Oral health status parameters		Treatment			p-value*
		Not needed n (%)	Needed n (%)	Total N (%)	
Gingival bleeding	Absent	734 (55.0)	600 (45.0)	1334 (100)	0.015
	Present	226 (48.5)	240 (51.5)	466 (100)	
No. of teeth affected with dental trauma	0	865 (54.6)	720 (45.4)	1585 (100)	0.025
	1	73 (47.7)	80 (52.3)	153 (100)	
	2	19 (35.8)	34 (64.2)	53 (100)	
	3	2 (28.6)	5 (71.4)	7 (100)	
	4	1 (50.0)	1 (50.0)	2 (100)	

[Table/Fig-3]: Comparison of gingival bleeding and dental trauma among the study subjects without and with orthodontic treatment needs.
*Pearson's Chi-square test

Oral health status parameters		Treatment		p-value*
		Not needed	Needed	
DI-S	Mean±SD	0.80±0.48	0.88±0.48	0.001
	Mean rank	862.01	944.49	
CI-S	Mean±SD	0.62±0.54	0.76±0.58	<0.001
	Mean rank	839.32	970.42	
OHIS	Mean±SD	1.42±0.87	1.64±0.90	<0.001
	Mean rank	840.34	969.25	

[Table/Fig-4]: Comparison of oral hygiene status among the study subjects without and with orthodontic treatment needs.
*Mann-Whitney U

It was observed that there was a difference in mean rank scores for all OHIP-14 domains and the overall mean rank OHIP-14 score among the study subjects in the orthodontic treatment needed and not needed groups, and it was statistically very highly significant (p<0.001) [Table/Fig-5].

OHIP-14 domains		Treatment		p-value*
		Not needed	Needed	
Functional limitation	Mean±SD	0.38±0.976	1.54±2.027	<0.001
	Mean rank	753.21	1068.83	
Physical pain	Mean±SD	0.47±1.126	1.56±1.976	<0.001
	Mean rank	758.92	1062.30	
Psychological discomfort	Mean±SD	0.47±1.126	1.56±1.976	<0.001
	Mean rank	709.06	1119.29	
Physical disability	Mean±SD	0.35±0.946	1.81±2.133	<0.001
	Mean rank	727.37	1098.36	
Psychological disability	Mean±SD	0.24±0.783	1.59±2.062	<0.001
	Mean rank	733.85	1090.96	
Social disability	Mean±SD	0.25±0.883	1.30±1.960	<0.001
	Mean rank	766.14	1054.06	
Handicap	Mean±SD	0.19±0.724	1.00±1.757	<0.001
	Mean rank	790.20	1026.55	
Overall score	Mean±SD	2.43±4.425	11.06±10.263	<0.001
	Mean rank	652.75	1183.64	

[Table/Fig-5]: Comparison of mean rank scores of domains of OHIP-14 among the study subjects without and with orthodontic treatment needs.
*Mann-Whitney U Test

Through the binomial logistic regression analysis, it was found that study subjects with orthodontic treatment needs had 1.301 times the odds of having dental caries compared to study subjects without

orthodontic treatment needs (OR=1.301, 95% CI: 1.08-1.56), and this difference was statistically significant (p=0.005). Additionally, study subjects with orthodontic treatment needs were 1.29 times more likely to experience gingival bleeding than those without orthodontic treatment needs (p=0.015) (OR=1.299, 95% CI: 1.052-1.605). The odds of experiencing dental trauma were 1.518 times higher among study subjects with orthodontic treatment needs compared to those without orthodontic treatment needs, and this difference was statistically significant (p=0.004) (OR=1.518, CI: 1.139-2.022) [Table/Fig-6].

Dependent variable	Predictor variable	Beta coefficient	Std. Error	Significance	Odds ratio	95% CI for odds ratio	
						Lower	Upper
Dental caries	Treatment required	0.263	0.095	0.005*	1.301	1.080	1.566
	Constant	-0.163	0.065	0.012	0.850		
Gingival bleeding	Treatment required	0.262	0.108	0.015*	1.299	1.052	1.605
	Constant	-1.178	0.076	0.000	0.308		
Traumatic dental injuries	Treatment required	0.417	0.146	0.004*	1.518	1.139	2.022
	Constant	-2.209	0.108	0.000	0.110		

[Table/Fig-6]: Binomial logistic regression analysis showing the influence of orthodontic treatment needs on dental caries, gingival bleeding and traumatic dental injuries.
*Significant

A linear regression analysis was conducted to predict the OHRQoL (OHIP-14) based on IOTN scores. The model summary indicated that the independent variable (IOTN) explained approximately 30.4% to 30.5% of the variance in the dependent variable (OHIP-14) (R²=0.305 and adjusted R²=0.304). The analysis of variance demonstrated that the regression model was a good fit for the data, and the independent variable significantly predicted the dependent variable (F (1,787)=54.339, p<0.001). For every one-unit increase in the IOTN scores, the oral health impact profile scores increased by 5.213, and this increase was statistically highly significant (p<0.001) [Table/Fig-7].

Parameters	Unstandardised coefficients		Standardised coefficients	t	p-value
	Beta coefficient	Std. Error	Beta		
Constant	-2.600	0.367	0.552	-7.092	0.000
IOTN	5.213	0.186		28.059	<0.001

[Table/Fig-7]: Linear regression according to Oral Health Related Quality of Life (OHRQoL) and its association with IOTN.

The relationship between orthodontic treatment needs and OHIP-14 is depicted in [Table/Fig-8]. Among the study subjects who did not require any orthodontic treatment, 98.4% had a good oral health impact profile, whereas among those requiring orthodontic treatment, only 76.9% had a good oral health impact profile. These observed differences were statistically highly significant (p<0.001). Additionally, among the study subjects with moderate OHRQoL, it was noted that 92.4% required orthodontic treatment while 7.6% did not, and this difference was statistically highly significant (p<0.001).

Orthodontic treatment need	OHIP-14 group			Total N (%)	p-value*
	Good n (%)	Moderate n (%)	Poor n (%)		
Treatment not required	945 (52.5)	15 (0.8)	0	960 (53.3)	<0.001
Treatment required	646 (35.9)	182 (10.1)	12 (0.7)	840 (46.7)	
Total	1591 (88.4)	197 (10.9)	12 (0.7)	1800 (100.0)	

[Table/Fig-8]: Distribution of study subjects according to the impact of orthodontic treatment needs on Oral Health Impact Profile -14 (OHRQoL).
*Pearson's Chi-square test

DISCUSSION

The results of the present study indicate a definite relationship between malocclusion, orthodontic treatment needs, dental caries, periodontal diseases, dental traumatic injuries, oral hygiene, and OHRQoL.

In the present era, orthodontists recommend starting orthodontic treatment at the earliest sign of any malocclusion, following the adage “catch them young”. Initiating treatment at a younger age offers the advantage of modifying and harnessing growth for the prevention and interception of malocclusion [21]. Various myofunctional appliances, which transmit, eliminate, or guide the muscles' natural forces, can be utilised to decrease or increase jaw size, alter the spatial relationship of jaws, change the direction of growth, and accelerate desirable growth. By the age of 12 years, all permanent teeth would have erupted in the oral cavity except for the third molars, and any features of malocclusion would be readily apparent. If an individual presents with malocclusion at this age, it indicates a lack of both preventive and interceptive orthodontic treatment for malocclusion.

The population chosen for present study represented those who had missed out on treatment at an early age. Additionally, the adolescence and young adulthood period shape an individual's values, morals, character, and pave the way to their future as an adult. Both positive and negative experiences during this period influence an individual's decisions as an adult. Peer influences and pressure also play a role in the development of habits and mannerisms, which can have both positive and negative impacts lasting a lifetime. Comments and compliments from individuals they come in contact with also influence and shape their thoughts and emotions [22].

The physical appearance of an individual is scrutinised both positively and negatively, especially by their peer group, which helps them recognise their best and worst features. A beautiful smile with evenly arranged teeth is often appreciated, giving the individual a boost to smile more often. However, if the teeth are crooked, broken, or unevenly arranged, they may be made fun of by others, which can deter the individual from smiling and lead them to keep their lips sealed while doing so [23]. Since this can have a lasting impact, it is necessary to correct malocclusion at earlier ages to prevent negative impacts on OHRQoL. Studies have also revealed that malocclusion can predispose an individual to various other oral diseases, such as dental caries, periodontal diseases, and poor oral hygiene status [2-6]. Thus, the present study analyses the effects of malocclusion on these oral conditions.

Authors also observed a higher prevalence of dental caries among study subjects with orthodontic treatment needs, which was similar to previous studies suggesting that malocclusion was associated with both the occurrence and severity of dental caries [2,12].

Bollen AM suggested a positive correlation between the severity of malocclusion and periodontal conditions, which aligns with the findings of the present study. However, Nalcaci R et al., found no correlation between malocclusion and periodontal disease [2,13]. The difference in findings may be attributed to variations in oral hygiene maintenance habits and food consumption practices among the populations studied. Malaligned teeth can pose a risk factor for poor oral hygiene. Kolawole KA and Folayan MO suggested that malocclusion can increase the prevalence of moderate and severe gingivitis [24]. Additionally, Salim NA et al., suggested that subjects with higher IOTN grades (3, 4, and 5) had higher scores in both arches for OHI-S and DMFT compared to subjects without malocclusion traits [25]. These findings are consistent with the present study.

Among the study subjects, 11.9% had one or more teeth affected by dental trauma, ranging from only enamel fracture to teeth missing due to dental trauma. The present finding is similar to the study by Dua R and Sharma S, where 14.5% of the subjects had dental

trauma, and the authors found that individuals with Angle's class II div 1 malocclusion were at a greater risk for traumatic injuries [26]. Only 0.4% had undergone treatment for the dental injury, highlighting the poor dental attendance pattern among the study subjects.

Furthermore, in the present research, binomial logistic regression analysis was conducted, suggesting that study subjects with orthodontic treatment needs had greater odds of experiencing dental caries, gingival bleeding, and traumatic dental injuries compared to study subjects without orthodontic treatment needs, which is consistent with previous studies [11,26,27].

The mean OHIP-14 score of study subjects with orthodontic treatment needs was 11.06 ± 10.26 , which was similar to a study by George R et al., where the mean OHIP-14 score was found to be 11.8 ± 8.0 [28]. The mean OHIP-14 score among study subjects without orthodontic treatment needs was significantly lower than that of study subjects with orthodontic treatment needs. This suggests that study subjects with orthodontic treatment needs had a negative impact on OHRQoL, which is consistent with a study conducted by Kavaliauskienė A et al., [29]. Additionally, it was observed that malocclusion significantly affected all aspects of OHRQoL (OHIP-14). Individuals with orthodontic treatment needs experienced complications in physical, psychological, and social aspects of health. Malocclusion also led to issues in mastication, swallowing, speech, temporomandibular disorders, and increased the individual's susceptibility to traumatic injuries, dental caries, and periodontal diseases [30].

In the present study, all domains of OHIP-14 were found to significantly impact the OHRQoL of the study subjects. This finding aligns with a study by Masood Y et al., where the psychological discomfort domain had the highest negative impact on OHRQoL [7]. Rusanen J et al., in a study, reported that physical pain, psychological discomfort, and disability domains were the most commonly perceived oral impacts [31]. According to Claudino D and Traebert J, poorer oral aesthetic self-perception was observed among young adults with severe malocclusion [6]. This suggests that individuals with malocclusion perceived various complications such as trouble in pronunciation, self-consciousness, and embarrassment. Furthermore, a study suggested that treatment of malocclusion led to lower scores on the OHIP-14, indicating improved OHRQoL [32].

A key strength of the present study was assessing the impact of malocclusion on dental caries, periodontal diseases, dental traumatic injuries, oral hygiene, and OHRQoL collectively. Additionally, the study included an in-depth analysis of extensive information from a large, diverse population from schools and colleges, representing a wide age group from various zones in the city.

Limitation(s)

However, since the study was limited to Chennai, the results may not be extrapolated to the entire country, and multicentric studies are needed for generalisation. As malocclusion and oral health status were measured simultaneously, the temporal sequence of events cannot be established, which is necessary for understanding the directionality of relationships. It is recommended that regular orthodontic assessment of a patient should be complemented with the measurement of OHRQoL in order to understand their psychosocial status and expectations from the treatment. A regular school-based dental program may be conducive in imparting dental health knowledge among the upcoming generation.

CONCLUSION(S)

The results of the study suggested a positive association between malocclusion and dental caries, gingivitis, dental traumatic injuries, OHI-S, and OHRQoL, thus confirming the hypothesis. Therefore, it is recommended that the assessment of patients for the treatment of malocclusion should be complemented with OHRQoL analysis to assess their expectations from the treatment. Prevention and

treatment of malocclusion at an earlier stage can prevent oral complications and psychological stress.

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