Tufts University

School of Dental Medicine

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Association of tooth wear to temporomandibular joint disorders and sleep breathing disorders in Indian school children

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Thesis submitted by

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Abstract

Aim:

The aim of this study was to find if any association exists between the non- carious tooth wear, temporomandibular disorders and sleep breathing disorders in children.

Introduction:

Tooth wear, temporomandibular disorders (TMD) and sleep breathing disorders (SBD) are some common disorders in adults as well as children. These conditions may be present either alone or in combination. Sometimes these disorders remain undiagnosed for a long time, especially in children as they may not realize that this discomfort is pathological. Early detection of these disorders may positively impact a child's growth and overall health.

Methods: This cross-sectional observational study included 1009 Indian school children. Validated indices like Helkimo Index and Sleep Disorder Scale for Children by Bruni for SBD were used to determine TMD and SBD respectively. A child was considered tooth wear positive if any of the tooth surfaces presented tooth wear.

Associations between these three conditions were evaluated using chi-square tests. All analyses were performed using SAS, Version 9.2 (SAS Institute, Cary, NC).

Results:

1009 subjects, 405 girls and 604 boys between 10 years and 16 years of age formed the sample of the study. Mean (standard deviation) age was 12.8 (0.78) years. Of the 1009, 853 (84.5%) had tooth wear (661 mild and 192 severe), 356 (35.3%) had sleep breathing

disorders, 587 (58.2%) had clinically diagnosed temporomandibular disorders, and 371 (36.8%) had self-diagnosed temporomandibular disorders.

Of the 356 with sleep breathing disorders, 253 (71.1%) had clinically diagnosed temporomandibular disorders, compared to 334 of the 653 (51.1%) without sleep breathing disorders. This was a statistically significant difference.

Of the 853 with tooth wear, 492 (57.7%) had clinically diagnosed TMD as compared to 95 of the 156 (60.9%) with no tooth wear. This was not a statistically significant difference.

Of the 853 with tooth wear, 307 (36%) had sleep breathing disorders, compared to 49 of the 156 (31.4%) with no tooth wear. This was also not statistically significant difference.

Conclusion:

This study concludes that there is a high prevalence of tooth wear, sleep breathing disorders and temporomandibular disorders in Indian school children. There is statistically significant association between sleep breathing disorders and temporomandibular disorders and there may be no significant association between tooth wear and sleep breathing disorders and temporomandibular disorders.

Thesis committee

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Introduction

Tooth wear, temporomandibular disorders (TMD) and sleep breathing disorders (SBD) are some common disorders in humans.[1-3] People may experience these conditions either alone or in combination.[4] At times these disorders remain undiagnosed for a long time, especially in children as they may not realize that this discomfort may be pathological. Early detection of these disorders can have a positive impact on a child's growth and hence, overall health. Epidemiological studies have reported signs and symptoms of these disorders in children and adolescents to be as common as in adults.[5-8]

Tooth wear may lead to loss of vertical dimension of masticatory system and thus cause imbalance in oral tissues. This may lead to temporomandibular disorders and sleep breathing disorders.[9] Temporomandibular disorders and sleep breathing disorders affect the physical, physiological, psychological and mental growth and development of a child.[10-12] Day time sleepiness, irritability, hyperactivity, lack of concentration, etc are some of the consequences of these conditions.[5] Examining and analyzing tooth wear may provide vital information for clinicians to screen for otherwise hidden disorders and thus change the destiny of the child towards a normal and healthy life pattern.

Tooth wear

Tooth wear is a collective term, commonly used for loss of tooth structure. Various terms like tooth surface loss (TSL)[13] occlusal wear and tooth surface wear[14] have been used in the literature. Until recently, tooth wear was considered a non significant, physiologic phenomenon; however studies reveal that this condition is on the rise.[15] Perceptions about tooth wear are now changing and more studies are being conducted.[15] Based on factors like dietary habits, cultural variation, psychological behavior, economic status, social

status, among others, tooth wear may be presented differently and can be considered physiologic or pathological.[3]

Tooth wear is a common finding in children as well as adults. In fact, tooth matter loss is more severe in deciduous dentition due to differences in physical and chemical properties as compared to permanent dentition.[16] The mineral content responsible for hardness is less in deciduous teeth.[17] Smaller size and different anatomical structure also result in more tooth wear in deciduous teeth when compared with permanent teeth.[15] Tooth wear can cause loss of vertical dimension of masticatory system thus creating imbalance in oral tissues which in turn may lead to temporomandibular disorders and sleep breathing disorders.[9,18,19]

Tooth wear is an irreversible damage and has multifactorial etiological aspects.[3] Although the terminology is being widely used, the clinical appearance and their interpretations vary amongst the clinicians.[3,11,14,15,20-26] According to recent knowledge, there may be several factors that can cause tooth wear.[20] They are referred to as abrasion, demastication, attrition, abfraction, resorption and erosion.[24] It may be appropriate to understand the different terminologies used for factors responsible for tooth wear. The clinical presentation of tooth wear varies depending on the main cause of tooth wear.

Mechanical tooth wear

Abrasion is a mechanical process like rubbing, grinding or scraping that result in the wearing of a substance. The clinical term, dental abrasion, is used to describe the mechanical wear of enamel and dentin through abnormal mechanical processes involving foreign objects or substances ingested in the mouth and contacting the teeth. Based on the

etiology, the pattern of wear can be generalized or localized. Factors causing abrasion may be material or patient related.[24]

Materialistic factors include the type of dentifrice used, its abrasiveness and pH as well as the amount of dentifrice. Patient related factors may include the duration of the dentifrice used, the stiffness of the brush, force applied during brushing and the technique of brushing. Occupational factors may include working in an abrasive dust atmosphere, holding nails between teeth and biting thread.[23,27,28]

Dental attrition is defined as the physiologic wearing of teeth resulting from tooth to tooth contact without any food or during mastication.[29,30] Occlusal and proximal surfaces of opposing and neighboring teeth rub with each other during various activities like mastication, swallowing, speech and exercising in gymnasium. Clinically, the first presentation of attrition is in the form of small polished facets on cusp tips or marginal ridges or incisal edges.[24,28] Dental attrition is considered physiologic and its presentation may vary according to the age. It may be hastened by external factors like type of diet, culture and occupation.[27]

Seligman and Pullinger described attrition as a result of multi-factorial etiologies including age and canine guidance. Parafunctional activities, dental crowding, occlusal slides, crossbites, chewing habits, and diet may also contribute to tooth wear. Studies also show that enamel wear is affected by changes in lubricating conditions, acidity, and loads.[31] Tooth wear due to above factors clinically differs from progressive dentin wear associated with increasing load.[32]

Tooth wear due to parafunctional habits

Parafunctional habits like clenching and bruxism may also cause attrition.[4,33] Mechanical tooth wear may also occur due to normal masticatory function and parafunctional habits like bruxism and clenching of teeth either during day or night.[34]

The prevalence of bruxism in school going children is about 25 -30%[4] and tooth wear is one of the main outcomes of this parafunction.[35] The forces exerted on the molars are several times greater in parafunctional activities as compared to normal masticatory forces.[36] Studies by Mehta *et al*. have shown that maxillary and mandibular teeth contact each other for about 20 to 25 minutes in 12 hours for mastication where as they may grind against each other up to 40 minutes in one hour during parafunctional activities. Also, the forces during parafunction are much higher.[4,36] This may lead to various changes in dental structures and tooth wear can be one of the most common findings.[37] Bruxism is considered one of the main factors for mechanical tooth wear.[37] Studies by Carlson *et al.* show that bruxism is less common as the child turns adolescent.[38] Children should be diagnosed and treated for tooth wear as it can prevent pathological changes in their masticatory system.

Abfraction is the result of eccentrically applied occlusal forces that cause the tooth to flex and may not be due to abrasion alone.[20,39] Based on the tooth flexure theory, masticatory or parafunctional forces in areas of eccentric-occlusion or malocclusion may affect one or several teeth to strong stresses like tensile, compressive or shearing stresses. These forces may cause micro fractures in enamel and dentin at the CEJ. Gradually, these microfractures may result in further breakdown of enamel and dentin. These resulting wedge-shaped defects look different from abrasion cavities and have sharp rims.[20] More

studies need to be explored to establish the scientific base of the tooth flexure theory and it is not yet sufficiently explored. More research is needed for a better understanding of this process.

Chemical tooth wear

Dental erosion is a term used to define loss of tooth structure due to nonbacterial chemical processes.[29] If the pH of saliva drops below 5.5 then enamel will dissolve and breakdown resulting in erosive lesions.[40] Erosive wear also depends on length and frequency of acidic attack. The longer the duration and more frequent the exposure, the effect may be more severe.[15]

Clinical presentation of dental erosion varies from carious wear. Erosive lesions present as concave and rounded defects whereas carious lesions present as rough margins. [41]

There have been several studies on dental erosion and the basic nomenclature of dental erosion is based on etiology, clinical severity, activity of progression and location of lesion.[2,15,20,22,25,26,28,42,43] Classification of dental erosion is based on its etiological factors. It is termed as extrinsic, intrinsic or idiopathic, implying that from the case history (anamnesis) the source of acid may be exogenous, endogenous or unknown.[24,25,44]

Extrinsic erosion is caused by exogenous acids like dietary acids (principal source), industrial acid fumes in work environment, chlorinated water in swimming pools and some medicaments like iron tonics.[20,45] The most commonly consumed dietary acids are colas (carbonic acid), fruit acids, vinegar and sports drinks.[20] Most recently ascorbic acid present in many cold drinks and candies has been identified as one of the most significant cause of dental erosion.[45,46] Life style changes like dieting and striving for a healthy life have prompted greater intake of fruits and diet drinks that are acidic. Appropriate dental

hygiene and frequent brushing of teeth immediately after an attack of acids has been shown to cause greater tooth wear.[45]

Intrinsic erosion is caused by endogenous acid sources. Gastric acid formed in the stomach finds its way back in the mouth during vomiting, regurgitation or reflux.[20,31] This could be due to several disorders like nervous vomiting, bulimia, pregnancy, alcoholism, GI disorders like Hiatus hernia, GRD.[47,48]

Idiopathic erosion refers to erosion when the cause of erosion is unknown and precise etiology cannot be related.

Pathological tooth wear

The word ‘resorption’ is derived from the Latin verb resorberc' (to suck back) and describes the process of biological degradation and assimilation of substances or structures previously produced by the body.[20] Clinical terms like root resorption, dental resorption, tooth resorption are used to explain the biological loss of dental hard tissue by cementoclasts, dentinoclasts and ameloclasts.[20] Resorption may be considered a physiologic process when the roots of deciduous teeth resorb before shedding or may be considered a pathological process when tooth structure is degraded due to trauma, cysts or neoplasms.[20] Mention of resorption is included here for the sake of completeness of information related to non-carious causes of destructive processes affecting the teeth.

Prevalence of tooth wear

Studies on the prevalence of tooth wear in children, young adults and old age subjects have not been consistent with regards to methodology. The literature mentions several indices used to classify the severity of tooth wear.[3,11,14,15,20-26] Van’t Spijker *et al*.,

reviewed articles published between 1980 and 2007 and compiled a systematic data on the prevalence of tooth wear.[3]

There is evidence that the presence of tooth wear due to non carious lesions is growing steadily and one of the main factors is dietary changes.[13] However, there was also a study that compared the status of tooth wear in children born during 1950s and 1990s.[30] This study has found that abrasive tooth wear is less in children born in 1990s.[30] It did not consider erosive tooth wear. Jaeggi and Lussi reviewed the data on the prevalence of tooth wear and found the results by different researchers fall in a broad range. Six to fifty percent of preschool children between 2 and 5 years of age showed erosion on deciduous teeth.[15] About 14% school children (aged 5-9 years) had erosive lesions on permanent teeth.[15] Eleven to 100% of children in the adolescent group (aged between 9 and 17 years), showed some amount of erosion.[15] Results vary greatly because the studies were performed in different parts of the world which have different dietary habits and socio-economic status. Also, some studies included few teeth surfaces and analyzed the data using different indices. Overall, the incidence of tooth wear seems to be high and hence, it is important that tooth wear be detected early to initiate adequate preventive measures.

Measurement of tooth wear

There are many methods used to measure tooth wear and they are broadly divided into quantitative and qualitative in nature. Tooth wear can be measured by clinical evaluation, physical methods, chemical methods, microscopy, micro-radiography, digital image analysis and profilometry and surface mapping.[21] In this study, tooth wear was evaluated clinically by visual examination.

Several indices have been used to analyze clinical tooth wear.[11,21] Unfortunately, the results presented by these indices are not comparable as the parameters in different studies vary and lack international standardization.[11,14,22,43,49]

Of the different indices, the Tooth Wear Index (TWI) developed by Smith and Knight has been validated and used by many researchers.[14] Some researchers have used the TWI with modifications pertaining to the particular age group being studied. Bardsley *et al*. modified the TWI to be used in an epidemiological study of 14 year old children in London. This version of the TWI was used in this study as it was suitable for the analysis of tooth wear of subjects included in the present study.[7] (see Appendix C)

Temporomandibular disorders

Temporomandibular disorders is an umbrella term which encompasses several chronic pain disorders including masticatory muscle dysfunction, joint disorders and headache disorders.[12] Temporomandibular disorders have generally been presumed to be conditions that affect only adults; however, epidemiological studies have reported signs and symptoms in children and adolescents to be as frequent as in adults but, because the signs and symptoms are milder they may not be recorded.[50] Like most other chronic pain disorders, the exact cause of temporomandibular disorders is often a matter of debate. Genetics, morphology, environmental factors, oral parafunctional activities, erosion and trauma may be possible etiological factors. Also, any factors that can cause muscle fatigue and micro trauma may also be responsible for temporomandibular disorders.[51] There are several studies which have shown an association between the dental anatomy of teeth, masticatory muscles and temporomandibular disorders.[12,19,52-54] Headache and

temporomandibular disorders are the most common orofacial pain complaints that lead to significant suffering and absenteeism from work or school.[12,55]

Prevalence of temporomandibular disorders

Torsdatter and Sorli (2011) reviewed different articles and found inconsistent results about the prevalence of these disorders. However, they found that prevalence of temporomandibular disorders is higher in women than in children and incidence increases as age increases.[56]

The prevalence of temporomandibular disorders in children varies widely in the literature. An article in the literature mentions the prevalence of temporomandibular disorders may vary from 16% to 90% in children with mixed dentition.[57]

Measurement of temporomandibular disorders

The most prevalent clinical signs of temporomandibular disorders are temporomandibular joint sounds (upon palpation), limitation of mandibular movements, temporomandibular joint tenderness and masticatory muscle tenderness. Reported symptoms of temporomandibular disorders may include headache, temporomandibular joint sounds, bruxism, difficulty in opening the mouth, jaw pain and facial pain.[50]

Several methods have been used by clinicians to study temporomandibular disorders in adults however; very few studies have been done on children. Among many indices the Helkimo index is one of the most widely used and studied index. It is a three section index including an anamnestic, a clinical dysfunction and an occlusal index. This study used the anamnestic questionnaire and the clinical dysfunction index to measure temporomandibular disorders (see Appendix C)[50,58]

Sleep breathing disorders

Sleep is a significant physiologic process in human beings. Humans normally spend about one third of a lifetime in sleep. The sleep quality of children is directly related to their physical health, emotional health and development of intelligence.[59] Sleep breathing disorders are usually caused due to inadequate space in the upper respiratory tract and may range from mild snoring to severe obstructive sleep apnea. Studies have shown that sleep breathing disorders affect the day time concentration of the child which in turn may affect the physiological and mental growth of the child.[60] The causes of sleep breathing disorders may likely be the combination of several factors such as structural abnormalities along the airway tract, soft tissue hypertrophy (adenotonsillar), craniofacial dysmorphology like micrognathia or macrognathia, neuromuscular or neuromotor dysfunction.[61] In addition, genetic, psychological and environmental factors may influence the imbalance and cause airway disruption.[62] A study by Carlson *et al* showed that excessive tooth wear was one of the most common sign of sleep breathing disorders[38] The first step in determining the likelihood of sleep breathing disorders in pediatric patients should be to screen for possible symptoms, especially in high-risk groups like - patients with adenotonsillar hypertrophy, obesity and attention-deficit/hyperactivity disorder. Children with sleep breathing disorders usually exhibit daytime manifestations of poor sleep, such as sleepiness, inattention, or irritability.[62] Thus, it is incumbent on primary care clinicians to know the potential signs and symptoms of sleep breathing disorders.

Prevalence of sleep breathing disorders

The prevalence of sleep breathing disorders in children vary due to non-standardized research criteria related to frequency, time of onset and chronicity. Overall most studies

presented the prevalence of sleep breathing disorders in children to be about 20 to 30%.[63] Sleep breathing disorders affect approximately 25% of all children at some point during childhood. They may present as short-term difficulties in falling asleep and night waking or may be more serious like obstructive sleep apnea.[64] A study done on school children in Turkey showed the prevalence of sleep breathing disorders to be about 7% in children. [60] No studies were found to be done on Indian children. A study done by Ng on Indian adults staying in Singapore found a prevalence of 10.9 %.[65]

Measurement of sleep breathing disorders

Several questionnaires have been developed to diagnose sleep breathing disorders in children. In general, clinician's diagnosis is based on anamnestic reports given by parents. Spruyt *et al.* stated that the scale should be reliable, reproducible, psychometrically robust and validated. They presented the 'dos and don'ts' for designing a practical, pragmatic and reproducible questionnaire.[6] There have been several scales and questionnaires used in the past and her group reviewed several questionnaires and found that very few were validated and standardized.[66] The Sleep Disturbance Scale for Children (SDSC) by Bruni is one of the two validated scales meeting all the ideal requirements given by Spruyt [67] and hence, this scale was used in this study. The SDSC is a 26 item, Likert - type rating scale designed to precisely perform psychometric analyses. It is reliably reproducible and hence validated to be used in children. The scale was administered at four randomly selected public schools in Rome and consistent results were found.[67] Few modifications were done based on the statistical analysis and the final scale was found to be easy to collect data and the scores were consistent even when tested and retested. The other salient feature of this scale is that it can help the clinician to focus on the six factors representing the most

common areas of sleep breathing disorders in childhood and adolescence. Hence, this would help the clinician to focus towards a specific area of dysfunction that would require detailed investigation.[67] Current literature review does not show if any clinicians have studied the sleep breathing disorders in Indian children using the SDSC.[67] (see Appendix C)

Specific Aims and Hypothesis

The aim of this study was to test if an association exists between non- carious tooth wear, temporomandibular disorders and sleep breathing disorders in Indian children. We hypothesized there would be a positive association between tooth wear and temporomandibular joint disorders; a positive association between tooth wear and sleep breathing disorders in children and a positive association between temporomandibular joint disorders and sleep breathing disorders.

Research Design and Methods

This study was a cross-sectional observational study on Indian school children. The protocol was reviewed and approved on July 16th 2012 by the Institutional Review Board – Ethics Committee (IRB-EC) of the Yerala Medical Trust and Research Centre. YMTRC Dental College and Hospital P.G. Institution institutional area, Sector 4, Kharghar, Navi Mumbai, India. 410210

Study population

Children between the ages of 10 and 16 years were approached for participation in the study. They represented a cross- section of Indian school children.

Inclusion and exclusion criteria

English speaking children with mixed or permanent dentition were accepted in the study. Potential subjects were excluded if they had cleft lip or palate or extensive tooth structure loss due to caries.

Questionnaires

Modified Helkimo Index questionnaire[50,58] for temporomandibular disorders and Sleep Disorder Scale for Children by Bruni for sleep breathing disorders[67] were used in the study. Both questionnaires were designed to be completed by parents in collaboration with the children. (see Appendix C). The questions were reworded to collect observations and self-reported problems instead of being completed by clinical examiners. The answers to the questions were dichotomized to detect the presence or absence of any symptom with subsequent detailed answers in the case of the positive response to any question. Responses to the eight questions were used to measure the self diagnosed temporomandibular disorders. Scores of 0, 1and 5 were given as follows: (0) for no symptoms, (1) for mild symptoms, and (5) for moderate to severe symptoms. The presence and absence of temporomandibular disorders and the severity was assigned based on the total score of the index.

Assessment for Temporomandibular disorders

A child was considered to have clinically diagnosed temporomandibular disorders, during on oral examination, if the incisal edge distance with mouth open was below the age-specific 2.5th percentile or if they were found to have the presence of temporomandibular joint sounds, temporomandibular joint tenderness to palpation, or if masticatory muscles

viz. temporalis, masseter or medial pterygoid muscle were tender. A child was considered to have self diagnosed temporomandibular disorders based on the health history form.

Assessment for sleep breathing disorders

A child was considered to have a sleep breathing disorder if the score of the response to the SDSC questionnaire was equal to or more than 39. The answers, "Never", "Occasionally", "Sometimes", "Often", or "Always" to the 26 questions were scored as 1,2,3,4 and 5, respectively. Severity of sleep breathing disorders was considered directly proportional to the score.

Since, the aim of this study was to examine the potential association between tooth wear, temporomandibular disorders and sleep breathing disorders; subjects were classified as normal or affected by sleep breathing disorders.

Assessment of tooth wear

A child was considered to have tooth wear if, during an oral examination, it was determined that any surface on the tooth included in the study, experienced any wear. The severity of the wear was considered "mild" if the surfaces were scored 1, but no surfaces were scored 2 or 3, and the wear was considered "severe" if any surface had a score of 2 or greater.

Since, the aim of this study was to find an association between tooth wear, temporomandibular disorders and sleep breathing disorders; subjects were classified as normal or affected by tooth wear.

Clinical examination

Three associate dentists, two interns and one office secretary comprised the team for this study. All team members were CITI certified before initiating the enrollment process for

the study. Prior to the start of the study, the team was calibrated by the principal advisor of the project in order to maintain uniformity of scores. Each team member was assigned a specific section of clinical examination.

The primary investigator clinically examined the temporomandibular joint and the muscles of mastication of every child for temporomandibular disorders. The second team member examined every child's tooth wear and the third clinician examined the range of mouth opening as well as dental health status. Each child was examined while seated on a regular chair under normal day-light and was serially transferred from one examiner to next examiner. All the findings were recorded in form 2 (see Appendix C).

To ensure accuracy of readings to calculate tooth wear, dental models of ten children were scored by the investigators and the results were analyzed by the advisor. Common consensus was reached to confirm the exactness of the readings. However, to maintain uniformity and minimize bias, one examiner was specifically assigned for recording tooth wear. To further maintain uniformity most children were examined at a specific time of the day to ensure similar light conditions.

Extra-oral examination

Clinical examination of temporomandibular disorders was done by the primary researcher to maintain the uniformity of palpation pressure and to study the temporomandibular joint sounds. The following parameters were examined:

1. The presence of temporomandibular joint sounds, which were either clearly audible or felt using the index finger during opening and closing of the mouth. Only those sounds that were detected in at least two out of three consecutive opening/closing actions were considered positive and recoreded.

2. The presence of temporomandibular joint sensitivity to palpation was checked using index fingers.

3. The presence of tenderness of masticatory muscles was assessed using palpation of the masseter (deep and superficial, left and right sides), the temporalis (anterior portion, left and right sides) and the medial pterygoid inner side of the angle of mandible (left and right sides) was checked. In the case of the positive findings, the child was asked to specify the level of tenderness as mild, moderate or severe.

Intraoral examination

The presence of wear facets on teeth were assessed according to modified Tooth wear Index (TWI) scale by Bardsley[14]. Scores were calculated as: follows:

Grade 0 = no wear,

Grade 1 (mild) = enamel wear only,

Grade 2 (moderate) = low enamel and dentin wear and

Grade 3 (severe) = significant enamel and dentin wear.

The assessed teeth included the incisal, labial and lingual (palatal) surfaces of maxillary and mandibular permanent or deciduous anterior teeth and occlusal surface of maxillary and mandibular permanent molars. Fractured teeth and extremely carious teeth were not scored.

Recruitment

A verbal communication was initiated in secondary schools and a scholastic training institute in Ghatkopar, a central suburb of Mumbai, India. Formal letters explaining the nature of study were sent to the students and their guardians. Parents and children who signed the informed consent form and assent forms respectively were included in the

study. (see Appendix C) Introductory sessions were conducted for the parents to explain the observations to be collected by parents. Children were either examined in the school or private institution. The same protocol for examination was followed in both locations. On the day of examination the duly signed consent forms by the parent (or surrogates) and the assent forms by the child along with the completed questionnaire were collected. All the parts of the study (including the clinical examination) were carried out only on those children who expressed their willingness to be examined and had signed the assent forms and whose guardian had duly signed the informed consent forms.

All the completed forms were filed in locked cabinet and were accessible to only to members of the research team.

Clinical findings which demanded urgent attention were highlighted and briefly discussed with the guardians so that the child's dental health would improve.

Statistical Analysis

Associations between the presences of each of the three conditions were evaluated using chi-square tests. Any p-values less than 0.05 were considered statistically significant. All analyses were performed using SAS, Version 9.2 (SAS Institute, Cary, NC).

Results

Questionnaires were distributed to 1500 children (627girls and 873 boys) aged 10 to 16 years. A total of 1009 (67.3%) subjects, 405 (40.1%) girls and 604 (59.9%) boys who submitted the consent forms and questionnaires comprised the final study sample. Thus, a response rate of 67.3 % was reached. The minimum age was 10 years and the maximum age was 16 years. Mean (standard deviation) age was 12.8 (0.78)years. Of the 1009, 853

(84.5%) had tooth wear (661 had mild tooth wear and 192 had severe tooth wear), 356 (35.3%) had sleep breathing disorders, 587 (58.2%) had clinically diagnosed temporomandibular disorders, and 371 (36.8%) had self-diagnosed temporomandibular disorders.

Of the 356 with sleep breathing disorders, 253 (71.1%) had temporomandibular disorders, compared to 334 of the 653 (51.1%) without sleep breathing disorders. This was a statistically significant difference ($p< 0.0001$). Also, of the 371 with self-diagnosed temporomandibular disorders, 188 (50.67%) had sleep breathing disorders, compared to 168 of the 638 (26.33%) without self-diagnosed temporomandibular disorders and this was also statistically significant difference ($p<0.0001$).

Of the 853 with tooth wear, 492 (57.7%) had temporomandibular disorders, compared to 95 of the 156 (60.9%) without tooth wear. This difference was not statistically significant ($p=0.454$).

Of the 853 with tooth wear, 307 (36%) had sleep breathing disorders, compared to 49 of the 156 (31.4%) without tooth wear. This difference was not statistically significant ($p=0.2710$).

Discussion

The current study was carried out in school children to evaluate the association between tooth wear, temporomandibular disorders and sleep breathing disorders. The selected sample of 1009 children was representative of the population of that age group with diverse socioeconomic status. An adequate number of boys and girls were present in this prevalence study and the findings reflect the general trend of oral and facial pathology.

Most studies on children have focused on age groups between 10 and 16 years because the index teeth present in the mouth are exposed to possible factors for tooth wear for about 4 - 6 years. Most children selected for this study were aged 12 to 14 years and the mean age was 12.8 years. The sample was felt to be sufficiently large to be representative of an urban community in India. The epidemiological study was simple to conduct since it was undertaken in a school and a private educational institution.

This study found statistically significant association between temporomandibular disorders and sleep breathing disorders. Sleep breathing disorders were more common in those with temporomandibular disorders than those without temporomandibular disorders (Table 19 and 20).

The results of our study also present that association between tooth wear and temporomandibular disorders as well as tooth wear and sleep breathing disorders is not statistically significant. (Table 15 -18)

This may be in keeping with the concept of a "Weak link theory" as described by Mehta *et al* in a study of adults. The study concluded that the association between bruxism and breakdown of the masticatory system often depends on that individual's most compromised "weakest" structure. Based on a weak link theory the weakest component of the masticatory system will breakdown first and the other areas will not show any evidence of breakdown.[4] In our present study the results also tend to support this concept in children as well.

This study also found high prevalence of tooth wear, temporomandibular disorders and sleep breathing disorders in the subject population. The results match several studies in current literature.[3,8,50,56,68,69]

Prevalence of tooth wear

Studies present a wide range of estimates of prevalence of tooth wear in children ranging from 0 – 82%[3,68,69] Most data are from European studies with only a few epidemiological studies from developing countries[68,70,71]. The range is vast probably due to the use of different indices, different diagnostic methods and different inclusion criteria among other factors by different researchers. The results of the present cross sectional study showed that the prevalence of tooth wear was 84. 5 %. (Table 8 -9) Six hundred and sixty one (65.5 %) children had mild tooth wear and one hundred and ninety two children (19.0 %) had severe tooth wear. When comparing the present findings with other studies conducted in developing countries, the prevalence of tooth wear in this study was found to be higher than the 74.1% in 12-14 year-old Sudanese[70] and much less than the 95% prevalence in 12-14 year-old Saudi Arabian boys[68]. The prevalence of tooth wear found in this study may be high as compared to many studies although fewer studies have found higher prevalence rates. This may also be due the selection criteria that even, if one surface out of 40 surfaces of the determined 16 teeth showed even mild wear, the child was considered to be affected. Since this study was focused on association between tooth wear, temporomandibular disorders and sleep breathing disorders, the analysis for mild and severe tooth wear has not been further analyzed. The clinical findings of high tooth wear prevalence need to be monitored and investigated further as its progression may become a matter of serious concern. Many possible causes like the parafunction, consumption of food with strong acidity, gastro-esophageal reflux and inadequate salivary buffering may attribute to tooth wear. Clinical presentation of different etiologies is different and usually an experienced clinician can differentiate them.

Prevalence of temporomandibular disorders

Temporomandibular disorders are defined as a group of disorders affecting the masticatory muscles and temporomandibular joints. They are associated with joint sounds, jaw locking, and or jaw pain. They are a set of chronic degenerative disorders, which may go unnoticed and worsen over a period of time. Self diagnosed temporomandibular disorders are an effective screening test of detecting temporomandibular disorders early. The findings of this study demonstrate that 50% of these patients also have sleep breathing disorders whereas only 26% of the children without self-diagnosed temporomandibular disorders had sleep breathing disorders. (Table 19) This difference was statistically significant. The presence of temporomandibular disorders and sleep breathing disorders in 50% of young school going children is clinically significant.

The prevalence of temporomandibular disorders among children and adolescents varies considerably. Out of 1009 subjects, this study found 587 (58.2%) had clinically diagnosed temporomandibular disorders, and 371 (36.8%) had self-diagnosed temporomandibular disorders. (Table 19 -20) However, the result of this study are much less than a study done with Turkish children, where the prevalence was found to be 68 %.[50,56,68] However, it is likely that a subject may present signs and symptoms of temporomandibular disorders without ever developing temporomandibular disorders. Also, the presence of these symptoms by themselves does not imply the need for treatment as they could signify a predisposition as well as an underlying condition.[56,68] In the current study, the percentage is much higher than many other studies, probably because a subject was considered to have temporomandibular disorders even if one of the signs of discomfort were present. This criterion was considered as we were studying only the association between tooth

wear and temporomandibular disorders. A disadvantage of screening for temporomandibular disorders in this manner is the risk of over-diagnosing as well as overtreatment.

Prevalence of sleep breathing disorders

International studies show the prevalence of sleep breathing disorders varies between 1 - 43%[8]. Prevalence of sleep breathing disorders in children in this study was found to be 35.3%. This result is similar to another study carried out on Chinese children in Beijing[72]. Several studies have analyzed different symptoms of sleep breathing disorders whereas this study has summarized different symptoms as it was focused on studying the correlation between tooth wear, sleep breathing disorders and temporomandibular disorders. Sleep breathing disorders (SBD) have been reported in literature to have serious impact on the growth of children, inappropriate development of many higher cognitive functions, neural damage and many diseases like the cardiovascular diseases, hypertension and diabetes. Early detection of the sleep breathing disorders will help to prevent adverse effects on the growth, development and behavior of the child. The results show that about 36% of children with tooth wear demonstrate sleep breathing disorders and about 31% of children with no tooth wear demonstrated sleep breathing disorders. Statistically the findings of sleep breathing disorders in children with or without tooth wear were not significant. But the high percentage of tooth wear in the study and that more than one third of them have sleep breathing disorders is suggestive of some association of tooth wear and sleep breathing disorders. Considering the long-term ill effects of sleep breathing disorders, it is imperative that dentists should identify sleep breathing disorders in children and suspect their presence when tooth wear is evident. Further investigations may present

data to identify whether tooth wear is a symptom of sleep breathing disorders or a cause of sleep breathing disorders. However, the presence of these symptoms by themselves does not imply the need for treatment as they could signify a predisposition or an underlying condition.

Limitation

The limitation of this study may be the finding of high prevalence of tooth wear and temporomandibular disorders. This may be due to the fact that even a single surface wear out of the forty surfaces examined was considered for tooth wear and even a single symptom of temporomandibular disorders was considered as positive for temporomandibular disorders. However, studies have shown that every symptom may not be pathological.

Conclusion

This study concludes that there is high prevalence of tooth wear, sleep breathing disorders and temporomandibular disorders in Indian school children. There is a statistically significant association between sleep breathing disorders and temporomandibular disorders. There may be no significant association between tooth wear and sleep breathing disorders and temporomandibular disorders.

Appendix A: Tables

Table 1: Age distribution of study cohort

Age distribution of study cohort		
Age	**N**	**Percent**
10	4	0.4%
11	31	3.1%
12	320	31.7%
13	492	48.8%
14	158	15.7%
15	3	0.3%
16	1	0.1%
Total	1,009	100 %

Table 2: Gender distribution of study cohort

Gender distribution of study cohort		
Gender	N	Percent
Female	405	40.1%
Male	604	59.9%
Total	1,009	100 %

Table 3: Age distribution of study cohort by gender

Age distribution by gender					
Age	**Female**		**Male**		**Total**
	N	Percent	N	Percent	
10	3	0.74%	1	0.2%	4
11	23	5.68%	8	1.3%	31
12	93	22.96%	227	37.6%	320
13	205	50.62%	287	47.5%	492
14	77	19.01%	81	13.4%	158
15	3	0.74%	0	0.0%	3
16	1	0.25%	0	0.0%	1
Total	405	40.1%	604	59.9%	1,009

Table 4: Distribution of tooth wear of study cohort

Distribution of tooth wear		
Tooth wear	**Frequency**	**Percent**
None	156	15.5 %
Mild	661	65.5 %
Severe	192	19.0 %
Total	1,009	100 %

Table 5: **Distribution of clinically diagnosed temporomandibular disorders (TMD)**

Distribution of clinically diagnosed TMD		
Clinically diagnosed TMD	**Frequency**	**Percent**
No	422	41.8 %
Yes	587	58.2 %
Total	1,009	100 %

Table 6: **Distribution of self diagnosed temporomandibular disorders (TMD)**

Distribution of self diagnosed TMD		
Self diagnosed TMD	**Frequency**	**Percent**
No	638	63.2%
Yes	371	36.8 %
Total	1,009	100 %

Table 7: Distribution of sleep breathing disorders (SBD)

Distribution of sleep breathing disorders		
SBD	**Frequency**	**Percent**
No	653	64.7 %
Yes	356	35.3 %
Total	1,009	100 %

Table 8: Distribution of tooth wear according to age

Distribution of tooth wear according to age							p-value < 0.0001	
Tooth wear	**10 years**	**11 years**	**12 years**	**13 years**	**14 years**	**15 years**	**16 years**	**Total**
Absent	2 (50.0%)	8 (25.8%)	42 (13.1%)	78 (15.9%)	26 (16.5%)	0 (0.0%)	0 (0.0%)	156
Mild	2 (50.0%)	8 (25.8%)	193 (60.3%)	342 (69.5%)	112 (70.9%)	3 (100.0%)	1 (100.0%)	661
Severe	0 (0.0%)	15 (48.4%)	85 (26.6%)	72 (14.6%)	20 (12.7%)	0 (0.0%)	0 (0.0%)	192
Total	4	31	320	492	158	3	1	1,009

Table 9: Distribution of tooth wear according to gender

Distribution of tooth wear according to gender			p-value = 0.0803	
Tooth wear	**Absent**	**Mild**	**Severe**	**Total**
Female	56 (13.8%)	259 (64.%)	90(22.2%)	405
Male	100 (16.6%)	402 (66.6%)	102(16.9%)	604
Total	156	661	192	1,009

Table 10: Distribution of clinically diagnosed TMD according to age

Distribution of clinically diagnosed temporomandibular disorders according to age							p-value = 0.0133	
TMD	**10 years**	**11 years**	**12 years**	**13 years**	**14 years**	**15 years**	**16 years**	**Total**
Absent	2	22	157	198	41	1	1	422
Present	2	9	163	294	117	2	0	587
Total	4	31	320	492	158	3	1	1,009

Table 11: Distribution of clinically diagnosed TMD according to gender

Distribution of clinically diagnosed temporomandibular disorders according to gender				p-value = 0.3362	
C- TMD	**Female**	**Female %**	**Male**	**Male %**	**Total**
Absent	169	41.7%	253	41.9%	**422**
Present	236	58.3%	351	58.1%	**587**
Total	405		604		1,009

Table 12: Distribution of self diagnosed TMD according to age

Distribution of self diagnosed temporomandibular disorders according to age							p-value = 0.0925	
S - TMD	**10 years**	**11 years**	**12 years**	**13 years**	**14 years**	**15 years**	**16 years**	**Total**
Absent	2	25	200	321	88	2	0	638
Present	2	6	120	171	70	1	1	371
Total	4	31	320	492	158	3	1	1,009

Table 13: Distribution of self diagnosed TMD according to gender

Distribution of self diagnosed temporomandibular disorders according to gender			p-value = 0.7812
S - TMD	**Female**	**Male**	**Total**
Absent	254 (62.7%)	384 (63.6%)	638
Present	151(37.3%)	220 (36.4%)	371
Total	405	604	1,009

Table 14: Distribution of sleep breathing disorders according to age

Distribution of sleep breathing disorders according to age							p-value = 0.0773	
SBD	**10 years**	**11 years**	**12 years**	**13 years**	**14 years**	**15 years**	**16 years**	**Total**
Absent	1	20	212	329	90	1	0	653
Present	3	11	108	163	68	2	1	356
Total	4	31	320	492	158	3	1	1,009

Table 15: Distribution of sleep breathing disorders according to gender

Distribution of sleep breathing disorders according to gender			p-value = 0.0423
SBD	**Female**	**Male**	**Total**
Absent	247 (61.0%)	406 (67.2%)	653
Present	158(39.0%)	198 (32.8%)	356
Total	405	604	1,009

Table 16: Association of tooth wear and clinically diagnosed TMD

Association of tooth wear and clinically diagnosed temporomandibular disorders			p-value = 0.454
	TMD - Clinical absent	**TMD - Clinical present**	**Total**
Tooth wear absent	61(14.5%)	95 (16.2%)	156
Tooth wear present	361 (85.5%)	492 (83.8%)	853
Total	422	587	1,009

Table 17: Association of tooth wear and self diagnosed temporomandibular disorders

Association of tooth wear and self diagnosed temporomandibular disorders			p - value = 0.0910
	TMD – self absent	**TMD – self present**	**Total**
Tooth wear absent	108 (16.9%)	48 (12.9%)	156
Tooth wear present	530 (83.1%)	323 (87.6%)	853
Total	638	371	1,009

Table18: **Association of tooth wear and sleep breathing disorders**

Association of tooth wear and sleep breathing disorders			p – value = 0.271
	SBD absent	**SBD present**	**Total**
Tooth wear absent	107 (16.4%)	49 (13.8%)	156
Tooth wear present	546(83.6%)	307 (86.2%)	853
Total	653	356	1,009

Table 19: Association between clinically diagnosed temporomandibular disorders to sleep breathing disorders

Association between clinically diagnosed temporomandibular disorders to sleep breathing disorders			p - value < 0.001
	SBD absent	**SBD present**	**Total**
TMD_Clinical absent	319 (48.9%)	103 (28.9%)	485
TMD_Clinical present	334 (51.1%)	253 (71.1%)	524
Total	653	356	1,009

Table 20: Association between self diagnosed temporomandibular disorders to sleep breathing disorders

Association between self diagnosed temporomandibular disorders to sleep breathing disorders			p – value <0.001
	SBD absent	**SBD present**	**Total**
TMD_self absent	470 (71.9%)	168 (47.2%)	638
TMD_self present	183 (28.1%)	188 (52.8%)	371
Total	653	356	1,009

Table 21: Analysis to compare self diagnosed temporomandibular disorders to clinically diagnosed temporomandibular disorders

Analysis to compare self diagnosed TMD to clinically Diagnosed TMD			p – value < 0.0001
	TMD_Clinical absent	**TMD_Clinical present**	**Total**
TMD_Self absent	311((73.7%)	327 (55.7%)	638
TMD_Self present	111 (26.3%)	260 (44.3%)	371
Total	422	587	1,009

Appendix B: Figures

Chart 1: Age distribution of study cohort

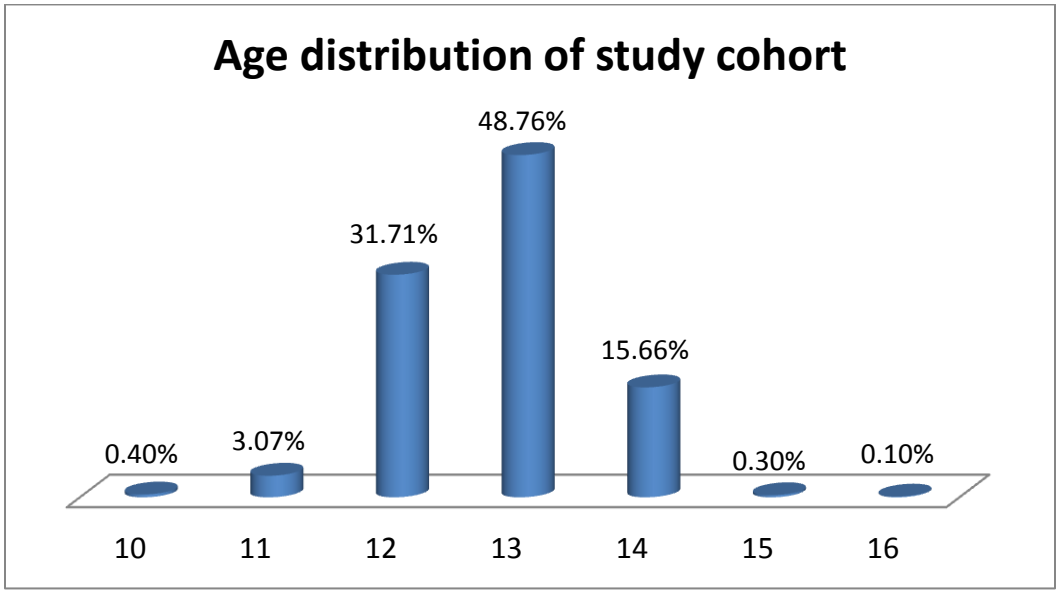


Chart 2: Gender distribution of study cohort

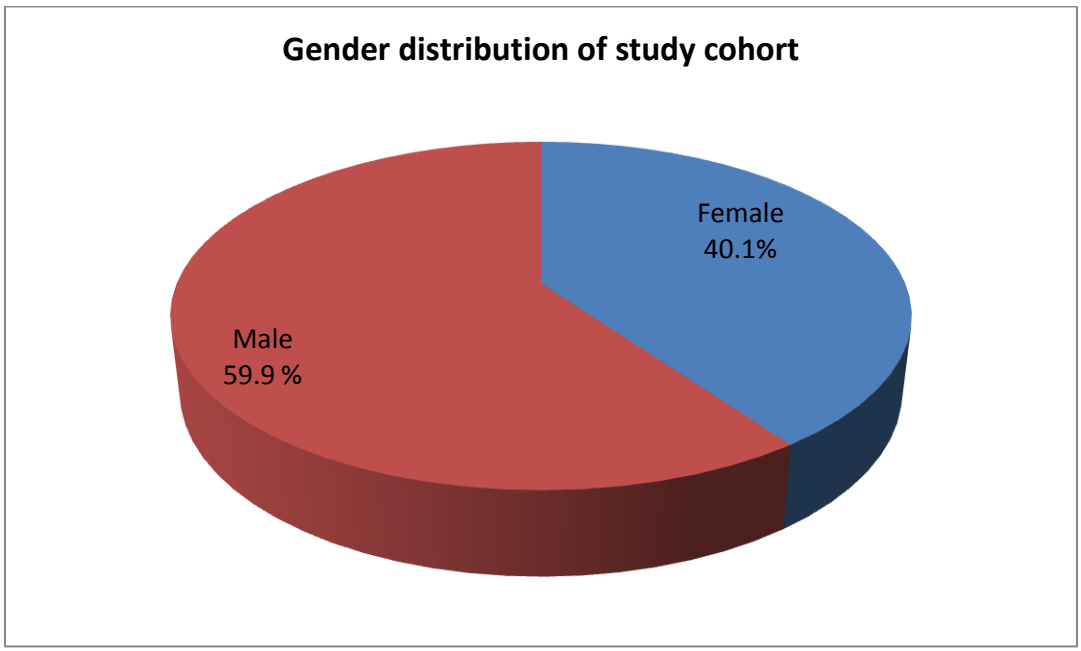


Chart 3 **Age Distribution by gender**

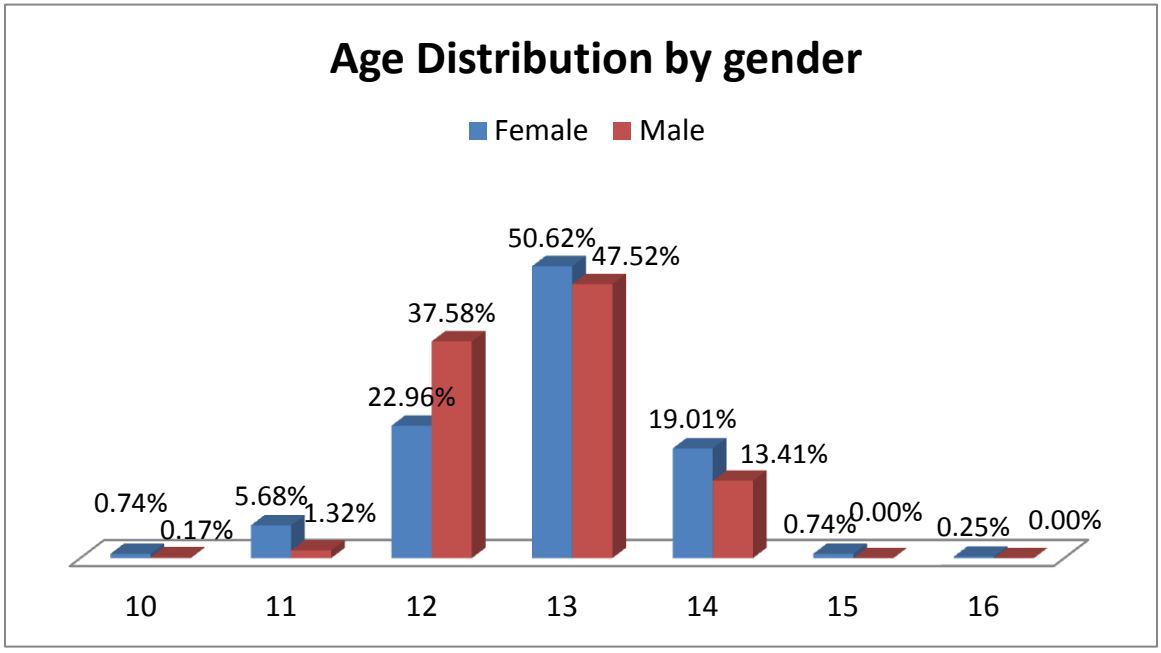


Chart 4: **Distribution of Tooth wear**

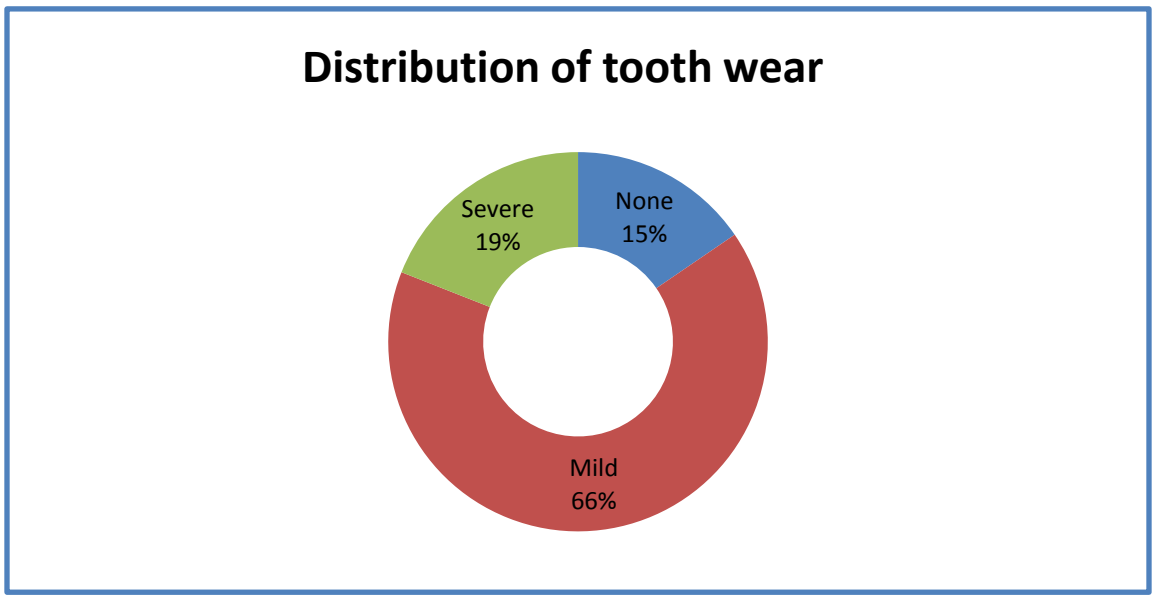


Chart 5: **Distribution of clinically diagnosed TMD**

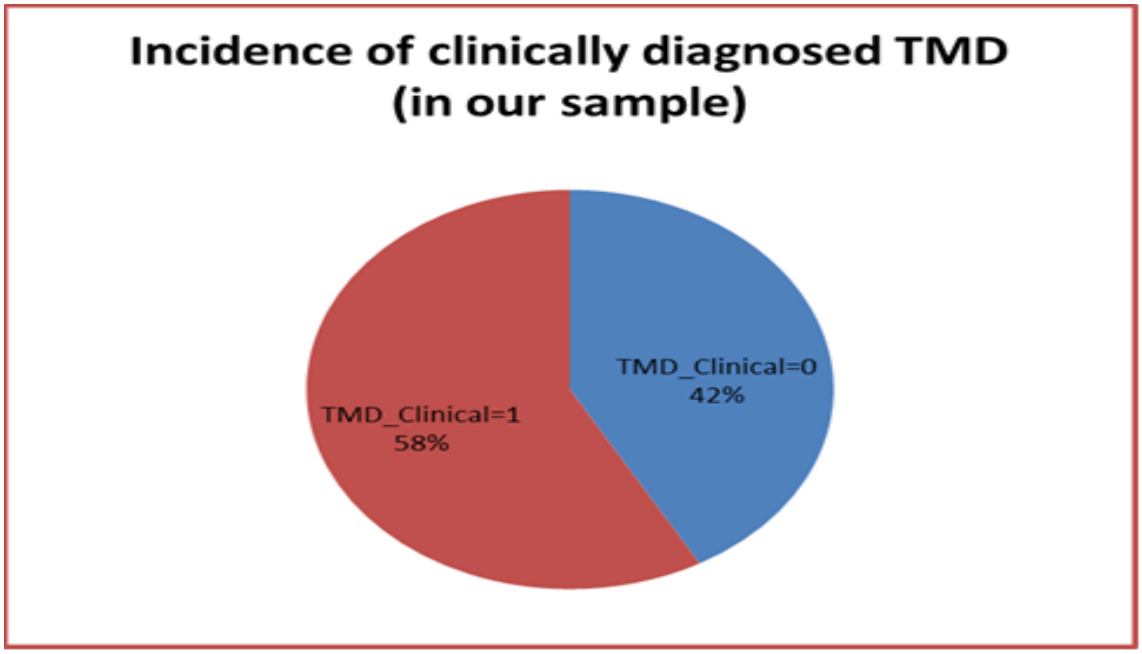


Chart 6 **Distribution of self diagnosed temporomandibular (TMD)**

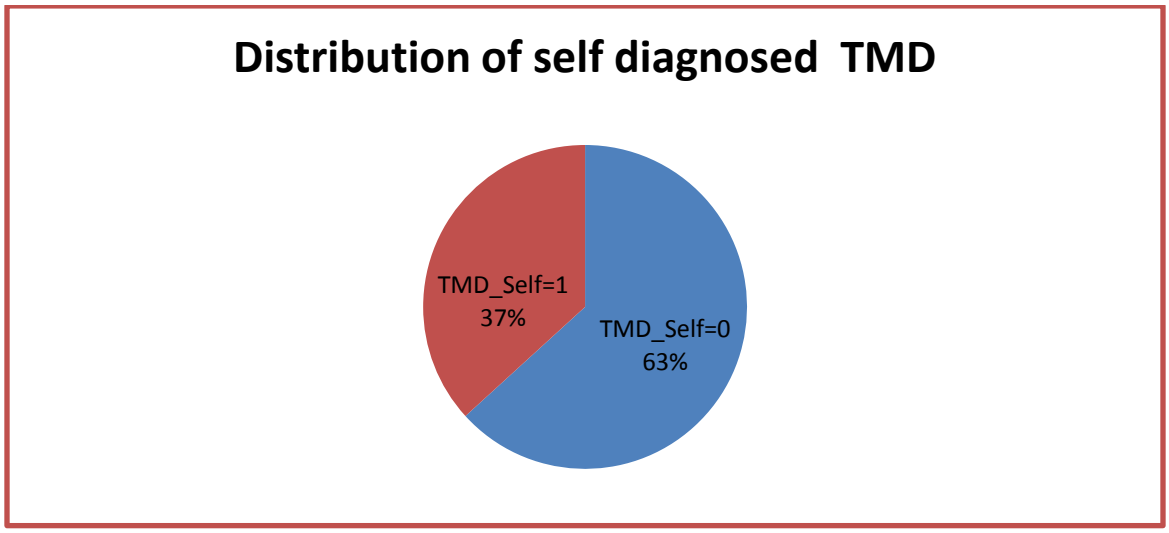


Chart 7: Distribution of sleep breathing disorders

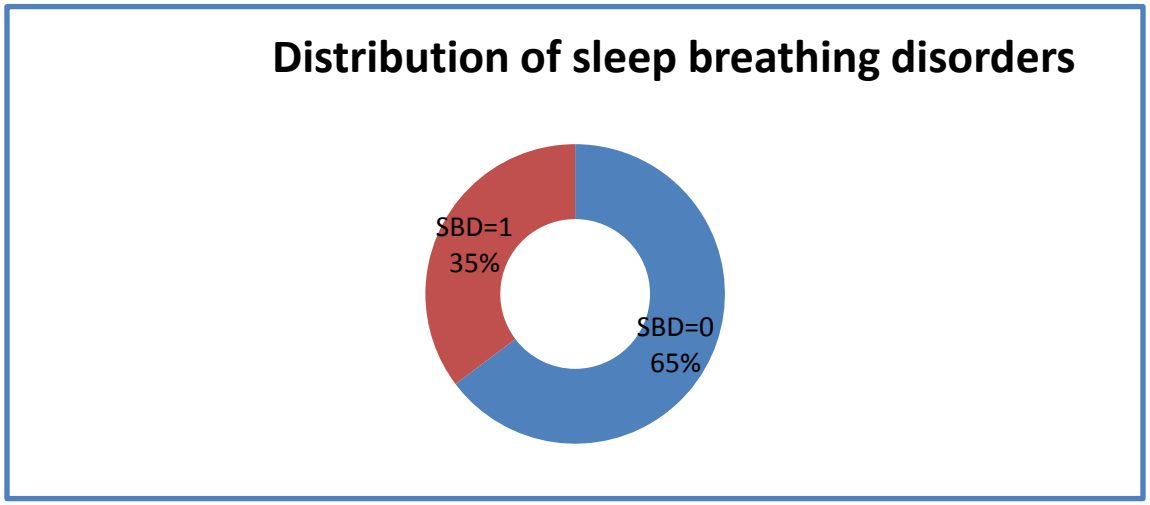


Chart 8: Distribution of tooth wear according to Age

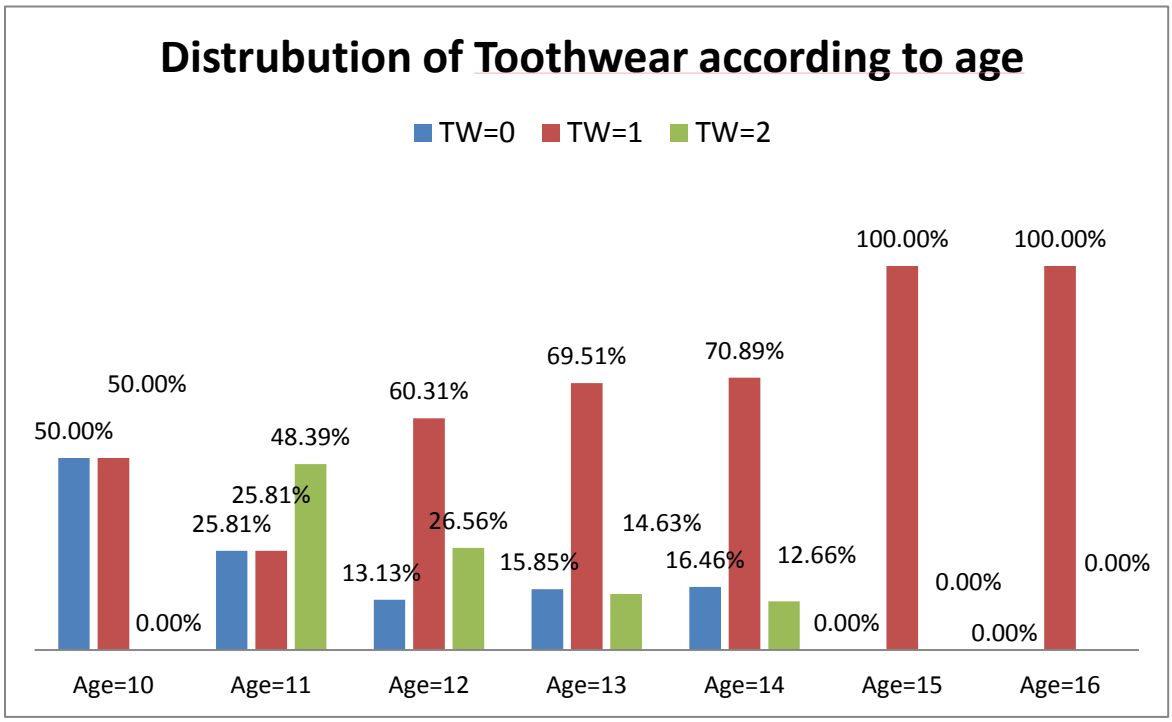


Chart 9: Distribution of tooth wear according to Gender

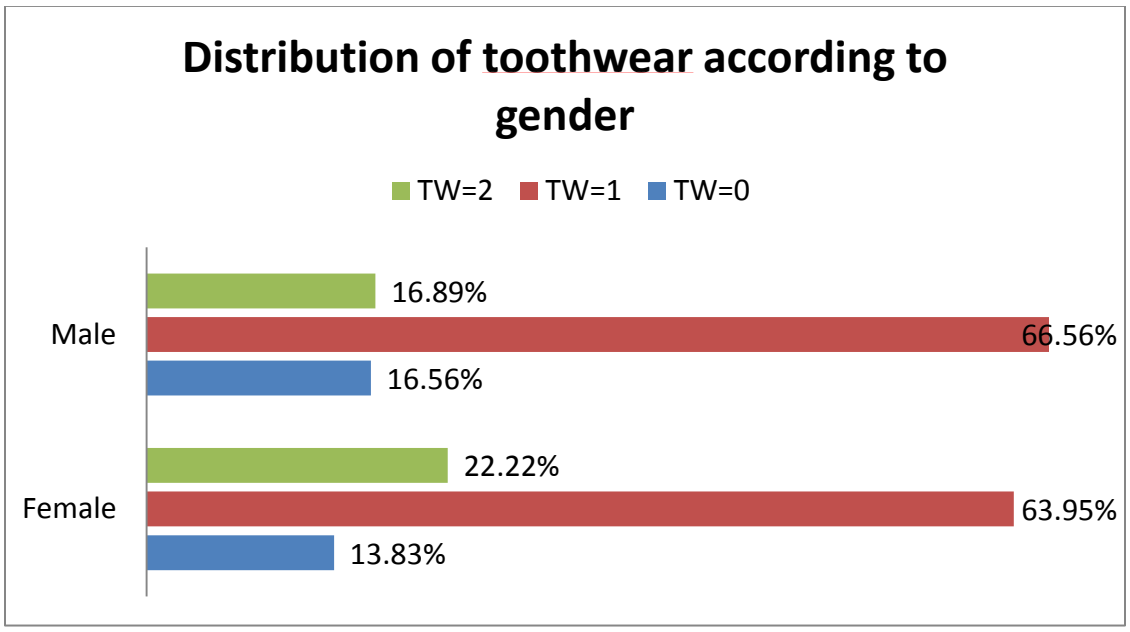


Chart 10: Distribution of clinically diagnosed temporomandibular disorders according to age

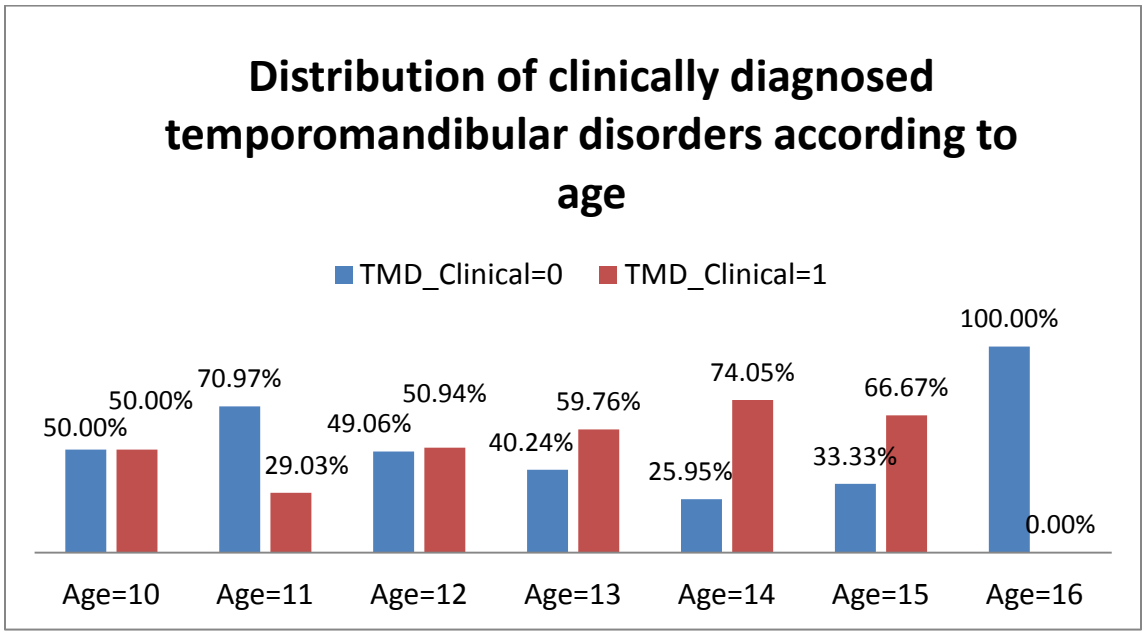


Chart 11: Percentage incidence of clinically diagnosed TMD across genders

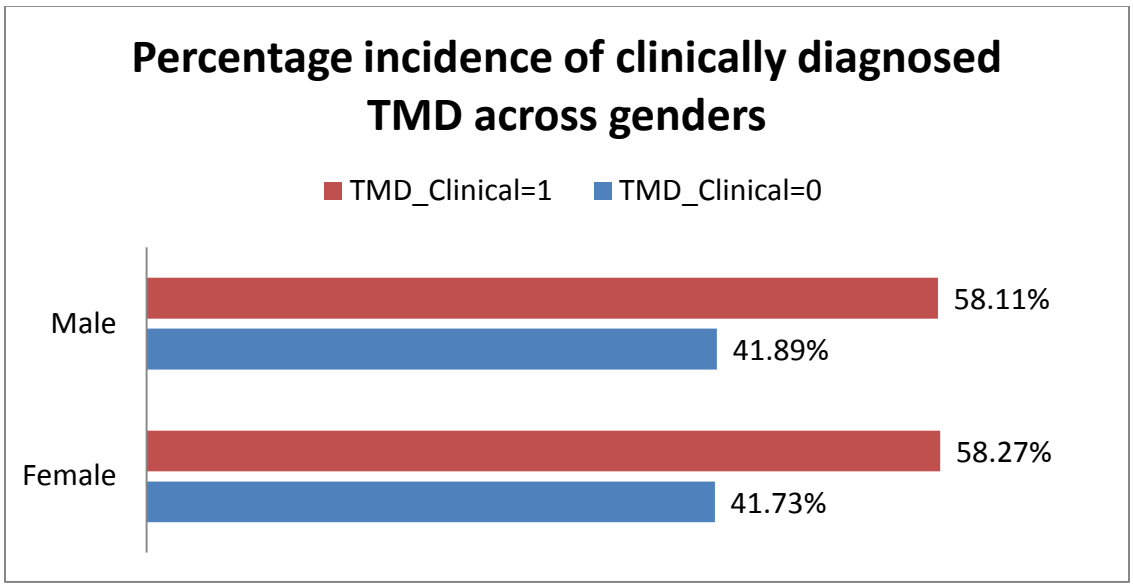


Chart 12: Distribution of self diagnosed temporomandibular disorders according to age

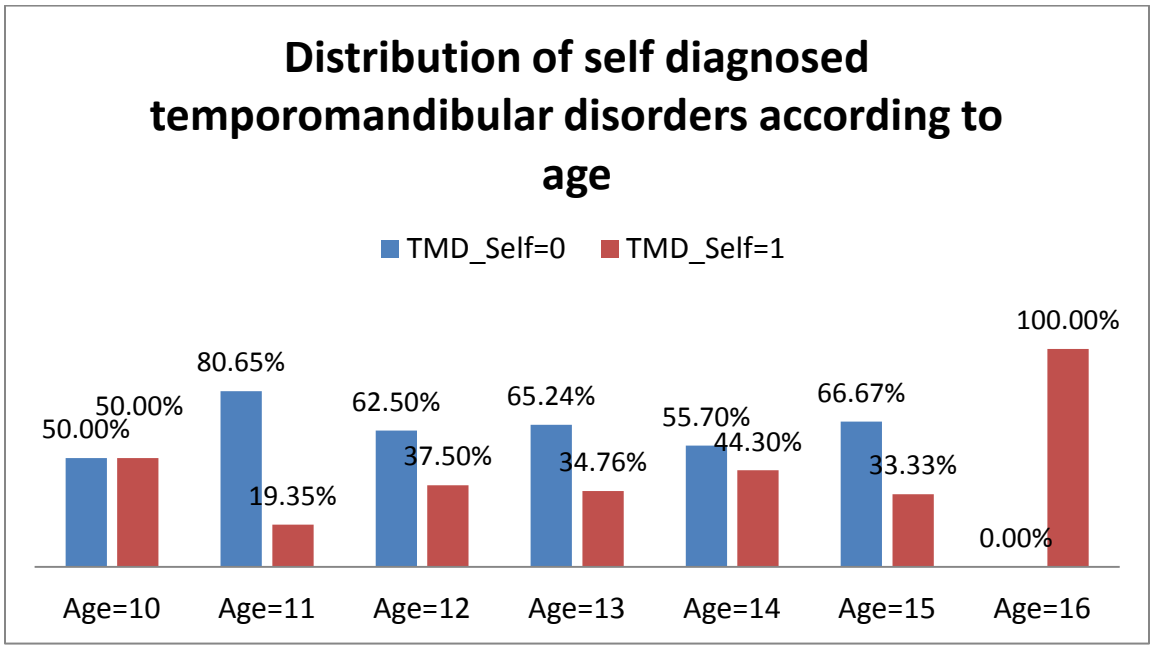


Chart 13: Distribution of self diagnosed temporomandibular disorders according to gender

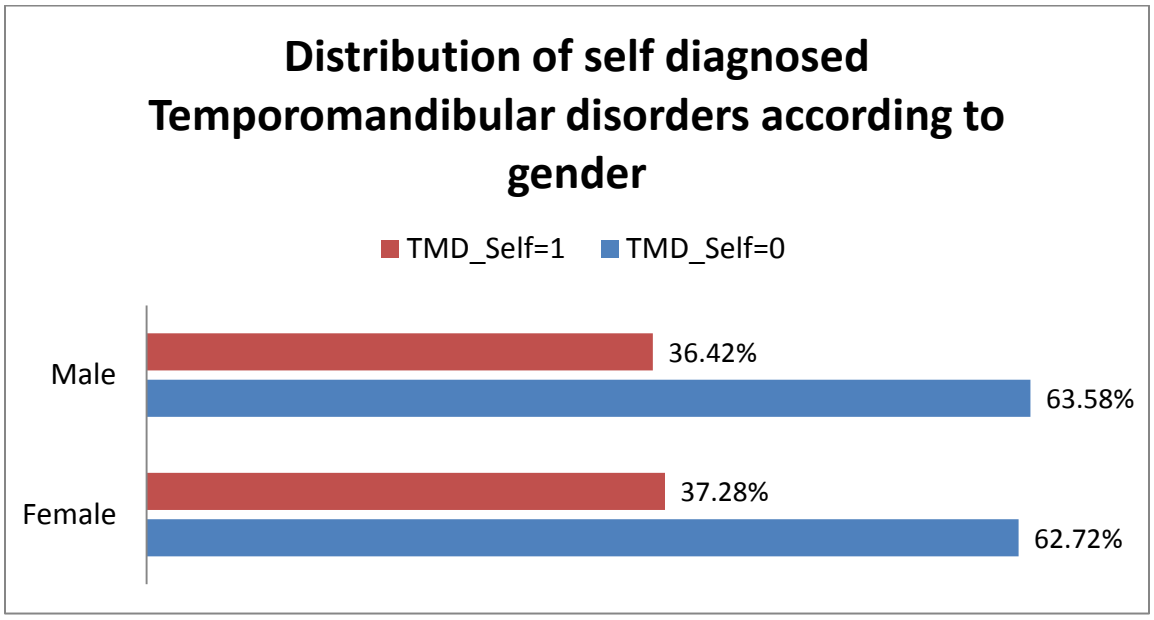


Chart 14: Distribution of Sleep breathing disorders according to age

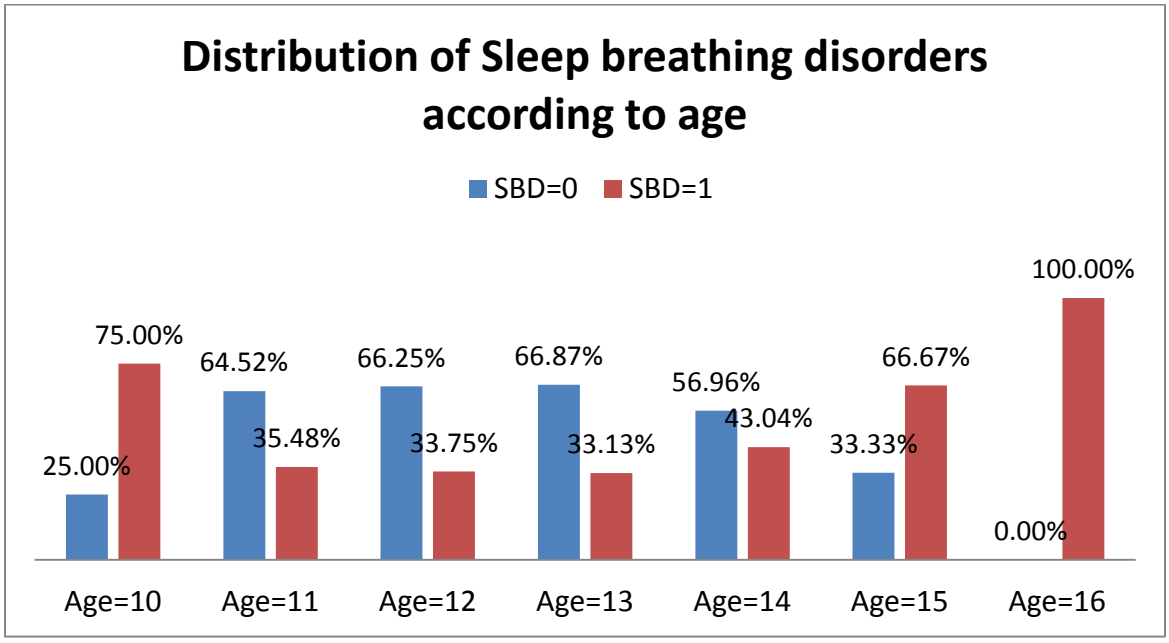


Chart 15 Percentage incidence of SBD across genders

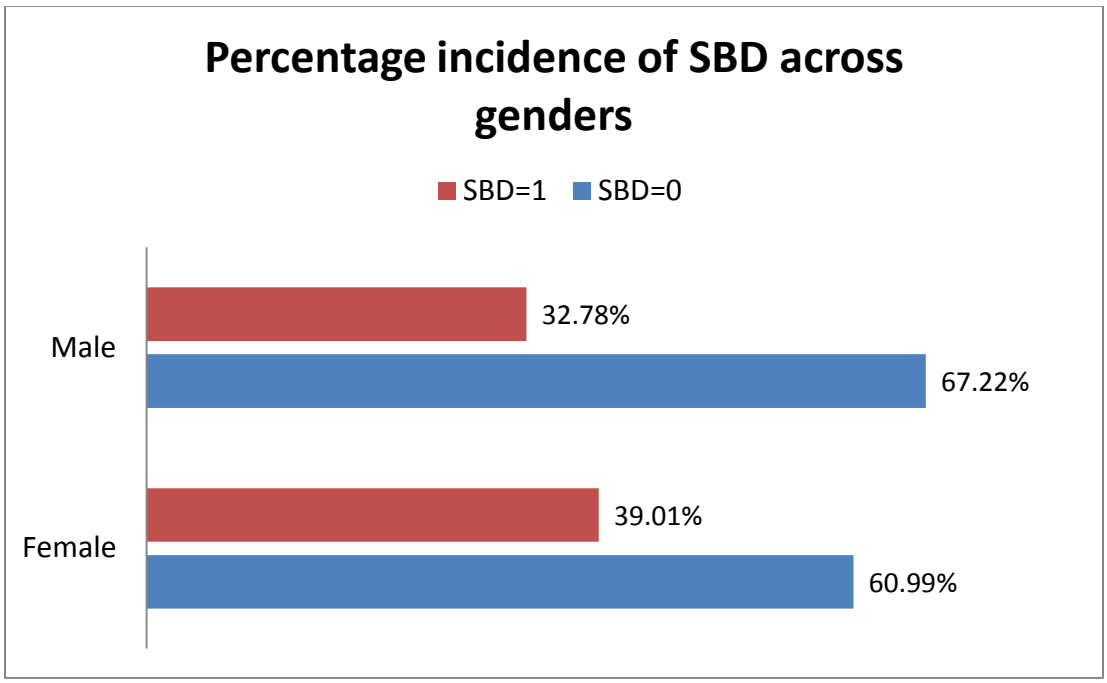


Chart 16: Association of tooth wear and clinically diagnosed temporomandibular disorders

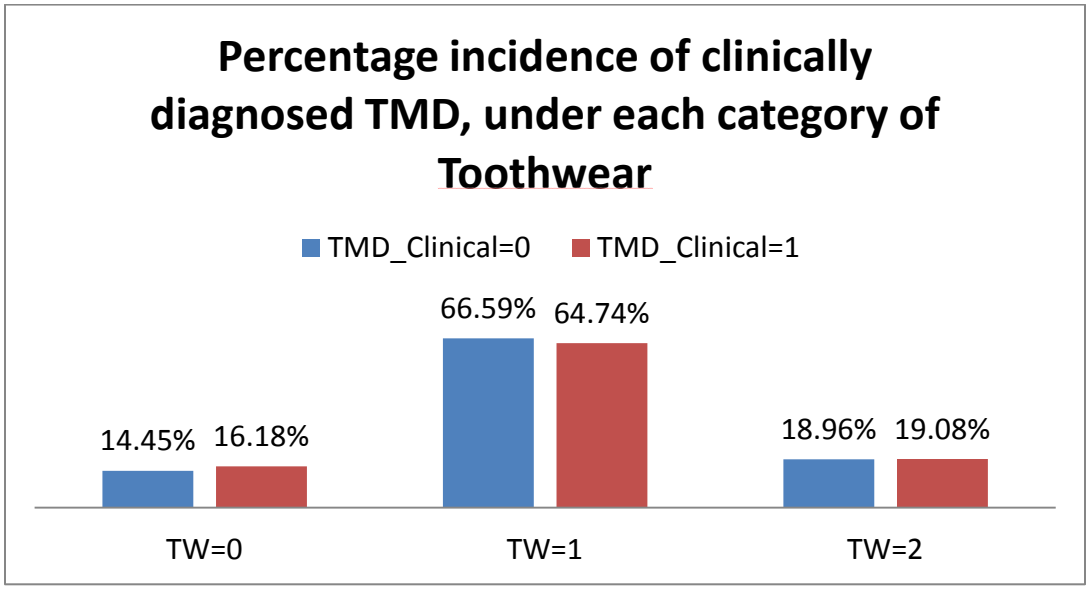


Chart 17: Association of tooth wear and self diagnosed temporomandibular disorders

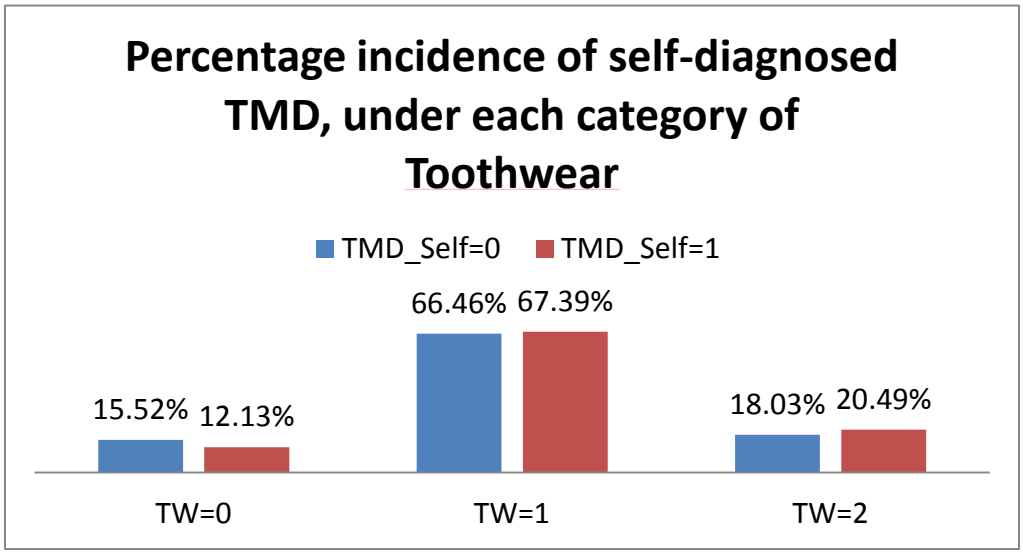


Chart18: **Association of tooth wear and sleep breathing disorders**

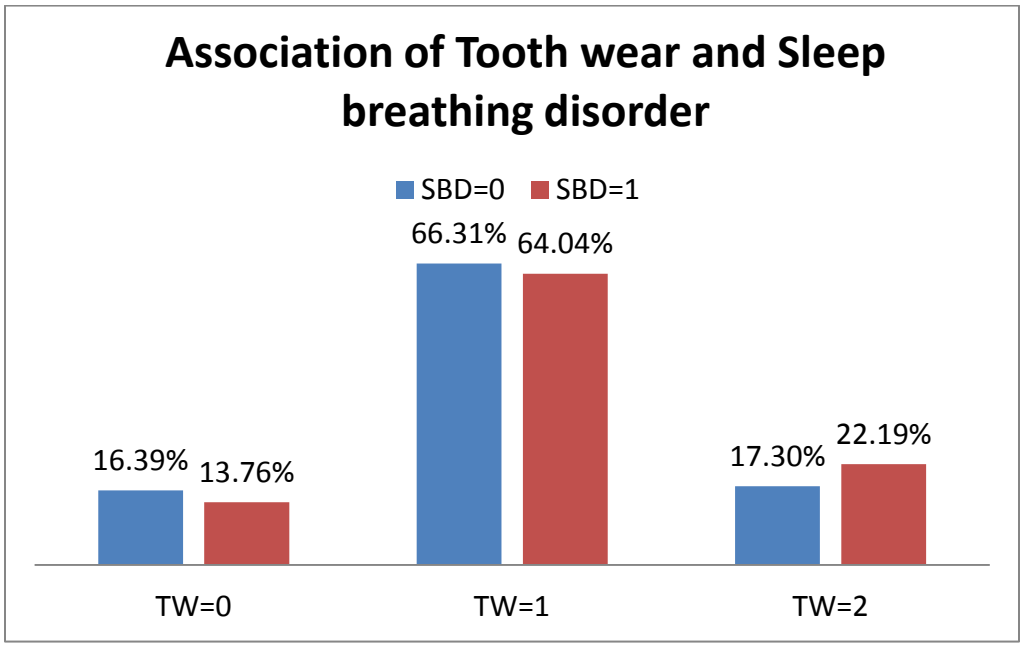


Chart 19: Association between clinically diagnosed temporomandibular disorders to sleep breathing disorders

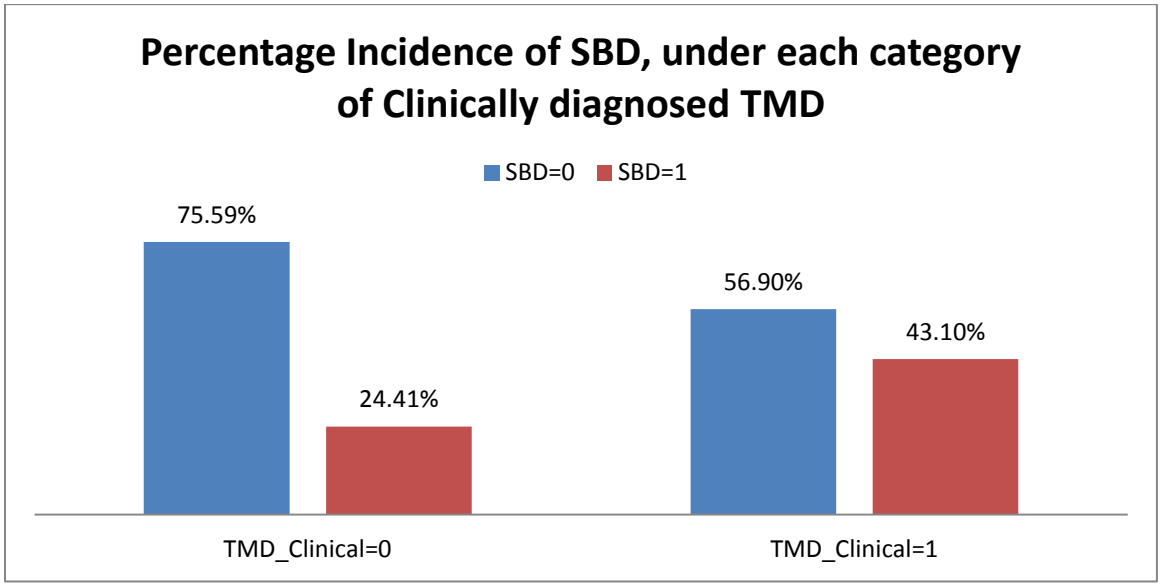


Chart 20: Association between self Diagnosed Temporomandibular disorders to sleep breathing Disorders

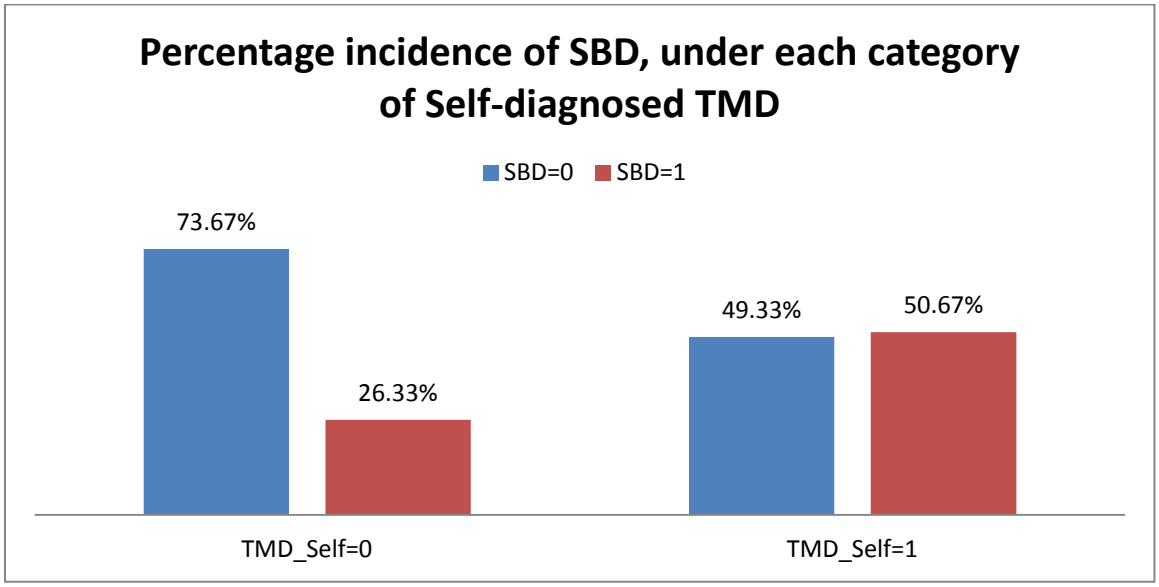
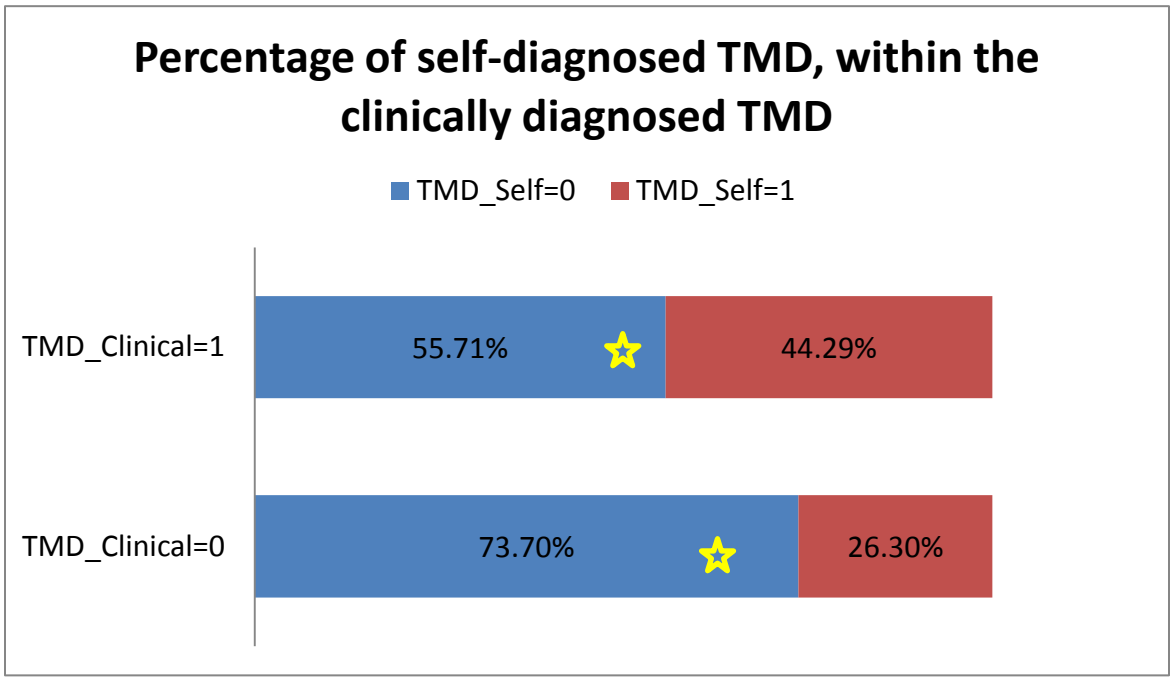


Chart 21: Analysis to compare self diagnosed temporomandibular disorders to clinically diagnosed temporomandibular disorders



In this graph, we would expect that the two boxes marked in yellow stars would have the highest possible percentage values, as these boxes indicate whether the self-diagnosis matches with the clinical diagnosis. We can make a rough analysis that these two measures (clinical v/s self diagnosis) are not very highly correlated.

It would be interesting to investigate whether our self-diagnosis test is well-defined or if it asks the patients to record some information that is not easy to recollect and note down.

Appendix C: Survey instruments

Following forms were submitted to the parents. They were explained the details and were asked to fill in the forms.

Appendix C - 1: Consent to Participate in Research

Dear Parent,

I, Satish K Bhalgat, am a researcher and post-graduate student at the TUFTS University, Boston, USA and as a requirement of the course I am conducting this non clinical minimum risk research study. I earnestly request your permission for your child to participate in this study as he/she visits my study centre for scholastic training. I will briefly explain the study to the child and seek his/her agreement to participate in the study as well.

The subject of research paper is "Association of tooth wear with headaches, Sleep breathing disorders, and temporomandibular disorders in Indian school children". Participating children will be given brief questionnaires to answer regarding headaches, temporomandibular joint discomforts and sleep breathing disorders. Their teeth will be examined for positive findings of tooth wear and alginate impressions will be made for making models which will be used measuring the amount of tooth wear. All these clinical procedures are non-invasive, hence without risks. Though there will be no direct benefits to the child for participation in the study, the results of the study will help us to better understand association between some common discomforts which remain undiagnosed in children.

I will keep this information confidential by limiting individual's access to the research data and keeping it in a secure location. My research team and the Department at TUFTS University are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated, unless you have agreed otherwise.

If you have any queries about the research you may contact me at 022 2102 2111 or mail me on satish.bhalgat@tufts.edu

Your child's participation is voluntary and so he/she may not participate in the study if he/she does not wish to. If you agree now and later wish to withdraw, you may do so at any time. There are no untoward consequences if you do not participate in the study. Your child will not be ignored and will keep getting the same attention in the class.

The kind of study I have taken up will likely benefit your child by understanding any undiagnosed issues like headache, temporomandibular disorders or sleep breathing disorders. However, further investigations and consultations from the physician will be necessary for confirmation of probable diagnosis. This study may probably add value to knowledge and information to the medical science and hence benefit the society.

For participating in this study, your child will receive a free consultation for dental health and two radiographs will be taken at no cost, if required.

I request you to kindly sign the consent form and return it if you are willing to let your child participate. I greatly appreciate your support.

Yours sincerely,

Dr. Satish Bhalgat.

Parents Consent Form

I the undersigned, parent of Mast/ Miss _____ hereby consent to participate in the research study "Association of tooth wear with Temporomandibular and Sleep breathing disorders in Indian school children" that will be conducted by Dr. Satish Bhalgat and his team at his dental office.

Name of child: _____

Signature of child: _____

Name of the Parent/ Guardian: _____

Signature of the Parent/ Guardian: _____

Date: _____

Place : _____

Appendix C – 2: Informed assent form

Child's assent Form

I the undersigned, Mast/ Miss _____ hereby assent to participate in the research study "Association of tooth wear with Temporomandibular and Sleep breathing disorders in Indian school children" that will be conducted by Dr. Satish Bhalgat and his team at his dental office.

I am also informed that I can withdraw from the study at any time.

Name of child:

_____

Signature of child: _____

Date: _____

Place : _____

Appendix C - 3: Health History Form

Id. No _____

Name of the Parent _____

First name of child _____*M.I.*___ *Last*_____

Date of Birth: _____ *Sex* _____

Address: _____

_____

City _____ *Zip Code* _____

*Phone: Home:*_____*Cell:* _____

Email: _____

*Circle **yes or no** in the following questions. Your answers are for our records only and will be considered confidential. You are answering on behalf of your child.*

1. Do you feel healthy? *_ Yes _ No*

2. Has there been any change in your health within the past year? *_ Yes _ No*

3. Are you now under care of a physician? *_ Yes _ No*

If yes, what is the condition being treated?

_____

Name and Phone number of the physician:

_____

4. Have you ever had any serious illnesses/ operation or have been hospitalized?

_ Yes _ No

If yes, what was the illness or operation?

_____

5. Do you have any of the following: Allergy, asthma or dizziness *_ Yes _ No*

If yes, which condition _____

6. Have you had surgery, x-ray or drug treatment for a tumor, growth or other conditions of your head and/or neck? *_ Yes _ No*

7. Are you taking any drugs, pills, or medications? *_ Yes _ No*

If yes, name them:

_____

Dental History:

1. How often do you brush your teeth (__/day?) *_____times*

2. Do you use dental floss? *_ Yes _ No*

3. Do you use a mouth rinse or wash? *_ Yes _ No*

4. Do you chew gum? *_ Yes _ No*

5. Relating to Temporomandibular Joint disorders (TMJ Disorders), do you have or have had:

a. Difficulty and/ or pain opening your mouth, such as when yawning? *_ Yes _ No*

b. Your jaw getting "stuck", "locked" or "going out?" *_ Yes _ No*

c. Difficulty and/ or pain when chewing, talking or using your jaws? *_ Yes _ No*

d. Noises in the jaw joints? *_ Yes _ No*

e. Pain in or about the ears, temples or cheeks? *_ Yes _ No*

f. Soreness of jaw muscles? *_ Yes _ No*

g. Clenching or grinding of your teeth? *_ Yes _ No*

h. An unusual or uncomfortable feeling bite? *_ Yes _ No*

i. Frequent headaches? *_ Yes _ No*

j. Recent injury to your head, neck or jaw? *_ Yes _ No*

k. Treatment for jaw/ joint problem? If yes, when? *_ Yes _ No*

Sleep History

Weekdays schedule: Bed Time_____ Wake up_____

Weekends schedule: Bed Time_____ Wake up_____

Trauma History:

Have you been involved in accidents in the past in which your head was snapped as in whiplash auto accidents? If yes, please list every accident of this type.(you may use a separate sheet)

_____

Have you received a blow to the face or jaw? If yes, list every accident or incident of this type.

_____

I authorize the release of a full report of examination, findings and diagnosis and relevant information in your research report.

Child's Signature: _____ *Date:_____*

Parent's Signature _____ *Date : _____*

Appendix C - 4: Clinical examination form

Clinical examination will include the extra-oral and intra-oral examination. The examination will be carried out in the dental office on subjects in reclined position under adequate lighting conditions using autoclaved/ disposable diagnostic instruments and air syringe.

Extra-oral examination:

i) Range of mandibular movement: _____

ii) TMJ sounds: Present_____, Absent_____

iii) TMJ Tenderness to palpation: Yes ___, No ____

iv) Masticatory muscle tenderness: absent, mild, moderate, severe

Temporalis _____ Masseter _____ Medial pterygoid _____

Intraoral examination:

Each tooth will be wiped with clean and dry cotton rolls and dried with air syringe and following findings will be noted.

Number of teeth present: ____ Deciduous: _____ Permanent: _____

Carious: _____ Missing : _____

Tooth wear examination

Tooth Number	3	6	7	8	9	10	11	14	19	22	23	24	25	26	27	30	
Incisal or Occlusal																	
Labial	X							X	X							X	
Lingual	X							X	X							X	
Total																	

Score for tooth wear suggested by Bardsley *et al.* [14]

Score	**Amount of wear on the surface of teeth**
0	No wear into dentin
1	Dentin just visible (including cupping) or dentin exposed for less than a third of the surface
2	Dentin exposure greater than a third of the surface
3	Exposure of pulp or secondary dentin

Appendix C - 5: Helkimo Index Questionnaire

Anamnestic questionnaire: During the last five (5) years:

1. Do you experience headaches in temple area? Yes____ No___

   How often? ___Two or less per week ___More than two per week

   Rate average severity: 1 5 10

   mild moderate severe

2. Have you experienced noise (popping, clicking, or grating) in your jaw joints?

   Yes___ No___

   Painful___ Not painful___ 1 5 10

   mild moderate severe

3. Do your jaws frequently feel tired or stiff? Yes___ No___

   1 5 10

   mild moderate severe

4. Do your jaws lock open or closed? Yes___ No___

   1 5 10

   mild moderate severe

5. Do you have any difficulty opening wide? Yes___ No___

   1 5 10

   mild moderate severe

6. Do your jaws hurt when opening, closing, chewing, or yawning?

   Yes___ No___

   1 5 10

   mild moderate severe

7. Do you have pain in your jaw joint(s) or in front of your ear(s)?

Yes___ No___

1 5 10

mild moderate severe

8. Do you have pain in your temples or cheek muscles? Yes___ No___

1 5 10

mild moderate severe

Anamnestic Index Analysis

Ai-0	Made up of individuals free from dysfunction symptoms
Ai-I	Made up of individuals with mild dysfunction symptoms
Ai-II	Made up of individuals with severe dysfunction symptoms

The second is the clinical dysfunction index, which considers a functional evaluation of the masticatory system. In accordance with the presence and/or severity of these clinical symptoms, individuals are assigned a score of 0, 1, or 5 points.

The following items will be observed:

a - Range of mandibular motion;

b - TMJ function impairment;

c - Muscle tenderness during palpation;

d - TMJ pain during palpation;

e - Pain during mandibular movement – only recorded when clearly identified.

Scores of Clinical dysfunction questionnaire

According to the score attained, the individuals will be classified in four groups:

Table 5: Clinical Dysfunction Index Analysis

Di-0	0 points - Individuals clinically free from dysfunction symptoms
Di-I	1 to 4 points - Individuals with mild dysfunction symptoms
Di-II	5 to 9 points - Individuals with moderate dysfunction symptoms
Di-III	10 to 25 points - Individuals with severe dysfunction symptoms.

Based on the scores the child will be classified as Temporomandibular Disorders positive or negative.

Appendix C – 6: Sleep Disturbances Scale For Children Questionnaire

INSTRUCTIONS**:** This questionnaire will allow your doctor to have a better understanding of the sleep-wake of rhythm of your child and of any problems in his/her sleep behaviour. Try to answer every question; in answering, consider each question as pertaining to the past 6 months of the child's life. Please answer the questions by circling or striking the applicable term.. Thank you very much for your help.

Name: ---------- Age: ---------- Date: ----------

1. How many hours of sleep does your child get on most nights?	1 9-11 h	2 8-9 h	3 7-8 h	4 5-7 h	5 Less than 5 h
2. How long after going to bed does your child usually fall asleep?	1 Less than 15'	2 15-30'	3 30-45'	4 45-60'	5 More than 60'

3. The child goes to bed reluctantly	Never	Occasionally	Sometimes	Often	Always
4. The child has difficulty getting to sleep at night	Never	Occasionally	Sometimes	Often	Always
5. The child feels anxious or afraid when falling asleep	Never	Occasionally	Sometimes	Often	Always
6. The child startles or jerks parts of the body while falling asleep	Never	Occasionally	Sometimes	Often	Always
7. The child shows repetitive actions such as rocking or head banging	Never	Occasionally	Sometimes	Often	Always

while falling asleep					
8. The child experiences vivid dream-like scenes while falling asleep	Never	Occasionally	Sometimes	Often	Always
9. The child sweats excessively while falling asleep	Never	Occasionally	Sometimes	Often	Always
10. The child wakes up more than twice per night	Never	Occasionally	Sometimes	Often	Always
11. After waking up in the night, the child has difficulty to fall asleep again	Never	Occasionally	Sometimes	Often	Always
12. The child has frequent twitching or jerking of legs while asleep or often changes position during the night or kicks the covers off the bed.	Never	Occasionally	Sometimes	Often	Always
13. The child has difficulty in breathing during the night	Never	Occasionally	Sometimes	Often	Always
14. The child gasps for breath or is unable to breathe during sleep	Never	Occasionally	Sometimes	Often	Always
15. The child snores	Never	Occasionally	Sometimes	Often	Always
16. The child sweats excessively during the night	Never	Occasionally	Sometimes	Often	Always
17. You have observed the child sleepwalking	Never	Occasionally	Sometimes	Often	Always
18.you have observed the child talking in his/her sleep	Never	Occasionally	Sometimes	Often	Always

19.The child grinds teeth during sleep	Never	Occasionally	Sometimes	Often	Always
20.The child wakes from sleep screaming or confused so that you cannot seem to get through to him/her, but has no memory of these events the next morning	Never	Occasionally	Sometimes	Often	Always
21.The child has nightmares which he/she doesn't remember the next day	Never	Occasionally	Sometimes	Often	Always
22.The child is unusually difficult to wake up in the morning	Never	Occasionally	Sometimes	Often	Always
23.The child awakes in the morning feeling tired	Never	Occasionally	Sometimes	Often	Always
24.The child feels unable to move when waking up in the morning	Never	Occasionally	Sometimes	Often	Always
25.The child experiences daytime somnolence	Never	Occasionally	Sometimes	Often	Always
26.The child falls asleep suddenly in inappropriate situations	Never	Occasionally	Sometimes	Often	Always

Score analysis of Sleep Disturbances Scale For Children

Disorders of initiating and maintaining sleep (sum the score of the items 1,2,3,4,5,10,11)
Sleep Breathing Disorders (sum the score of the items 13, 14,15)
Disorders of arousal (sum the score of the items 17, 20.21)
Sleep-Wake Transition Disorders (Sum the score of the items 6,7,8,12,18,19)
Disorders of excessive somnolence (Sum the score of the items 22,23,24,25,26)
Sleep Hyperhydrosis (Sum the score of the items 9,16)
Total score (sum 6 factors' scores)

Total scores above 39 are considered to be sleep breathing disorder positive and may be classified from mild to moderate to severe based on the score.

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