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Original Research Article

Prevalence of tooth wear and its associated risk factors among industrial workers in Daman, India: a cross-sectional study

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ABSTRACT

Background: Tooth wear is an ever increasing problem. Therefore, the aim of the present study was to assess the prevalence of tooth wear and its associated risk factors among industrial workers in Daman, India.
Methods: This cross sectional study was conducted among 613 industrial workers selected using simple random sampling. The clinical assessment of tooth wear was done using tooth wear index (TWI) developed by Smith & Knight. A specifically designed questionnaire was used to seek information on risk factors of tooth wear. Data were analyzed using Pearson's chi-square test, ANOVA and a multiple logistic regression model.
Results: The overall prevalence of tooth wear was found to be greater in mandible (86.8%) as compared to maxilla (61.7%). In both maxilla and mandible, the most frequently affected teeth were incisors (55.8% and 83.7%) followed by canines (52.2% and 81.2%), pre molars (38.5% and 42.1%) and molars (37.8% and 38.8%). Among the risk factors, consumption of hard or acidic foods (p=0.01, OR=1.73) and use of hard toothbrush bristles (p=0.04, OR=0.04) in maxilla and clenching or grinding of teeth (p=0.01, OR=3.96) in mandible were significantly associated with tooth wear. However, work environment involving dust or acid gas was the only risk factor associated with tooth wear in both maxilla (p=0.004, OR=0.53) and mandible (p<0.001, OR=0.35).
Conclusions: There is a high prevalence of tooth wear among industrial workers. Thus, efforts should be made by dentists to increase awareness about tooth wear and plan a three-level prevention program based on analysis of risk assessment.

Keywords: Industry, Prevalence, Risk factor, Tooth wear, Workers

INTRODUCTION

Tooth wear (TW) has become an increasing problem worldwide and is most often left untreated.[1] It can be defined as an irreversible, multi factorial and destructive loss of dental hard tissues caused by mechanical and/or chemical processes in the absence of caries or trauma.[2-7] It is more evident in recent years due to the current substantial decline in dental caries and people becoming more interested in keeping their dentition healthy for a longer time which could be exposed to wear.[1,8,9]

There are three main forms of tooth wear, namely, attrition, abrasion and erosion.[7] It has been shown through various clinical and experimental observations that individual tooth wear types rarely exist alone but interact with each other.[1] At an initial stage of development, tooth wear might be unnoticeable, but it may affect aesthetic and appearance in some patients especially if anterior teeth are involved.[2,10] The consequence of excessive tooth wear often includes hypersensitivity especially during eating, drinking or tooth brushing, pulpitis, periapical periodontitis and pulp necrosis.[1,4,6] Several studies have investigated diet, foreign objects, bruxism, parafunctional

activity, environment, occupation, oral health behaviour, medicaments, gastrointestinal problems, and acid regurgitation among the risk factors that contribute to tooth wear.[2,6,7] Therefore, an understanding of the nature of tooth wear and its risk factors is important in the patient's diagnostic protocol and management strategy.

Due to rapid economic growth and industrial progress, it becomes imperative that safety and health at workplace be given its due importance. The workers of the industry are highly exposed to harmful elements/acids in their work environment which is considered responsible for dental erosion.[11] They are identified as a high risk group due to their stressful working conditions, busy schedules and poor economic conditions which drives them to engage in unhealthy behaviours like poor oral hygiene and consumption of alcohol and tobacco which further deteriorate tooth wear.[12] There are many different tooth wear indices which have been developed for clinical and laboratory use all over the world.[9] However, most of the indices use changes to the anatomical appearance of teeth to record the amount of wear. Some indices record tooth wear on every surface of tooth, some use selected sites and others use specific surfaces.[7] In this study, the Tooth Wear Index (TWI), introduced by Smith and Knight was used.[13]

The World Health Organisation (WHO) places occupational risks as one of the leading cause of morbidity and mortality.[14] Despite of the hazardous nature of the risks posed on the oral health of the industrial workers; very little research has been conducted and reported on their tooth wear. Thus, in order to gain an understanding of tooth wear and its risk factors, the aim of the present study was to assess the prevalence of tooth wear and its associated risk factors among industrial workers in Daman, India.

METHODS

Study settings

Daman and Diu are situated on the western coast of India at a distance of about 700 kms from each other. Daman is the head quarter of this union territory. Easy accessibility, availability of land and labour, tax concessions and similar other factors have contributed to the industrial development in Daman. Thus, a cross-sectional study was conducted among industrial workers in Daman, India from January-April 2016 to assess the prevalence of tooth wear and its risk factors.

Sampling and sample size

Before the commencement of the study, list of industries in Daman was obtained and 8 industries were selected using simple random sampling. For calculating the sample size, we used the formula: $\frac{4Z2\ \alpha/2\ P\ (1-P)}{L^2}$

{Prevalence, P= 89% (obtained from pilot study), 95% confidence interval (CI): Precision, L= 0.05, Zα/2 = 1.96}. Thus, we calculated that $N=4\times1.96^2\times0.89\times 0.11/0.05^2=553$. Considering 10% of non-response rates, the final sample size was taken as 613. The inclusion criteria for the study participants were as follows: provision of written informed consent after understanding the study purpose and protocols, age 18–60 years, and the willingness to comply with all research procedures and requirements. The participants with presence of any systemic diseases that may affect the integrity of the study data or the safety of the subjects were excluded from the study.

Clinical examination

The clinical assessment was done by the investigator with ADA type III examination. Table 1 shows the scores and criteria for Tooth Wear Index (TWI) developed by Smith & Knight in 1984.[13] It is a comprehensive system in which all four visible surfaces (buccal, cervical, lingual and occlusal/incisal) of all teeth present are scored for tooth wear. In both maxilla and mandible, teeth were divided into incisor, canine, premolar and molar groups. Among the incisor groups, we examined the central and lateral incisors, the canine groups included the canines, the premolar groups consisted of the first and second premolars, and the molar groups included the first and second molars. The third molar and restored or carious teeth were excluded from the analysis. A total of eight groups (four maxillary and four mandibular) were formed. According to the severity of tooth wear, scores of 0–4 were assigned to the teeth.

In our study, the examiner was trained and calibrated in the Department of Public Health Dentistry to ensure uniform interpretations, understanding, and application of the codes and criteria for the tooth wear and to ensure consistent examination. The examiner applied the diagnostic criteria by examining a group of 20 subjects, with full range of disease condition, twice on successive days. The intra examiner reliability for TWI was evaluated according to the WHO recommendation giving a Kappa agreement of 90%. A pilot study was carried out among 30 industrial workers to determine the feasibility and practicability of the study and the time required for examination of each subject. It helped to know the practical difficulties while conducting the survey. The participants of the pilot study were excluded from the main study.

Questionnaire

Following the clinical examination, participants were interviewed using a specifically designed questionnaire based on the literature search and expert opinion. Through the questionnaire, the participants were asked to provide information on risk factors of tooth wear like the presence of clenching/grinding of teeth, the consumption of hard or acidic foods, working environment (related to dust or acid gas), clicking of the temporomandibular

joint, acid reflux, tobacco habits (smoking/smokeless/ both), oral hygiene practices (toothbrush/neemstick/ finger/other), type of toothbrush bristle and method of tooth brushing. The responses of the participants were recorded as yes/no. In addition, information regarding presence or absence of tooth sensitivity was also obtained.

Statistical analysis

The data was analyzed using SPSS version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages, means and standard deviations. The mean scores of different groups of teeth were compared using ANOVA and Tukey's post-hoc test. Tooth wear prevalence among different groups of teeth and the relationship between tooth wear and its risk factors were evaluated using Pearson's chi-square test and a multiple logistic regression model. For all tests, confidence interval and p value were set at 95% and <0.05 respectively.

RESULTS

The prevalence rates of tooth wear in participants were calculated (Table 2). In both maxilla and mandible, the most frequently affected teeth were incisors (55.8% and 83.7%) followed by canines (52.2% and 81.2%), pre molars (38.5% and 42.1%) and molars (37.8% and 38.8%). However, only in maxilla, significant difference was observed among these four groups of teeth ($p<0.05$).The overall prevalence of tooth wear was found to be greater in mandible (86.8%) as compared to maxilla (61.7%).

Table 1: Smith and Knight TWI.

Score	Surface	Criteria
0	B/L/O/I	No loss of enamel surface characteristics
1	B/L/O/I	Loss of enamel surface characteristics
2	B/L/O	Loss of enamel exposing dentin on less than one-third of surface
	I	Loss of enamel, just exposing dentin
3	B/L/O	Loss of enamel exposing dentin on more than one-third of surface
	I	Loss of enamel and substantial loss of dentin
4	B/L/O	Complete enamel loss, pulp exposure, secondary dentin exposure
	I	Pulp exposure or exposure of secondary dentin

B=buccal; L=lingual; O=occlusal; I=incisal

Table 2: Tooth wear in maxilla and mandible (n=613)

Groups	Maxilla		Mandible	
	Tooth wear Number (%)	**Tooth wear score Mean±SD**	**Tooth wear Number (%)**	**Tooth wear score Mean ±SD**
Molars	232 (37.8)	2.0 (0.37)[a]	238 (38.8)	2.21 (0.57)[a]
Premolars	236 (38.5)	1.75 (0.79)[a]	258 (42.1)	1.67 (1.37)[a]
Canines	320 (52.2)	1.39 (0.64)[a]	498 (81.2)	2.51 (1.68)[a]
Incisors	342 (55.8)	2.67 (0.94)[a]	518 (83.7)	2.81 (1.04)[a]
p-value	0.76	<0.001[¶]	0.04*	<0.001[¶]
Overall prevalence	378 (61.7)		532 (86.8)	

SD-standard deviation, $p<0.05$ statistically significant using *Chi square test and [¶]ANOVA. Same letters (vertically) indicate significant differences between groups (Tukey's post-hoc test).

The wear severity of four groups of teeth in the maxilla and mandible were also measured (Table 2). In the maxilla, the wear severity of the incisor group and molar group was greater than that of the pre molar group, which was, in turn, greater than that of the canine group. In the mandible, the wear severity of the incisor group and of the canine group was greater than that of the molar group, which was, in turn, greater than that of the premolar group. Statistically significant differences were seen among these groups of teeth in both maxilla and mandible ($p<0.05$).

Out of 613 participants, females were more commonly affected with tooth wear as compared to males. The mean age of participants was 32.7 years. Notably, in both maxilla and mandible, work environment involving dust or acid gas (69.5% and 95.4%), tobacco use (67.5% and 86.7%) and acid reflux (59.4% and 83.2%) were the top three risk factors responsible for tooth wear (Table 3).The participants using both smoking and smokeless forms of tobacco reported greater tooth wear in both maxilla (82.4%) and mandible (88.2%).With respect to oral hygiene practices, participants using hard toothbrush bristles and performing mixed method of tooth brushing were found to have greater tooth wear in maxilla and mandible. The participants using neem stick to clean their teeth reported greater tooth wear in maxilla whereas those using finger/other oral hygiene aids reported greater tooth wear in mandible. The participants complaining of tooth sensitivity were found to have greater tooth wear in both

maxilla (57.4%) and mandible (84.1%). However, there was no statistical significant difference seen between sensitivity and tooth wear (Table 4).

Table 3: Association of risk factors with tooth wear in maxilla and mandible.

Variables	Total (n=613)	Maxilla		Mandible	
		Tooth wear n (%)	P value	Tooth wear n (%)	P value
Gender					
Male	384 (62.6)	233 (60.7)	0.51	326 (84.9)	0.07
Female	229 (37.4)	145 (63.3)		206 (90)	
Clenching or grinding of teeth					
Yes	21 (3.4)	12 (57.1)	0.66	13 (61.9)	0.001*
No	592 (96.6)	366 (61.8)		519 (87.7)	
Consumption of hard or acidic foods					
Yes	116 (18.9)	57 (49.1)	0.002*	95 (81.9)	0.08
No	497 (81.1)	321 (64.6)		437 (87.9)	
Work environment involving dust or acid gas					
Yes	197 (32.1)	137 (69.5)	0.006*	188 (95.4)	<0.001*
No	416 (67.9	241 (57.9)		344 (82.7)	
Clicking of temporomandibular joint					
Yes	12 (2)	4 (33.3)	0.04*	8 (66.7)	0.03*
No	601 (98)	374 (62.2)		524 (87.2)	
Acid reflux					
Yes	143 (23.3)	85 (59.4)	0.53	119 (83.2)	0.15
No	470 (76.7)	293 (62.3)		413 (87.9)	
Tobacco use					
Yes	120 (19.6)	81 (67.5)	0.14	104 (86.7)	0.96
No	493 (80.4)	297 (60.2)		428 (86.8)	

*p<0.05 statistically significant using chi square test

Table 4: Association of tobacco use, oral hygiene practices and self-reported tooth sensitivity with tooth wear in maxilla and mandible.

Variables	Total (n)	Maxilla		Mandible	
		Tooth wear n (%)	**P value**	**Tooth wear n (%)**	**P value**
Forms of tobacco (n=120)					
Smoking	41 (34.2)	26 (63.4)	0.84	33 (80.5)	0.21
Smokeless	98 (81.7)	69 (70.4)	0.03*	86 (87.8)	0.75
Both smoking and smokeless	17 (14.2)	14 (82.4)	0.07	15 (88.2)	0.85
Oral hygiene practice (n=613)					
Toothbrush	577 (94.1)	355 (61.5)	0.77	497 (86.1)	0.06
Neem stick	25 (4.1)	23 (92)	0.92	23 (92)	0.34
Finger	4 (0.7)	3 (75)	0.75	4 (100)	0.23
Other	7 (1.1)	1 (14.3)	0.01*	7 (100)	0.29
Type of toothbrush bristle (n=577)					
Ultra soft	30 (5.2)	18 (60)	0.66	25 (83.3)	0.34
Soft	240 (41.6)	137 (57.1)	0.06	203 (84.6)	0.19
Medium	285 (49.4)	196 (68.8)	0.001*	249 (87.4)	0.69
Hard	22 (3.8)	17 (77.3)	0.04*	20 (90.9)	0.55
Method of tooth brushing (n=577)					
Horizontal	115 (19.9)	51 (44.3)	<0.001*	84 (73)	<0.001*
Vertical	14 (2.4)	4 (28.6)	0.01*	10 (71.4)	0.08
Mixed	448 (77.6)	321 (71.7)	<0.001*	437 (97.5)	<0.001*
Self-reported tooth sensitivity (n=613)					
Yes	176 (28.7)	101 (57.4)	0.16	148 (84.1)	0.21
No	437 (71.3)	277 (63.4)		384 (87.9)	

*p<0.05 statistically significant using chi square test

The result of multiple logistic regression analysis showed that the consumption of hard or acidic foods (p=0.01, OR=1.73) and use of hard toothbrush bristles (p=0.04, OR=0.04) in maxilla and clenching or grinding of teeth (p=0.01, OR=3.96) in mandible were significantly associated with tooth wear. However, work environment involving dust or acid gas was the only risk factor associated with tooth wear in both maxilla (p=0.004, OR=0.53) and mandible (p<0.001, OR=0.35).

DISCUSSION

This study to assess prevalence of tooth wear and its associated risk factors among industrial workers in Daman is a pioneer study by itself, so a direct comparison with studies conducted on industrial population is difficult. Therefore, study results are compared with other populations similar in character. The current study evaluated non-specific tooth wear using Smith and Knight TWI. The index is widely employed for assessing tooth wear in some studies due to its easy comparability and coverage of whole dentition.[8] In this study, the prevalence of tooth wear was found to be more in mandible (86.8%) as compared to maxilla (61.7%). The other studies have shown prevalence of 59.2%, 29.7% and 77.1% respectively.[8,10,15] This variation can be attributed to differences in the indices used, study criteria and diagnostic criteria, which makes the comparison of results almost impossible.

In the present study, in both the maxillary and mandibular dentitions, the prevalence of tooth wear was higher for the incisors and canines. Similar findings have been reported in several other studies.[4,7,8] The higher degree of wear in the incisors and canines may be attributed to the thinner enamel and their active role in both masticatory and excursive jaw movements during function and parafunction, which may place greater demands upon these teeth than that endured by the larger posterior teeth. Furthermore, incisors and canines are, on average, the most frequently retained teeth among people, which may influence the level of wear to which they are subjected. Our study also reported higher mean wear scores of the incisal surfaces of the mandibular anterior teeth than that of the maxillary anterior teeth, and this result may be due to the role of the lower incisal edges during incision and throughout the process of protrusive guidance.

There is substantial evidence demonstrating the role of both endogenous (intrinsic) acid and exogenous (extrinsic) sources of acids in the progression of dental erosion. Repeated or prolonged exposures of teeth to acid leads to selective dissolution of specific components of the tooth surface, with eventual loss of tooth substance, hypersensitivity, functional impairment, and even tooth fracture.[5,16] The present study found acid reflux (intrinsic) as an important risk factor of tooth wear. The pH of gastric contents with 0.4% hydrochloric acid during digestion is ~3.8. Acid reflux reduces the pH of the oral cavity, thus increasing the risk of tooth wear.[9] Additionally, in vitro studies have shown that low pH acidic foods and drinks cause erosion of enamel and dentin whereas the coarseness or grit of the diet during function is a main causative factor in occlusal wear.[4,7] In this study, the high consumption of hard or acidic foods exhibited high odds ratios in maxilla (1.73), indicating a strong association with tooth wear.

In this study, tooth wear was significantly associated with the habit of clenching or grinding of teeth. Although its effect is dependent on the nature, onset and duration of habit, the high biting and masticatory forces due to clenching/grinding of teeth are thought to be responsible for the increased wear seen in incisal/occlusal surfaces of teeth.[8] These findings are in line with the other studies.[2,6,7,9] Another possible cause of clenching of teeth could be psychosocial, such as one's stress adaptive capacity especially among industrial workers, which may play an important role in tooth wear.[15] Although an association between tooth wear and clicking of temporomandibular joint has been reported, most studies indicate that it is not a risk factor for tooth wear.[6]

This study found 81.7% prevalence of smokeless tobacco use among participants. The reasons underlying this may be low educational status and occupation involving hard labour, which makes them addicted to tobacco use.[13,14] A greater tooth wear was reported in maxilla and mandible in participants consuming both smoking and smokeless forms of tobacco however; significant association was seen only between smokeless tobacco use and tooth wear. Similar findings have been reported in the other studies.[9,10] It has been estimated that 96 million (52%) Indians consume tobacco in smokeless forms. The use of 'gutkha' and 'pan masala' with tobacco is common modalities of tobacco use. Tobacco contains abrasive silica particles which when mixed with saliva and chewed forms an abrasive paste that over the period of time can wear down the teeth. In addition, the number of pathologically worn surfaces increases with the simultaneous increase in the frequency and duration of chewing tobacco.[9]

This study observed that the use of hard and medium bristled toothbrushes was related to tooth wear. In addition, a horizontal and mixed brushing technique, which is one of the most important reasons for wedge-shaped defects, was positively associated with tooth wear. One of the most important pathological changes caused by tooth brushing is abrasion. The mechanical friction caused by tooth brushing accelerates dental hard tissue defects resulting in characteristic appearance of abrasion-induced cavities along the cervical margins of the teeth. These findings are consistent with the other studies.[4,5,10,16] Industrial environmental factors have been reported to cause dental erosion. In this study, the environmental dust/acid exposure from industries was strongly associated with tooth wear in both maxilla and mandible. This finding can be a result of less use of personal protective measures (PPM) like protective

masks, goggles and face guards by workers to decrease dust/acid exposure or a violation of the governmental regulations concerning maximal tolerable concentration of potentially erosive agents at workplace. Similar results were seen in the other studies.[13,14,16]

It is very clear from the above discussion that tooth wear and its risk factors are prevalent and there is no look out for the oral health status of industrial workers. The first and the most important step in the management of the risk factors is the accurate diagnosis of the cause of tooth wear. Intrinsic erosive tooth wear may need to be managed with habit modification and appropriate referrals could be considered. Extrinsic erosive tooth wear would require diet advice and habit modification. Attrition may progress at a slower rate with the use of an occlusal splint. The management of abrasion and erosion would take into consideration the adaptation of oral hygiene habits and the elimination of acidic challenges.[4,16] At the community level, well planned training programs and health promotion among the industrial workers requires coordinated action by the dental profession, local factory authorities, social and economic sectors and voluntary organizations. Mass media could also play a significant role by providing systematic updates regarding native and contiguous working conditions as to how it can be improved. Guidelines to the industries like installing efficient ventilation and exhaust systems at work sites, implementation and mandatory use of personal protective equipment to workers and providing medical and dental care services is important. Government must take suitable measures and a strict law for the rights of workers regarding health should be formulated along with regular inspections and follow up.[12]

The present study had limitations because of its cross-sectional design. However, a representative sample was used by simple random sampling to avoid bias. The clinical expression of dental wear largely depends on the strength, frequency and duration of exposure to the abrasive and erosive challenges, which were not considered in this study. Therefore, longitudinal studies are recommended to measure the cumulative effect of tooth wear on teeth and also to find the association with other risk factors.

CONCLUSION

Tooth wear is a serious and notable condition among industrial workers in Daman. In particular, incisors and canines are most susceptible to tooth wear. The excessive consumption of hard/acidic foods, exposure to dust/acids during work, clenching of teeth and brushing habits particularly horizontal method of brushing and use of hard bristle tooth brushes were the strongest risk factors associated with tooth wear. Thus, efforts should be made by dentists to increase awareness about tooth wear and plan a three-level prevention program based on analysis of risk assessment.

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