

Original Article

Impact of occupational dental erosion on oral health-related quality of life among battery factory workers in Bengaluru, India

Amit Kumar¹, Manjunath P. Puranik², K. R. Sowmya², Soni Rajput²

¹Unit of Public Health Dentistry, Oral Health Sciences Centre, PGIMER, Chandigarh, ²Department of Public Health Dentistry, Government Dental College and Research Institute, Bengaluru, Karnataka, India

ABSTRACT

Background: A greater understanding of impact of occupational dental erosion on oral health-related quality of life (OHRQoL) will sensitize both employee and employers to adopt strict protective measures for oral health. The research aimed to determine the relationship between occupational dental erosion and OHRQoL among battery and other factory workers in Bengaluru, India.

Materials and Methods: This cross-sectional comparative study enrolled a total of 400 workers. Structured proforma assessed information on sociodemographic details, oral hygiene practices, adverse oral habits, and work-related practices. OHRQoL was determined using oral health impact profile-14 (OHIP-14). Dental erosion was measured using Smith and Knight's tooth wear index modified by Millward *et al.* 1994 scoring system independent t-test, Mann-Whitney U-test and Spearman's correlation was performed. $P < 0.05$ was considered statistically significant.

Results: The mean age of the participants in the study and control groups was 43.11 ± 8.02 and 45.93 ± 6.16 years, respectively. Less than half of the participants in the study group had positive behavioral work practice. The prevalence and severity of dental erosion was significantly higher in study group (39.5%) than control group (11.5%). Mean OHIP-14 score was significantly lower in study group (23.88 ± 0.88) than control group (26.06 ± 9.67). Dental erosion significantly correlated with work experience and OHIP-14.

Conclusion: The findings highlight the impact of occupational dental erosion on OHRQoL. Measures to enhance occupational safety thereby reducing exposure to occupational hazards are needed.

Key Words: Acid, dental erosion, occupational, oral health, quality of life

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Address for correspondence:
Dr. Amit Kumar,
Senior Resident, Oral
Health Sciences Centre,
PGIMER, Chandigarh, India.
E-mail: thakur.amit100@gmail.com

INTRODUCTION

Oral health is a vital part of general health and is a valuable asset of every individual.^[1] There are a number of factors which have an impact on both general and oral health, environmental factors being most predominant.^[2] The varied and complex occupational environment predisposes to

different occupational-related diseases.^[3] Industrial environmental factors may be considered responsible for dental erosion among battery workers since they are exposed to sulfuric acid fumes created by the harmful processes in forming and charging.^[4] Prolonged working hours, unprotected acid handling,

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and limited safety measures further compromise battery workers' oral health.^[4-6]

Up to 100% of acid-exposed workers in African and Asian countries^[7-13] when compared to 8%–31% of European^[5,14,15] and Japanese workers by Suyama *et al.*^[16] exhibited dental erosion. Studies in India have reported the prevalence of dental erosion from 55% by Kundu *et al.*^[13] to 100% by Khurana *et al.*^[8] Possibly, this might be a result of an inadequate use of personal protective equipment, insufficient preventive measures to decrease acid exposure, or a violation of the governmental rules and regulations concerning maximal tolerable concentration of potentially erosive agents at workplace.^[9] Occupational dental erosion may have an impact on quality of life among these workers.

It is of utmost importance to know the prevalence of occupational dental erosion and how it affects the oral health quality of life among these workers. Very few studies in literature have determined the relationship between occupational dental erosion and oral health-related quality of life (OHRQoL). Hence, the present study was conducted with the following objectives: to assess and compare the prevalence and severity of dental erosion and OHRQoL and to determine the relationship between dental erosion and OHRQoL among battery and other factory workers. The research hypothesis aimed to find the relationship between dental erosion and OHRQoL among battery factory workers.

MATERIALS AND METHODS

A cross-sectional comparative study was conducted among battery and other factory workers over a period of 4 months (January–April 2015) in Bengaluru, India. Ethical approval was obtained from the Institutional Ethical Committee. The permission to carry out the study was procured from the managers/chief executive officers of the respective factories. The written informed consent was obtained from all the study participants. The research has been conducted in full accordance with the World Medical Association Declaration of Helsinki.

The investigator was trained and calibrated before the pilot study and interexaminer reliability of 0.75 (substantial agreement). A pilot study was conducted on 24 participants from one of the battery factories to check for the feasibility of the study and relevance of the proforma. Considering 80% statistical power, 95%

confidence interval, and 10% margin of error (E), the sample size of 200 for each group was derived.^[17]

Two battery factories were selected randomly from the compiled list of battery factories in Bengaluru, India. Participants working in battery factories exposed to acidic environment were included in this study. Participants suffering from eating disorder, acidic reflux conditions and those who were on acidic medications were excluded from the study. Age- and gender-matched comparison group (not exposed to acidic environment) were selected from other factory in the same vicinity.

Structured proforma designed both in English and local language were used to collect information for the present study. Out of two parts in the proforma, the first part included respondent's demographic profile, socioeconomic status (modified Kuppaswamy scale),^[18] work experience, medical and dental history, and oral hygiene practices. Awareness and practices related to working condition and self-perceived severity of conditions were assessed using close-ended questions among study group only. OHRQoL was determined using oral health impact profile (OHIP)-14.^[19] Back translation of OHIP-14 was performed to ensure linguistic validity.^[20] The second part included clinical assessment of dental erosion using Smith and Knight's tooth wear index (TWI) modified by Millward *et al.* 1994 (modified TWI).^[21] All the surfaces except incisal edges and occlusal surfaces were assessed for dental erosion.

The study proforma was administered to the participants after providing necessary instructions followed by a clinical examination. The clinical assessments were carried out by the investigator in the sequence prescribed in the proforma and were recorded by a trained assistant in the factory premises during the working hours. All the standard procedures and protocols were followed to ensure the infection control during the study.

The data collected were tabulated in Microsoft Excel sheet to generate tables and figures. The Statistical Package for the Social Sciences 17.0 (SPSS Inc., Chicago, IL, USA) was used for the analysis of the data. The data were checked for normality using Kolmogorov–Smirnov test. Variables which showed a significant association in bivariate analysis were used for multivariate analysis. Test of significance included independent *t*-test, Mann–Whitney U-test,

and Spearman's correlation. Level of significance was set at 5%.

RESULTS

The mean age of the participants in the study and control groups was 43.11 ± 8.02 (range = 25–59) and 45.93 ± 6.16 (range = 31–59) years, respectively. All the participants in both the groups were males. Majority in study group (109 [54.5%]) and control group (164 [82.0%]) belonged to upper middle class. The mean work experience was 12.19 ± 5.61 (range = 2–25) years in study group while it was 16.45 ± 6.09 (range = 4–30) years in control group. Nine in ten participants used toothbrush and toothpaste for cleaning the teeth in both the groups. Less than 50% of the participants in both the groups had visited the dentist in the past 5 years. Predominant treatment received was restoration followed by oral prophylaxis and extraction.

Majority of the participants in study group received instructions about protective measures while working (69%), information about job-associated harmful effects (60.5%), and attended training course about occupational health and safety (56%). Very few participants were aware of hazards of acidic environment on oral health (<20%). Among self-reported conditions, 22% of the study group reported “teeth becomes smaller” followed by teeth turning yellow (19%). Participants in the study group perceived “occasionally to very often” sensitive teeth (41%), dry mouth (34%), and toothache (20%).

The prevalence of dental erosion (Code 1 or more) was significantly higher in the study group (39.5%) when compared to control group (11.5%) [Table 1]. In the upper arch, a significant difference was seen between the groups for buccal surface ($P < 0.01$) and lingual surface ($P < 0.05$) and between buccal and lingual surface in the study group ($P < 0.01$), while in the lower arch, a significant difference was seen between the groups for buccal surface ($P < 0.01$). The prevalence of dental erosion decreased from central incisors to second molars in both the groups. However, the difference in prevalence between the groups was statistically significant ($P < 0.01$) [Table 2].

OHRQoL as measured by OHIP-14 showed statistical significant difference between the study (23.88 ± 0.88) and control group (26.06 ± 9.67) ($P < 0.02$). A significant difference was observed between the

groups for the domains, i.e., physical pain, social disability, and handicap ($P < 0.01$) [Table 3]. Highly significant correlation was found between dental erosion and OHIP-14 as well as work experience in the study group ($P < 0.01$) when compared to control group ($P < 0.05$) [Table 4].

Table 1: Prevalence of dental erosion (modified tooth wear index) among study participants

Prevalence	Study group*** (n=200), n (%)	Control group*** (n=200), n (%)
Code 0	121 (61)	178 (89)
Code 1	36 (18)	12 (6)
Code 2	26 (13)	7 (4)
Code 3	12 (6)	3 (1)
Code 4	5 (2)	-

*** $P < 0.001$

Table 2: Prevalence of dental erosion (modified tooth wear index) according to tooth affected among study participants

Tooth	Study group** (n=200), n (%)	Control group** (n=200), n (%)
Central incisor	79 (40)	21 (11)
Lateral incisor	72 (36.0)	20 (10.0)
Canine	36 (18.0)	16 (8.0)
First premolar	32 (16.0)	11 (6)
Second premolar	30 (15.0)	5 (3)
First molar	24 (12.0)	3 (1)
Second molar	13 (6)	3 (1)

** $P < 0.01$

Table 3: Domain-wise and overall mean oral health impact profile-14 scores of study participants

Domains	Mean±SD		P
	Study group (n=200)	Control group (n=200)	
Functional limitation	3.49±1.77	3.46±1.68	0.83
Physical pain	3.34±1.57	4.63±2.18	<0.01
Psychological discomfort	3.39±1.58	3.50±1.57	0.50
Physical disability	3.93±1.95	3.85±1.90	0.69
Psychological disability	3.38±1.58	3.35±1.44	0.84
Social disability	3.35±1.73	3.83±1.87	<0.01
Handicap	3.01±1.48	3.46±1.79	<0.01
Total	23.88±0.88	26.06±9.67	<0.02

SD: Standard deviation

Table 4: Correlation between dental erosion and other variables among study participants

Correlation	Study group (ρ)	Control group (ρ)
Dental erosion versus work experience	0.72**	0.11*
Dental erosion versus OHIP-14	0.43**	0.16*

** $P < 0.01$, * $P < 0.05$. OHIP-14: Oral health impact profile-14

DISCUSSION

The key findings of the study give an insight into the impact of occupational dental erosion and OHRQoL among battery factory workers. The study group consisted of battery factory workers working in acidic environment and control group was selected from another factory not exposed to acidic environment. On the contrary, some studies in literature have considered control group from the same battery factory but not exposed to acidic environment.

Age and duration of work are widely documented as factors associated with dental erosion. With the increasing age, salivary flow rate is reduced and its clearance and buffering capacity are negatively impacted. Decreased salivary flow rate results in abnormal acid retention in the mouth which further contributes to dental erosion.^[22] The age of the participants in the study group ranged from 25 to 59 years which is in line with studies reported in the literature.^[5-9,15,16] Similarly, duration of the work adds to the impact of occupational exposure on health. Work experience in both the groups ranged up to 30 years.

In this study, all the participants were males. This is in agreement with most of the studies reported in the literature.^[5,6,8,9,14,15] The reason for male predominance in these studies may be attributed to hazardous working atmosphere and laborious nature of work where only males are employed.

The reasons for dental visit reported by both the groups were problem driven rather than periodic checkups. This might be ascribed to the insufficient knowledge about the importance of an early preventive dental visit. A study by Petersen *et al.*^[15] reported 71.0% of the study participants visiting dentist on regular basis. Restoration was the most utilized dental treatment in this study while Amin *et al.*^[6] reported tooth extraction as most utilized treatment.

Dry mouth was reported in 34.0% of participants which is higher than Petersen *et al.* (25.0%)^[15] but lower than other studies.^[6,8] Sensitivity was perceived by 41.0% of participants which is lower than Agrawal *et al.* (57.6%),^[9] Khurana *et al.* (78.7%),^[8] and Amin *et al.* (83.0%)^[6] study. Toothache was stated by 20.0% of participants which is almost similar to previous studies^[8,15] but lesser than Amin *et al.* (69.0%)^[6] study.

Studies in literature have used Smith and Knight TWI, modified TWI, ten Cate's criteria, Eccles and Jenkins

classification dental erosion index, and industrial dental hygiene criteria for measuring dental erosion.^[23] In this study. Modified TWI was considered for the present study as it record all the surfaces of the teeth present in the oral cavity and also it has been used in previous epidemiological investigations.^[21] However, the criticism for modified TWI says that it does not relate the etiology to the outcome of wear seen on the teeth. The present study has excluded incisal edges and occlusal surfaces and assessed only facial/palatal surfaces to overcome the criticism like previous studies. The prevalence of dental erosion in the study group (39.5%) is higher than reported by Petersen *et al.* (31.0%)^[15] and Tuominen *et al.* (18.4%)^[14] but lower than reported by Agrawal *et al.*, (74.0%)^[9] Amin *et al.* (79.2%),^[6] Basavaraj *et al.* (98.8%),^[7] and Khurana *et al.* (100%).^[8] Higher prevalence in the study group may be attributed to industrial acid mist, which after entering the oral cavity through inhalation decreases the pH of saliva, thus affecting the hard tissues such as enamel and the underlying dentin.^[8]

In the control group, the prevalence of dental erosion was 11.0% which is in line with Tuominen *et al.* (8.6%)^[14] but lower than Amin *et al.* (46.7%)^[6] and Khurana *et al.* (86.0%)^[8] study. Since the control group is not exposed to acid mists, the possible reasons for erosion may include dietary habits (coarse food or excessive consumption of acidic fruits and juices) or other intrinsic factors.

Independent of the arch, buccal surface was affected significantly higher in study group when compared to control group. This is suggestive of pathognomonic nature of exposure to acid mists signifying occupational dental erosion (extrinsic factor) and lack of positive occupational health behavior. Irrespective of the group and the arch, lingual surface revealed minimal erosion that could not attain statistical significance. This may reflect the absence of intrinsic factor if any.

Most of the reports have indicated that industrial dental erosion affected incisors and occasionally canine teeth; premolars and molar teeth were never affected.^[10] Canines, premolars, and molars are apparently adequately protected by the salivary wash to which they are submitted.^[24]

In the current study, the prevalence of dental erosion significantly decreased anteroposteriorly (central incisor to second molar) more so in study group than control group and are in line with previous

studies.^[8,14,24] In contrast, few studies^[6,10,15] reported dental erosion in the upper and lower front teeth only and no erosion on posterior teeth whereas Suyama *et al.*^[16] reported development of dental erosion in mandibular anterior teeth sparing maxillary teeth.

OHIP is a comprehensive measure of self-reported dysfunction, discomfort, and disability attributed to oral conditions. OHIP is concerned with impairment and three functional status dimensions (social, psychological, and physical).^[25] In this study, overall, the study group had better quality of life when compared to control group. Besides in this study, dental erosion correlated with OHRQoL (OHIP-14): moderately in study group and weakly in control group suggestive of significant impact on quality of life. This could be due to the fact that quality of life is the outcome of multiple factors and factors other than dental erosion influenced OHRQoL in the control group when compared to study group.

Studies in literature have related dental erosion with work experience.^[6-8,10,14] In this study, significantly strong positive correlation between dental erosion and work experience ($P = 0.72$) among the battery workers (study group) indicates cumulative effect of occupational exposure that can be hazardous.

The study has few limitations. The causal relationship cannot be established because of the cross-sectional design used. However, longitudinal studies cannot be devised due to ethical considerations. While information on concentration of acid fumes in the working environment of the factory workers was not collected, duration of work experience was taken as proxy measure. Tool used in the study can suffer from reporting bias, social desirability, and central tendency bias. Still information gathered from patients' perspective may have a value in planning long-term health-care measures. Considering dental erosion as a work-related condition, measures to promote occupational health are suggested. Education about occupational hazards, worksite oral-health promotion, and training for the adoption of standardized work behaviors should be provided.

CONCLUSION

Higher prevalence and severity of dental erosion was observed among the study group (battery factory workers) than the control group (other factory workers). OHRQoL was significantly better among battery factory workers than other factory workers. A significant correlation

was observed between dental erosion and OHRQoL in both the groups. Hence, there is a relationship between occupational dental erosion and OHRQoL.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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Kumar, *et al.*: Occupational dental erosion on oral health-related quality of life

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