Oral conditions among German battery factory workers

Poul Erik Petersen[1] and Charlotte Gormsen[2]

[1]Institute for Community Dentistry and Graduate Studies, Royal Dental College, Copenhagen, [2]Institute for Orhtodontics, Royal Dental College, Aarhus, Denmark

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Abstract – The purpose of the study was to evaluate the oral health situation of workers in a modern battery factory; in particular, to describe the prevalence and the severity of dental erosion and attrition in relation to exposure of airborne acids in the work environment. Measurements of the work environment at a German battery factory showed that the workers were exposed to sulfuric acids (0.4–4.1 mg/cm^3). All workers at the factory were included in the survey and a total of 61 dentate individuals completed a questionnaire on their work environment, dental health, and symptoms from the mouth, nose, and throat. Information on oral health status, erosion, and attrition was collected by clinical examinations. Nearly all workers reported exposure to etching substances in their work environment; 56% complained of sharp and thin teeth and 29% of short teeth. Poor dental health conditions were observed (e.g. mean D-T = 3.8); the mean number of teeth with crown restoration was 5.3. The prevalence of erosion was 31% and 92% were affected by attrition. Erosion was found only in front teeth while attrition also occurred in posterior teeth. Due to the high level of crown restorations a rather moderate dose-effect relationship was observed. In conclusion, severe erosion and attrition due to sulfuric acid mists should be recognized as an occupational disease.

Key words: attrition, dental; erosion, dental; epidemiology, oral; industrial dentistry; occupational disease, oral

P. E. Petersen, Institute for Community Dentistry and Graduate Studies, Royal Dental College, 20 Nörre Alle, DK-2200 Copenhagen N, Denmark

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Oral cavity injuries which occur as a direct result of an occupation are rather common. The injurious effects of occupational hazards may manifest themselves in the teeth, jaw bones, periodontal tissues, tongue, lips, and oral mucosa. The effects of the various etiologic agents depend on their specific chemical, physical, and bacterial nature, their physical state, and their mode of entry (1). Dental erosion refers to the loss of tooth substance by a simple chemical process due to the exposure to acids. Industrial environmental factors may be considered responsible for dental erosion among battery workers since they are exposed to sulfuric acid mists (2, 3). The harmful processes are known as forming and charging. Severe attrition, i.e. the mechanical wearing down of the tooth surfaces during masticatory movements, has also been observed among battery workers (3). The purpose of the present study was to evaluate the oral health situation of workers in a modern German battery factory; in particular, to describe the prevalence and the severity of dental erosion and attrition in relation to the exposure to airborne acids in the work environment.

Study population and methods

The survey took place in 1988 and included all workers ($n = 63$) in a German (BRD) battery industry. The study group consisted of 61 dentate workers with a mean age of 46 yr (range 20–58). Only males were employed at the factory; one quarter of the workers had been employed for 10 yr or less and three quarters for 11 yr or more. The working processes may be described in the following way: In the forming process, lead battery plates are immersed in tanks of dilute sulfuric acid. The plates are then joined together in groups to give a negative and positive pole. A direct current of 110 volts is passed through the circuit, which "forms" the plates. During this process, small gas bubbles carry a spray of acid mist into the atmosphere. The charging process consists of filling finished batteries with acid and charging them by means of direct current. The present study was preceded by measurements of acid mists performed by the local Labor Inspection Service. At the time of investigation the concentration of airborne acids varied from 0.4 to 4.1 mg/cm^3. Highly structured questionnaires were used to collect data on residence, education, work conditions, dental health behavior, self-assessment of dental health status, and symptoms from mouth, nose, and throat. Information about dental health status was based on clinical observations. Dental caries was recorded as described by WHO (4) and the periodontal registrations included measurements of pocket depth in mm of the indicator teeth 16, 11, 23, 36, 41, and 44. The dental erosion or attrition of each tooth was assessed according to recommended criteria (3, 4). The following coding for erosion was used: 0 = no erosion; 1 = loss of enamel only; 2 = loss of enamel with involvement of dentin; 3 = loss of enamel and dentin with exposure of secondary dentin; and 4 = loss of enamel and dentin resulting in pulpal exposure. The following codes for attrition were set: 0 = no attrition; 1 = attrition of the enamel – cusp still visible; 2 = dentin exposed; 3 = occlusal relief worn away leaving a peripheral rim of enamel; and 4 = crown worn down close to the cementoenamel junction. Finally, the presence or absence of pain or tenderness from the temporomandibular muscles was recorded according to the results of a palpation test (5).

Table 1. Percentages of workers who reported exposure to various working conditions

Work conditions	%
Etching substances	92
Draft	87
Unpleasant smell	84
Temperature excessively cold	68
High noise level	66
Dust	66
Dirtiness	60
Excessive changes in temperature	60
Reduced light	45
Smoke	44
Temperature excessively warm	42
Vibration	13

Table 2. Percentages of workers who reported various symptoms from mouth

Symptom	%
Sharp and thin teeth	56
Bad taste	39
Short teeth	29
Dry mouth	25
Foul breath	23
Bleeding from gums	19
Oral inflammation	18
Tooth pain	17
Ulcers in mouth	13
Itching, burning or smarting pain	10

In the data analysis caries experience was described by the DMFT index and the periodontal status by the number of scored teeth with pockets deeper than 5 mm. For the description of dental erosion and attrition, the number of teeth with various conditions was calculated, and the means were computed.

Results

Various disturbing or embarrassing work conditions were frequently reported (Table 1). The respondents claimed the use of protective equipment as follows: protective gloves (93%), dress (92%), and shoes (87%); ear protector (42%), eye protector (40%), and face guard (31%).

Regular dental visits during childhood were claimed by 55%, and 71% actually saw a dentist on a regular basis. Most of the workers (93%) brushed their teeth at least twice a day and 61% brushed their teeth twice a day at work. All in all, 37% were denture wearers, one half of whom had dentures in both jaws, one third in the maxilla only and about one tenth in the mandible only. Two-thirds of the workers declared that their teeth were bad or fairly good. Forty-four percent reported that they often had problems with their teeth and gums, mostly gingival bleeding, hypersensitivity of teeth, pain, and "crashing of teeth". Half claimed that these problems were related to the work environment. Various symptoms from the mouth were reported by the workers (Table 2). Moreover, 44% complained of dry nose, 40% had itching nose, 37% had bleeding nose, 24% had disturbed sense of smell, and 37% complained of dry throat. Finally, 40% reported that they often had a headache.

The mean caries experience was 25.5 DMFT (DT = 3.8, MT = 15.0, FT = 6.7) and the mean number of scored teeth with gingival pockets deeper than 5 mm was 2.1. Forty percent had crown or bridge restorations; the mean number of teeth with crown restoration was 5.3. This type of restoration was relatively frequent among the older individuals and among persons employed for 11 yr or more. Thirty-one percent of the workers were affected by dental erosion and 92% by attrition. The mean number of teeth affected by erosion was: 0.6 of grade 1, 0.4 of grade 2, 0.2 of grade 3, and 0.1 of grade 4. The mean number of teeth with attrition was: 4.1 of grade 1, 3.1 of grade 2, and 0.1 of grade 3. No case of grade 4 attrition was observed. Erosion was mostly found in the front teeth whereas attrition was also observed in posterior teeth. Table 3 shows the mean number of teeth with erosion and attrition according to duration of exposure. The results of the palpation test showed that 2% of the workers had symptoms from the temporal muscles and 15% had symptoms from the pterygoid muscles, while no symptoms were found from the masseter muscles.

Table 3. Mean number of teeth with erosion and attrition, mean number of teeth affected in total, and affection rate in percent according to duration of exposure

Duration of exposure	Erosion				Attrition			No. of teeth affected	Affection rate in percent
	1	2	3	4	1	2	3		
≤10 yr	1.3	–	0.2	–	3.6	3.6	–	8.7	41.6
>10 yr	0.4	0.5	0.3	0.1	4.4	2.9	0.1	8.7	55.8

Discussion

The study was initiated by the occupational health service in order to plan oral health promotion at the workplace. The survey comprised workers with marked exposure to acid mists at a modern battery factory and a response rate of 100% was obtained. Nearly all workers reported the exposure to etching acids and this was supported by results of the technical measurements. Various embarrassing symptoms from the teeth and the oral cavity were dominant. It is noteworthy that rather uncharacteristic symptoms like short, sharp, or fragile teeth were frequent. Many workers were aware of a poor dental status and related their dental problems to the work environment. The prevalence of dental erosion was comparable to previous findings among battery workers but a less severe pattern was observed (2, 3). Industrial erosion first affected the surfaces of the teeth most exposed to the atmosphere. These were the incisal one-third to one-half of the labial surfaces of the front teeth. No erosion of the posterior teeth was seen. This pattern is in contrast to erosion caused by internal factors (e.g. excessive vomiting) which mostly affect the lingual surfaces of all teeth. Severe attrition may occur from the habit known as bruxism, i.e. grinding of teeth during sleep. Grinding of teeth due to hyperactivity in the masticatory muscles is often considered to be prerequisite for the development of pathological attrition. In this study attrition caused by hyperactivity may be excluded as an explanation of dental wear since only a few participants had symptoms from the masticatory muscles. The observed dental wear among the battery workers should therefore be ascribed to the effect of the work environment and the findings support the hypothesis that enamel of acid-eroded teeth is abnormally fragile (3). Considering time of exposure, a rather weak dose-effect relationship was outlined. However, this may be explained by the very high pro-

portion of teeth restored by crowns or bridges.

First of all, dental erosion and attrition among battery workers and similar occupational groups ought to be prevented through the reduction of the acid mist level. However, until such a reduction is achieved, the use of safeguards and regular toothbrushing at work should be recommended. In the case of extremely eroded and worn dentitions, dental reconstruction is not only a difficult clinical problem but also very expensive. Since these severe dental conditions are closely related to the work environment, the lesions should be considered occupational diseases and the workers entitled to compensation according to national legislation on industrial injuries insurance.

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