Occurrence of periodontal pockets and oral soft tissue lesions in relation to sulfuric acid fumes in the working environment

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The effect of inorganic acid fumes from the working environment on the occurrence of periodontal pockets and soft oral tissues was investigated in a cross-sectional, blind study. A sample of 186 workers was drawn from 4 factories. Of the 170 participants, 82 were working in departments containing acid fumes, and 88 controls had never worked under such conditions. Of the workers exposed to acid fumes 36.9% and of the controls 30.9% had periodontal pockets. The presence of periodontal pockets increased with age significantly more among the acid-exposed workers than among the controls ($p < 0.0001$). Oral mucous membrane lesions were observed among 23.2% of the acid-exposed workers and 21.6% of the controls. The findings suggest that acid fumes in the workplace air do not increase the occurrence of oral mucous lesions but may lead to an increase in the prevalance of periodontal pockets. □ *Inorganic acid fumes; oral mucous membrane lesions; periodontology; subjective oral symptoms*

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Many reports in the dental literature indicate that occupational hazards may cause damage to the oral tissues. The erosive effect of acid fumes on the teeth is well documented (1–4). In contrast, more contradictory results have been reported in studies on the effect of acid fumes on soft oral tissues (5–9).

Workers exposed to acid fumes in factories have been reported to have reddened gums and sunburned-looking lips (5). Acids in the breathing air have been suggested to cause ulceration, hemorrhage, and stomatitis in the oral mucosa (6). In a survey of workers in several factories in England (9) periodontal diseases were found to be more prevalent among the acid-exposed workers than among the controls. In another study (10), however, none of the 126 acid-exposed workers had infection of the gums. No differences in the prevalence of inflamed gingivas between the acid-exposed workers and the controls have also been reported (7).

The aim of this work was to study whether oral mucous lesions and subjective oral symptoms are more prevalent and whether periodontal pockets are more prevalent and more severe among workers exposed to inorganic acid fumes in their work than among controls.

Subjects and methods

A sample of 186 blue-collar male workers was drawn from 4 factories—2 battery factories (Akkuteollisuus Ltd. in Espoo and Pakkasakku Ltd. in Vantaa) and 2 galvanizing factories (Outokumpu Ltd. in Harjavalta and Kokkola) (Fig. 1). These companies were chosen because they were known to employ workers exposed to inorganic acid fumes almost continuously and because they also employed workers in acid-free departments. Sulfuric acid was the commonest acid to which the workers were exposed.

The control subjects were from acid-free departments of the same companies in which the acid-exposed workers were employed. No worker was accepted as a control if he

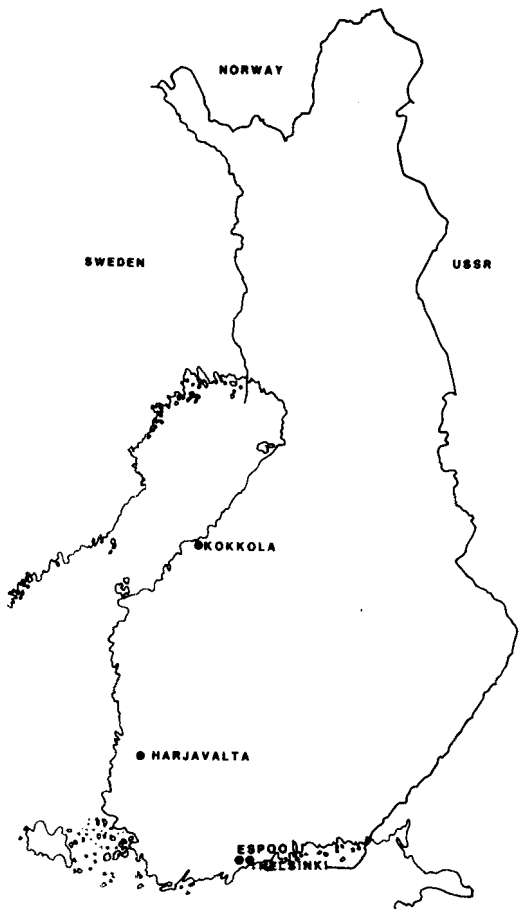

Fig. 1. Locations of the towns with battery factories (Espoo and Vantaa) and galvanizing factories (Harjavalta and Kokkola).

had ever worked in a department containing acid fumes during his present or previous employment. The survey was carried out during November and December of 1986.

The acid-exposed workers' mean age was 38 (SD, 9.3) years and that of the controls 39 (SD, 7.6) years. More detailed information about the sampling, questionnaire, interviews, clinical recordings, caries status, and acid measurements has been published earlier (11). The findings are based on the clinical recordings of one dentist.

The following items of the questionnaire data were included in this study and classified as follows:

Age in years, which was classified as: 0) <25 years, 1) 26–34 years, 2) 35–44 years, and 3) 45+ years.

Time worked in the present job, which was classified as : 0) <7 years, 1) 8–15 years, and 2) 16+ years.

The frequency of smoking, both past and present, was ascertained. The responses were analyzed, first separately and then as an overall smoking history factor.

The workers were also questioned about the regularity of visits to a dentist, the time since their last dental visit, and the frequency of tooth-brushing.

Before the clinical examination, the workers were asked whether the following symptoms: burning sensation of intraoral mucous membranes or the tongue, rash and blisters, dry lips, and angular cheilitis had occurred: 0) never, 1) occasionally, or 2) continuously. Attention was also paid to any combinations of these symptoms. Gastric symptoms were ascertained.

At the clinical examination the mouth was thoroughly dried with air and examined in good light. A mouth mirror, a WHO periodontal probe, and an explorer were used. The dentist was unaware of the subjects' exposure status.

Oral mucous membrane lesions were classified as follows: 0) denture fibrosis, 1) denture stomatitis, and 2) other lesions. All lesions of mucous membranes not related to the denture were also photographed.

Of 170 participants 7.6% were edentulous. Among the exposed workers 7.4% had partial denture(s) and 25.6% had complete denture(s); the corresponding figures among the controls were 11.4% and 28.4%. The differences were not statistically significant (Table 1).

For the periodontal status analysis, only subjects with at least one remaining index tooth were included ($n = 157$). The periodontal status was registered in accordance with the Community Periodontal Index of Treatment Needs (CPITN) (12). A dichotomy (having periodontal pocket(s) or not) was formed, and the presence of shallow (4–5 mm) or deep (6 mm or deeper) periodontal pockets was also analyzed.

The Trend test (13) and the chi-square test were used for statistical analyses.

Table 1. Distribution of dentures among acid-exposed workers and controls

	Acid-exposed workers, *n*	Controls, *n*
No dentures	58	54
Partial denture/–	3	5
Complete denture/–	13	17
–/Partial denture	0	1
Partial denture/partial denture	0	3
Complete denture/partial denture	3	1
Complete denture/complete denture	5	7

Results

The acid-exposed workers had more periodontal pockets than the controls, but the differences were non-significant (Table 2). Periodontal pockets were diagnosed in anterior and posterior sextants equally often among the acid-exposed workers and the controls. The presence of periodontal pocket(s) increased with age among the acid-exposed workers statistically significantly more than among the controls (Fig. 2).

The duration of work in environments involving exposure to acid was associated with the number of periodontal pockets. When the effect of age was eliminated, the exposed workers with the longest duration of exposure had periodontal pockets significantly more often than the controls ($p < 0.03$). When the duration of exposure was shorter, the differences were not so obvious (Table 3).

In both the acid-exposed and the control groups neither the frequency of tooth-brushing nor the wearing of removable denture(s) was significantly associated either with the prevalence of pockets, whether shallow or deep, or with infection of the gums.

Lesions of oral mucous membranes were observed among 23.2% of the exposed workers and 21.6% of the controls. Age had an increasing effect on the prevalence of oral mucous membrane lesions in both groups (Table 4). When the effect of age was eliminated, prolonged exposure to inorganic acid fumes did not increase the prevalence of these lesions.

Of the exposed workers 69.5% and of the controls 55.7% had one or more of the oral symptoms inquired about (Table 5). The prevalence of the examined oral symptoms (except burning sensation) was higher among the acid-exposed workers than among the controls.

Among the exposed workers those with removable denture(s) had subjective oral symptoms significantly ($p < 0.02$) less often (50.0%) than those without denture(s) (77.6%). Among the controls, wearing denture(s) was not related to subjective oral symptoms. However, wearing denture(s) was highly significantly associated with the increasing occurrence of oral mucous membrane lesions among both the exposed workers and the controls ($p < 0.0001$).

Smoking, oral hygiene habits, the regularity of visits to a dentist, and the presence of gastric symptoms did not have an effect on the presence of periodontal pockets, oral mucous membrane lesions, or subjective oral symptoms.

Table 2. Percentage distribution of subjects in accordance with their periodontal status among acid-exposed workers and controls

	Acid-exposed workers (%)	Controls (%)
Healthy	3.9	3.7
Bleeding after probing	15.8	16.0
Supra- or sub-gingival calculus	43.4	49.4
Pocket 4–5 mm deep	31.6	28.4
Pocket 6+ mm deep	5.3	2.5

Statistical evaluation with the chi-square test = NS.

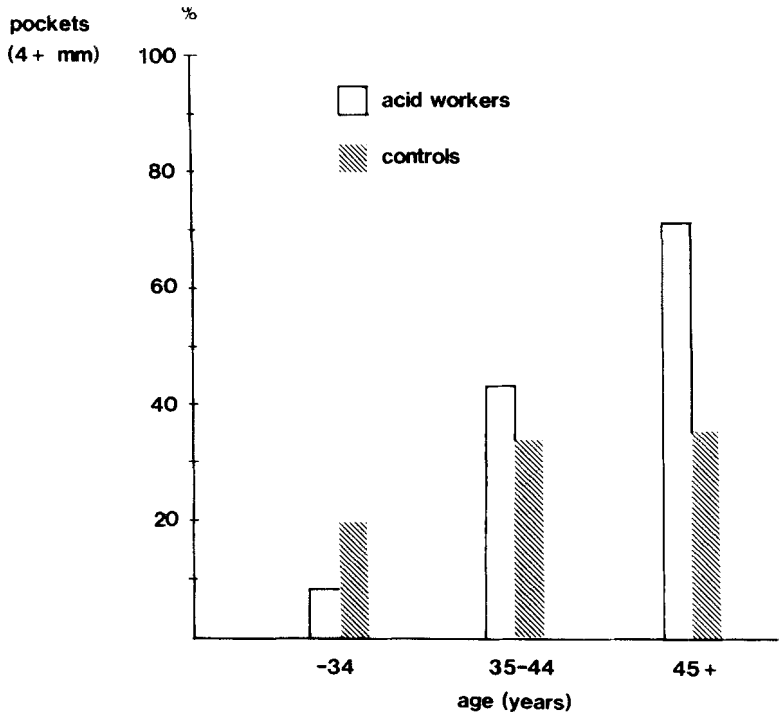

Fig. 2. Percentage distribution of workers with periodontal pockets among acid-exposed workers and controls, by age. Statistical analysis by the Trend test: $p < 0.0001$.

Table 3. Percentage distribution of subjects with periodontal pocket(s) (4 mm in depth or deeper) among acid-exposed workers and controls in accordance with the duration of time employed in the present type of job

Duration of employment	Acid-exposed workers (%)	Controls (%)
0–7 years	26.7	23.1
8–15 years	40.9	33.3
16+ years	51.7*	31.6

* Chi-square test: 5.08175 → $p < 0.03$.

Table 4. Percentage distribution of subjects with oral mucous lesions by age and work status

Age distribution (years)	Acid-exposed workers (%)	Controls (%)
<34	12	10
35–44	27	25
45+	30	25

Statistical evaluation with the chi-square test: between the acid-exposed workers and controls = NS.

Discussion

Because the examiner was unaware of the subjects' exposure status, I had the opportunity to examine the effect of acids without allowing my subjective expectations to affect the results.

The exposed workers and the controls were selected from the same factories and had the same occupational status. The groups also had the same income distributions. Thus it is evident that the exposed group and the control group represented the same socio-economic group.

The number of people continuously exposed to inorganic acid fumes is limited in Finland, so it was not possible to increase the sample sizes significantly. With larger sample sizes, more subjects with soft oral tissue lesions would probably have been found.

The occurrence of periodontal pockets in this population was higher than in another industrial population (14) but lower than that among the general Finnish adult population (15). Markkanen (14, 15) had female sub-

Table 5. Prevalence of the oral symptoms experienced occasionally or continuously among acid-exposed workers and controls

Symptom	Acid-exposed workers (%)	Controls (%)	Statistical evaluation
Burning sensation	4.9	6.8	NS
Rash and blisters	28.0	21.6	NS
Dry lips	50.0	37.5	NS
Angular cheilitis	14.6	13.6	NS
One of more symptoms	69.5*	55.7	NS

* Chi-square test: $3.4385 \rightarrow 0.05 < p < 0.1$.

jects in her study too, which may partly explain the lower prevalence of periodontal pockets. In the nationwide study (15), which included pensioners, the age distribution differed greatly from that in the present study, a fact that may have contributed to the difference. The results of the present study conflict with the findings of Tuominen et al. (16), who reported a highly significant association between the wearing of removable partial dentures and the prevalence of periodontal pockets. Since the study by Tuominen et al. (16) was based on the same nationwide sample as the work by Markkanen (15), the inclusion of older people might explain the contradictory results.

Ten Bruggen Cate (9) and Sandin (8) stated that it was difficult to analyze the effect of acids on the prevalence of periodontal diseases because the subjects differed from the controls in oral hygiene practice and age. In addition, the controls in the study of Sandin (8) were drawn from another company, not from the company employing the exposed workers. Schour & Sarnat (6) suggested that poor oral hygiene makes the worker more susceptible to oral occupational hazards, but they did not give data supporting this claim, nor did they refer to the study from which they had drawn their conclusions. The findings of the present study do not support their suggestion. In the present study the acid-exposed workers and controls (all blue-collar workers) were equal with regard to oral hygiene practices and age, so these could not have contributed to the differences in occurrence of periodontal pockets. Even so, an average equal toothbrushing frequency does not guarantee that the groups will have the same average plaque situation.

The findings of this study suggest that even low acid concentrations (11) in the breathing air may lead to an increase in periodontal pockets, especially among acid-exposed workers with a longer duration of exposure. Acids in breathing air may irritate periodontal tissue and weaken the natural defense system. This finding contradicts the results reported by Lynch & Bell (10). They found no infection of the gums among acid-exposed workers. It should be borne in mind that the standardized diagnostic criteria of periodontal diseases were only recently developed. Comparison of the results reported by Lynch & Bell (10) with those of the present study is probably unjustified because the diagnostic criteria may have been different.

Removable dentures have an increasing effect on the occurrence of mucous membrane lesions (17). Dentures irritate the mucosa, and thus may disturb the protective mechanism of the mouth. Use of removable dentures increases with age (18), and atrophic changes in oral mucosa also occur with age (19). These phenomena may partly explain the higher prevalence of mucous membrane lesions among older subjects. The literature does not explain why acid-exposed denture wearers have less subjective oral symptoms than acid-exposed workers not wearing dentures.

In this study the acid-exposed workers had more of the oral symptoms inquired about than did the controls, but the differences were not statistically significant, probably

owing to the small sample sizes. With bigger sample sizes the differences might have been more visible. The trend of our findings, however, corroborates those of Sandin (8), who found that one-third of acid-exposed workers studied in Sweden had dry lips. He also detected various grades of cheilitis. He did not find these complaints among the control subjects.

In 1919 Simpson (5) examined acid blowers and men working with acid pumps and reported that many of them had reddened gums and sunburned-looking lips. Occupational health legislation has undergone considerable changes in industrialized countries since then. It may well be that the currently allowable acid concentrations in the breathing air do not have such a damaging effect on the oral soft tissues as the concentrations formerly present in the air. One reason for the increased prevalence of periodontal pockets among the older workers might be that the older individuals had been exposed to acid fumes not only longer but also at a higher intensity.

It can be concluded that acid fumes in workplace air do not increase the occurrence of oral mucous lesions, but they may lead to an increase in the prevalence of periodontal pockets.

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