ORIGINAL ARTICLE

Dental erosive wear among Norwegian wine tasters

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Abstract

Objective. To assess the prevalence and severity of dental erosive wear among a group of professional wine tasters. Material and methods. Eighteen wine tasters currently employed at AS Vinmonopolet, Norway (3 women, 15 men; mean age 39 years) and 30 comparison participants (9 women, 21 men; mean age 39 years) were included in the study. The wine tasters were examined by four calibrated clinicians using the Visual Erosion Dental Examination system. Data concerning medical and dietary history, oral hygiene habits and occupational background were obtained from a self-completed questionnaire. Data were analyzed using Fisher’s exact test, and examiner agreement was determined by means of linear-weighted kappa and the intra-class correlation coefficient. Results. Nine (50%) of the wine tasters and six (20%) of the comparison group showed clinical signs of dental erosion. Among the wine tasters, 39% had dentine involvement, compared to just 7% of the comparison group. The erosive lesions were mainly found on the occlusal surfaces of mandibular first molars in the wine tasters, whereas for the controls, the palatal surfaces of upper centrals were most often affected. Conclusions. There was a significant difference in the prevalence of dental erosive wear between the two groups, the wine tasters having a higher prevalence and more severely affected surfaces than the comparison group. Half of the wine tasters had no erosive wear and, for the other half, there was no relationship between the duration of their professional life and the extent of erosive wear.

Key Words: Dental erosion, occupational risk, wine tasters

Introduction

Dental erosion is defined as the pathological loss of dental hard tissue due to the chemical influence of intrinsic and/or extrinsic acids without bacterial involvement [1]. In recent years, the main focus has been on extrinsic risk factors, in particular acidic drinks and food. Moreover, low-pH medications and daily occupational exposure to acids may also be classified as risk factors for erosive tooth wear [2,3]. Studies on occupational causes of dental erosion have been performed on workers exposed to sulfuric acid in battery-manufacturing factories [4], wine tasters [5] and competition swimmers exposed to high levels of hydrochloric acid in chlorinated swimming pools [6]. Although professional wine tasting is very common all over the world, there are few case reports and studies investigating the association between wine intake and dental erosive wear [5,7].

The potential of wine to cause dental erosion is a result of its fruit-acid content, with tartaric and malic acids being the most abundant [8,9]. The low pH of wine, which is reported to range from 3.0 to 4 [5,7,10], and the low concentrations of P and Ca ions, are also of importance for the erosive effect of wine.

AS Vinmonopolet in Norway is a state-owned alcoholic beverage retailer founded in 1922. It has the monopolist right to sell beverages with an alcohol concentration >4.7%. Professional wine tasters test all wines for quality, taste and flavor before approval for sale in the state liquor outlets. Wine tasters perform tasting sessions on 60 days per year on average, and a typical wine-tasting session last 6 h, with two 30-min breaks. In these sessions they taste 20–40 different wines by keeping the wine in the mouth for >6 s (according to the instruction manual for the wine tasters) and swilling it around to stimulate the taste buds before expectorating. The pH of the wine tested is in the range 3.0–3.8. In addition to the test sessions, the wine tasters typically attend 10 full-day courses a year involving several wine-tasting sessions per day.

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Based on such working descriptions it could be assumed that wine tasters are at risk for developing dental erosive wear. Therefore, the aim of this study was to assess the prevalence and severity of dental erosive wear among 18 Vinmonopol wine tasters and, using a comparison group of people not involved in wine tasting, to determine whether professional wine tasters are at risk of erosive damage to their teeth.

**Material and methods**

*Sample population and clinical examination*

The study involved 48 adults (36 men, 12 women; age range 24–56 years). The sample was divided into the following two groups:

1. **Wine tasters.** AS Vinmonopolet requested that all full-time wine tasters (n = 18; 15 men, 3 women; age range 30–56 years; mean age 39 years) should be included in the study. The length of their employment as wine tasters ranged from 1 to 20 years, with a mean of 6 years.

2. **Comparison group.** Thirty randomly selected, sex- and age-matched adults (21 men, 9 women; age range 24–55 years; mean age 39 years) who attended the Department of Cariology at the University of Oslo for regular dental treatment over a period of 14 days and consumed wine or spirits less than once a week formed the comparison group.

Written, informed consent was obtained from all participants, and the study was approved by the local Regional Committee for Medical Research Ethics and by The Norwegian Social Science Data Services.

To record the number and severity of dental erosive lesions, all the wine tasters were examined by all four dentists, who had been trained and calibrated using the Visual Erosion Dental Examination system [11]. The comparison participants were examined by one of the authors (A. M.), who had been previously calibrated with the other three clinicians [11].

The examination was carried out in a dental clinic with standard lighting and using mouth mirrors and probes. Surfaces were dried by compressed air and, if necessary, cotton rolls were used to remove food debris prior to the examinations. Twelve index surfaces per person were examined: the buccal surface of the upper right second premolar (15), the occlusal surface of the lower left second premolar (35), the occlusal surfaces of the mandibular first molars (36,46) and the labial and palatal surfaces of the maxillary incisors (12,11,21,22).

**Questionnaire**

In connection with the clinical intra-oral examination, participants were asked to complete questionnaires about their medical and dietary histories and oral hygiene habits. The medical questions included information about gastro-esophageal reflux and the type and frequency of medication, if used. The dietary questionnaire covered the frequency and amount of consumption of common drinks and foods associated with dental erosion, such as orange/apple/grapefruit juices, carbonated beverages and some types of fruit, such as oranges, grapefruit and apples. Dental hygiene habits, the frequency and duration of tooth brushing, fluoride consumption and time of last dental visit were also recorded. Additional information was collected from the wine tasters about the frequency of wine tasting, the number of years in the occupation, the number of wine tasting sessions per week and oral hygiene habits after wine tasting.

**Statistical analysis**

The inter- and intra-examiner agreement were measured by means of linear-weighted Cohen’s Kappa ($\kappa_w$) and the intra-class correlation coefficient (ICC), respectively. The statistical analysis, except for determination of $\kappa_w$, was performed using the Statistical Package for the Social Sciences, version 16.0 (SPSS, Inc., Chicago, IL). $\kappa_w$ was calculated using a spreadsheet program (Microsoft Excel). Data for the two groups were analyzed as 2×2 tables using Fisher’s exact test. The level of significance was set at 0.05.

When index surfaces were filled, considered to have attritions or wedge-shaped defects or if the tooth had been extracted, the surfaces and teeth were recorded as missing [n = 1.8% (wine tasters) and $n = 7.8\%$ (comparison group)], and excluded from the calculations.

**Results**

*Clinical examination*

The mean $\kappa_w$ value for the four examiners was 0.68 (range 0.61–0.78), while the ICC value was 0.77 (95% confidence interval 0.73–0.81). Re-examination of the participants was not performed owing to practical reasons. Therefore, the intra-examiner agreement was not assessed for this group. However, based on an earlier study, the intra-examiner agreement values expressed by means of $\kappa_w$ for the same four clinicians indicated a high level of agreement [11].

*Prevalence of dental erosive wear*

Erosive wear was recorded in 50% ($n = 9$) of the wine tasters and in 20% ($n = 6$) of the comparison group, a statistically significant difference ($P = 0.03$). Dentine involvement was recorded in seven out of the nine affected wine tasters, whereas hard tissue loss in the
The comparison group was most frequently registered in enamel (Figure 1).

More men than women had erosive wear, but the difference was not statistically significant ($P = 0.53$ in the wine tasters, $P = 0.84$ in the comparison group).

The distribution of dental erosive wear according to surface level between the two groups is shown in Figure 2. For the wine tasters, the occlusal surfaces of the lower first molars were most affected by dental erosive wear (36/46), while for the comparison group, most dental erosion was registered on the palatal surfaces of upper central incisors (11/21). For both groups, the lowest prevalence of dental erosive wear was on the occlusal surface of lower second premolars (35).

Eleven of the 18 wine tasters had been in the occupation for 1–5 years and, of these, five had erosive wear (one in enamel only and four in enamel and/or dentine). Of the seven wine tasters who had worked for >6 years, four had erosive wear: one in enamel and three in both enamel and dentine (Figure 3). There was no statistically significant difference ($P = 0.74$) between severity, number of dental erosions and years in the occupation.

**Questionnaire**

**Medical history.** All participants were healthy adults, with no relevant medical history. One of the wine tasters reported daily gastro-esophageal reflux; however, no dental erosive wear was registered in this participant.

**Dietary history.** All participants completed a dietary questionnaire, which showed regular, well-balanced diets with low consumption of acidic drinks and citrus fruits. Although there were no statistically significant differences between the groups, some trends in consumption were noted. Twenty-eight percent ($n = 5$) of the wine tasters consumed juices and carbonated beverages several times a day, while such consumption for the comparison group was registered for only three persons. Two of these wine tasters did not have

![Figure 1. Frequency and severity grade of dental erosive wear for wine tasters and comparison group participants.](image1)

![Figure 2. Frequency distribution of dental erosive wear according to surface affected.](image2)
any erosive lesions, while the other three had lesions in enamel and/or dentine (wine tasters numbers 2, 4 and 6 in Figure 3). However, daily consumption of these drinks was more frequent in the comparison group (73%) compared with the wine tasters (50%).

The consumption of apples and citrus fruits, such as oranges and grapefruit, was low in both groups. Fifty-five percent of the wine tasters and 67% of the comparison group reported that they consumed citrus fruits at most once-weekly.

**Oral hygiene habits.** Both groups of participants brushed their teeth twice a day for 2 minutes. Two (11%) of the wine tasters and 13 (43%) of the comparison group used daily fluoride rinses. At the end of the test sessions, all wine tasters rinsed their mouths with unfluoridated tap water; six (33%) of them also used fluoride solutions or fluoride tablets.

Of the wine tasters with erosive wear, four (one woman, three men; 44%) brushed their teeth directly after the tasting session, and all had dental erosive wear into dentine.

The participants in both groups stated that they made regular dental visits. Thirteen (72%) of the wine tasters and 18 (60%) of the comparison group had made their last dental visit 6 months prior to the examination. Seven of the nine wine tasters registered with dental erosive wear had not been informed by their dentist/dental hygienist about the presence of these lesions.

**Discussion**

This study showed a higher prevalence and severity of dental erosive wear for wine tasters, compared with a group of non-wine consumers. The majority of the wine tasters’ lesions involved dentine, while in the comparison group, most erosive wear was confined to enamel (Figure 1). In a study involving 19 Swedish wine tasters [5], erosive tooth wear occurred in 74% of participants, 36.8% (n = 7) showed erosion in enamel, less than one-third of dentine was involved in 26.3% of cases (n = 5) and 10.5% (n = 2) had severe tooth erosion (more than one-third into dentine). In another study [7], tooth surface loss among wine-makers in South Africa was two and a half times greater compared to a non-exposed group, and the severity of the exposed dentine (grade 2 and 3) was twice that of the non-exposed group. Although we can state that all three studies reported a high prevalence of erosive wear, direct comparison with the present study is difficult due to differences in diagnostic criteria and the studying of different age groups.

Tasting habits among the wine tasters may explain this high prevalence. Each mouthful of wine is kept and swilled around in the mouth for 6 s, which is a more pronounced challenge for the enamel compared with normal drinking habits. Millward et al. [12] concluded in their study that long and frequent exposure to low-pH beverages makes the teeth more likely to be eroded than if an acidic drink is swallowed rapidly. This may also explain the more severe erosive tooth wear among Swedish wine tasters [5] who, according to their self-assessment, held the wine in the mouth for a few minutes. However, the prevalence of dental erosion can be accentuated by several other factors. One of the behavioral factors considered in the present study was diet. Although no statistically significant difference between the groups was observed regarding diet, the consumption of low-pH beverages several times per day was more frequent among the wine tasters compared with the comparison group. Several studies [13,14] have
shown a correlation between dental erosion and acidic drinks. In addition to behavioral factors, it is known that chemical and biological factors are related to the development of dental erosion [15], which may explain some of the variation in severity of dental erosive wear among individuals in the present study—the number of affected surfaces and the severity of erosive wear varied among the wine tasters (Figure 3).

The clinical examinations of the participants were performed on index surfaces, based on earlier ‘full-mouth recording’ studies [7,16,17], which demonstrated the highest prevalence of dental erosion on the occlusal surfaces of mandibular molars and premolars, and on the facial and palatal surfaces of maxillary front teeth and premolars. The present study showed that dental erosive wear was not equally distributed on the index surfaces between the two groups. For the wine tasters, the occlusal surfaces of the lower first molars were the most frequently affected, whereas for the comparison group, the most frequently affected surfaces were the palatal surfaces of the upper central incisors (Figure 2). In a case report, Mandel [18] demonstrated the same pattern. According to the author, occlusal surfaces of molars are most likely to have contact with acid and therefore to be exposed during sipping and retaining of wine in the mouth. In addition, it could be expected that mandibular teeth will be more affected compared with maxillary teeth due to gravity [18].

Studies have demonstrated that the acquired salivary pellicle can protect the underlying enamel surface against erosive challenge [19–21]. The thickness of the pellicle may influence the level of protection [19]. The thinnest pellicle was formed on the palatal surface of upper teeth and, at this site, the pellicle was less resistant to acidic exposure than the pellicle on the lower lingual surfaces [19]. These observations may explain the high prevalence of dental erosive wear on the palatal surfaces of upper teeth in both groups in the present study. If a more resistant pellicle forms on the buccal surfaces of teeth, the occurrence of dental erosive wear among wine tasters on buccal surfaces of premolars may seem surprising. However, the wine tasters retain the wine in the mouth for a few seconds and swirl it around, increasing the duration of acid contact with the tooth surfaces.

In the present study, 44% of wine tasters with dentine erosive wear brushed their teeth shortly after the tasting session. Davis et al. [22] demonstrated in an in vitro study that the action of tooth brushing on already softened enamel is a factor that may accelerate tooth wear in general, and tooth brushing therefore should be postponed for a period after acid exposure. However, Kuroiwa and co-workers [23,24] showed that abrasives in dentifrices may reduce the thickness of or remove the pellicle, and therefore brushing should not be performed immediately before acid exposure.

The questionnaire used in the present study revealed that seven of the nine wine tasters with erosive wear who had recently been to their dentist had not been informed about the presence of these lesions, even though five of them had severe dentine erosions. This may indicate a lack of awareness among dental practitioners regarding dental erosive wear and also regarding occupational exposure as a possible cause of erosive tooth wear. In the study by Wiktorsson et al. [5], a similar finding was reported.

Although the present study demonstrated that the wine tasters had a higher prevalence of dental erosive wear compared with the comparison group, only 50% of examined participants had erosive wear. There was no clear connection between the duration of being a wine taster and the occurrence of lesions (Figure 3). Eight of the nine wine tasters without dental erosive wear had been employed for 1–10 years, which means that, despite extensive exposure to acid, no wear could be registered. However, five of the wine tasters who had worked at AS Vinmonopolet for a short period had several surfaces affected with severe lesions. For some individuals it may be assumed that wine was the only risk factor in the development of erosive wear. However, it is unlikely than an isolated factor, such as wine tasting, can be responsible for a multifactorial condition such as dental erosion.

Our recommendation is that wine tasters should have regular check-ups in order to identify dental erosive wear at an early stage and so as to plan a preventive strategy. According to Lussi et al. [25], preventive strategies should include dietary advice, fluoride regimes, stimulation of salivary flow and encouragement of non-destructive tooth-brushing habits. Gedalia et al. [26] have shown a significant increase in the hardness of enamel exposed to cola when cheese was consumed, and Mok et al. [9] found in their pilot study that resin protection and Fluor Protector were effective against dental erosions when the teeth were exposed to wine in vitro. In addition, wine tasters should be advised to reduce the frequency of tasting sessions to allow time for the formation and maturation of a more protective pellicle [19,20].

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