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Association between alcohol consumption and dental health

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Abstract

Objectives: To study the association of alcohol consumption with dental health in a sample from the County of Stockholm.

Material and Methods: In a longitudinal investigation, 513 individuals were examined in 1970 and 1990. Clinical and radiographic examinations were performed as well as an interview including questions on alcohol consumption. The clinical investigation consisted of the registration of the number of remaining teeth, dental restorations, caries and periodontal conditions. The marginal bone level and longitudinal bone loss were determined by assessments on the proximal surfaces of all measurable teeth on the radiographs. Stepwise multiple regression analyses were adopted to calculate the partial correlations between alcohol consumption and the investigated odontological variables.

Results: The group of subjects with the highest alcohol consumption (>5 cl pure alcohol per day) had more tooth surfaces with caries, more calculus and more teeth with apical lesions compared with those who reported an alcohol consumption $\leqslant 5$ cl of pure alcohol per day. Alcohol consumption was not associated with periodontal disease.

Conclusion: The observations do not support any association between alcohol consumption and periodontal disease. However, individuals with high alcohol consumption had significantly more teeth with decayed surfaces and apical lesions indicating that lifestyle-related factors may influence dental health.

Key words: alcohol; dental health; follow-up study; periodontitis; risk factor; risk indicator

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The variability for periodontitis progression has been analysed in several studies including risk factors, risk indicators and background factors as explanatory variables (for review, Genco 1996). Dental plaque is the principal aetiological factor of periodontitis, while smoking and diabetes mellitus are regarded as the most important risk factors for periodontitis, increasing the risk for severe periodontal disease (Albandar 2002). However, marginal periodontitis is a multi-factorial disease (Clarke & Hirsch 1995, Albandar 2002), and the total variability for disease progression has far from been explained in longitudinal studies. More longitudinal studies are needed to investigate whether the identified risk indicators for periodontal disease possess a true risk-modifying effect. Recently, life-style factors have been proposed to be potential unknown explanatory factors (Clarke & Hirsch 1995).

Conflict of interest and source of funding statement

The author declares that he has no conflict of interests.

In Sweden, about 90% of males and 80% of females use alcohol, while 18% of the males and 5% of the females in the population have hazardous or harmful alcohol use (Bergman & Källmén 2002). The health risks of alcohol are dose-dependent, and alcohol intake results in an increased risk of diseases such as liver cirrhosis, pancreatitis, oral cancer and stroke (Damström Thakker 1998). It has been demonstrated that females are more susceptible to the toxic effects of alcohol compared with males (Damström Thakker 1998).

Several studies have investigated the association between alcohol consumption and dental health (Novacek et al. 1995, Sakki et al. 1995, Shizukuishi et al. 1998, Tezal et al. 2001, 2004, Araujo et al. 2004, Copeland et al. 2004, Klein et al. 2004, Torrungruang et al. 2005, Wimmer et al. 2005). Heavy alcohol intake has been found to be associated with tooth loss (Copeland et al. 2004, Klein et al. 2004) as well as with a high prevalence of plaque accumulation and gingival inflammation (Araujo et al. 2004). In logistic regression models, alcohol consumption has been reported to be significantly correlated to an increased clinical attachment loss (Tezal et al. 2001) and deeper periodontal pockets (Sakki et al. 1995). Other studies did not find any significant correlations between alcohol consumption and periodontal disease (Novacek

et al. 1995, Torrungruang et al. 2005). In a study on elderly Japanese, tooth loss was significantly decreased for current drinkers in females compared with female non-drinkers (Hanioka et al. 2007). In another Japanese study, alcohol consumption was found to be a limited risk factor for tooth loss in the younger age group, but was unrelated to periodontal disease (Okamoto et al. 2006).

A study on the association between lifestyle, including alcohol consumption, and dental health found an association between lifestyle and decayed tooth surfaces (Sakki et al. 1994). Individuals undergoing treatment for alcohol disorders had significant levels of caries lesions (Araujo et al. 2004).

The purpose of the present investigation was to study the association of alcohol consumption with dental health in a sample from the County of Stockholm.

Material and Methods

In a longitudinal odontological investigation in the County of Stockholm, 513 individuals were examined in 1970 and 1990 (Jansson et al. 2002). A requirement to be included in the sample of 1990 was that the subjects had at least five remaining teeth available for alveolar bone loss or root/tooth length assessments on the radiographs. Clinical and radiographic examinations in 1990 were performed as well as an interview. The interviews had questions on dental care habits, frequency of dental visits, education, smoking habits and alcohol consumption. The questions about alcohol consumption included information about the frequency, the volume and the kind of alcoholic beverage. The questions were divided into kinds of beverage (beer, wine and hard liquor), and for every kind of beverage the frequency was expressed as number of days in a week and the average number of centilitres consumed during a day of alcohol consumption. This information was used to estimate the daily individual alcohol consumption in centilitres pure alcohol. The clinical investigation consisted of the registration of the number of remaining teeth, the longitudinal tooth loss between 1970 and 1990, dental restorations, caries and periodontal conditions. In 1990, Ainamo and Bay's Gingival Bleeding Index (Ainamo & Bay 1975) was used. The presence of plaque and calculus was estimated in accordance with Greene and Vermillion's Oral Hygiene Index Simplified, OHI-S (Greene & Vermillion 1964). The radiographic examination in 1990 included measurements of marginal bone level and presence of apical lesions. The marginal bone level and longitudinal bone loss was determined by assessments on the proximal surfaces of all measurable teeth on the radiographs from 1970 and 1990, using the Emago system (1997), which was described by Jansson et al. (2002). Only teeth that were measurable at both examinations were included in the study. The marginal bone level, defined as the distance between the alveolar bone crest and apex, was measured mesially and distally at all (buccal wherever applicable) roots and expressed in per cent of the apex–cementoenamel junction distance. The means of all marginal bone level values in the same individual were calculated. The difference in marginal bone level between 1970 and 1990 was named Longitudinal marginal bone loss. The mean root and tooth lengths were measured mesially and distally on the radiographs from 100 randomly selected teeth of every kind (with the exception of wisdom teeth) in people aged 18–65 years and the quotient root/tooth length was calculated (Lavstedt et al. 1986). This quotient has been used when the cemento-enamel was not visible.

Statistical methods

Descriptive statistics and statistical analyses were performed with a computer statistical package (SPSS PC+4.0, SPSS Inc., Chicago, IL, USA). One-way variance analysis was used to calculate differences between groups after stratification according to alcohol consumption. Pearson's correlation coefficient was calculated in order to examine the correlations between investigated variables and to estimate the intra-examiner agreement of distance measurements. Stepwise multiple regression analyses were adopted to calculate the partial correlations between alcohol consumption and the investigated odontological variables. Those variables which were correlated both to alcohol consumption and the dependent variable were included in the regression analyses as independent variables. Results were considered statistically significant at $p < 0.05$.

Results

Of the subjects who were examined in 1970 and 1990, 93% had answered the questions about alcohol consumption. This resulted in a final sample of 477 subjects. The mean age of the subjects was 54.9 years (SD 12.0) in 1990 and 53% were females.

The intra-examiner correlation of radiographic assessments was calculated based on repeated measurements of 221 teeth in 10 subjects. The correlation of the distance measurements was 0.98.

Means and standard deviations of the investigated dental health variables after stratification according to alcohol consumption are presented in Table 1. About 46% of the individuals reported a mean consumption of 0–1 cl of pure alcohol per day, while 5% consumed more than 5 cl alcohol per day. The distribution of alcohol consumption according to sex is illustrated in Fig. 1. The mean alcohol consumption was significantly larger for males ($p < 0.001$). A majority of the subjects (76%) reported that they had not changed the amount of alcohol consumption during the last 10 years. Significant differences according to number of surfaces with caries, number of teeth with apical lesions and restorations, number of remaining teeth and calculus index were found between groups with different alcohol consumption.

The number of centilitres of pure alcohol consumed per day was positively and significantly correlated to regular dental visits, smoking, calculus index and number of teeth with apical lesions (Table 2). Individuals who reported rheumatoid arthritis consumed significantly less alcohol compared with the other subjects of the sample (Table 2), and significantly more females reported presence of rheumatoid arthritis. The other investigated variables were not significantly correlated to alcohol consumption. If subjects with an alcohol consumption >5 cl of hard liquor per day were excluded from the analyses, none of the investigated dental health variables were significantly correlated to alcohol consumption.

In Table 3, the partial correlations between the dichotomized variable alcohol consumption ($\leqslant 5$ cl alcohol per day, >5 cl per day) and investigated dental health variables, when adjusted for confounding variables, are presented. The alcohol consumption was significantly and positively correlated to

Table 1. Means and standard deviations of the investigated dental health variables after stratification according to alcohol consumption (centilitres pure alcohol per day)

	0.00–1.00	1.01–2.00	2.01–3.00	3.01–4.00	4.01–5.00	>5.00	*p*
Bleeding index	53.0 (33.0)	52.0 (29.3)	50.1 (33.1)	51.0 (28.6)	51.3 (33.6)	71.1 (28.9)	NS
Marginal bone level	71.3 (14.6)	76.0 (10.5)	72.7 (11.3)	75.4 (12.0)	75.2 (8.18)	73.7 (10.9)	NS
Longitudinal marginal bone loss	10.2 (8.20)	8.97 (6.46)	9.03 (4.99)	8.51 (4.44)	11.7 (9.45)	9.36 (8.12)	NS
Number of surfaces with caries	2.67 (2.92)	2.84 (2.90)	1.88 (2.01)	3.00 (3.51)	2.45 (2.11)	4.84 (3.89)	0.01
Number of teeth apical lesions	0.66 (1.2)	0.58 (1.1)	0.46 (0.80)	0.47 (0.93)	0.37 (0.90)	1.01 (1.7)	0.01
Number of teeth with restorations	14.5 (7.74)	17.5 (5.92)	15.5 (6.39)	16.3 (6.48)	16.9 (6.11)	18.5 (5.01)	0.02
Number of remaining teeth	20.5 (9.88)	25.3 (6.64)	23.4 (8.52)	25.1 (8.60)	23.2 (7.91)	25.3 (3.63)	<0.01
Longitudinal tooth loss	2.99 (4.21)	2.39 (2.89)	2.82 (3.95)	2.67 (4.78)	2.80 (3.20)	2.57 (2.71)	NS
Plaque index	0.84 (0.63)	0.81 (0.58)	0.78 (0.53)	0.74 (0.53)	1.1 (0.80)	1.3 (0.57)	NS
Calculus index	0.70 (0.70)	0.82 (0.70)	0.80 (0.72)	0.81 (0.75)	0.78 (0.66)	1.3 (0.57)	0.04
N	221	116	62	30	24	24	

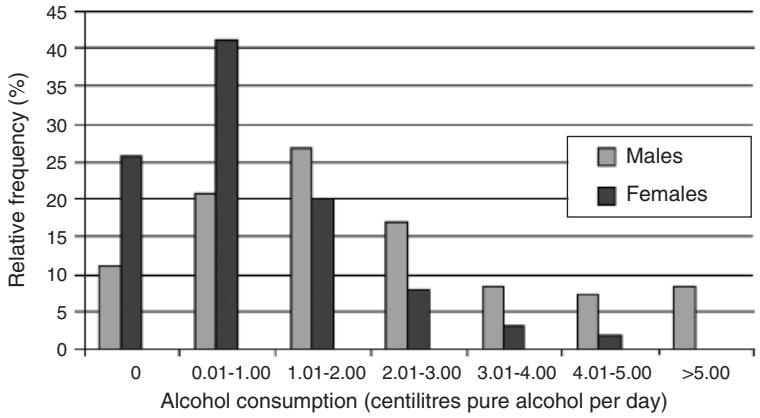

Fig. 1. Distribution of alcohol consumption (centilitres of pure alcohol per day) according to sex.

Table 2. Correlations between alcohol consumption (centilitres pure alcohol per day) and the investigated variables

Variable	*R*	*p*
Age	−0.04	NS
Male	0.32	<0.001
Smoking	0.23	<0.001
Education (number of years at school)	0.07	NS
Regular dental visits (⩾once every 2 years)	−0.10	0.04
Tooth brushing⩾twice per day	−0.05	NS
Proximal daily cleaning of teeth	−0.07	NS
Diabetes	−0.08	NS
Coronary heart disease	−0.03	NS
Rheumatoid arthritis	−0.21	<0.001
Number of remaining teeth	0.09	NS
Bleeding index	0.01	NS
Plaque index	0.03	NS
Calculus index	0.10	0.04
Number of surfaces with caries	0.05	NS
Number of teeth with apical lesions	0.18	<0.001
Number of teeth with restorations	0.05	NS
Marginal bone level	0.02	NS
Longitudinal marginal bone loss	−0.02	NS
Longitudinal tooth loss	−0.02	NS

number of tooth surfaces with caries, calculus index and number of teeth with apical lesions. The other investigated dental variables were not found to be significantly correlated to alcohol intake.

Individuals who consumed >5 cl pure alcohol per day visited dentists or oral hygienists significantly more irregularly than those who consumed ⩽5 cl per day when compensated for confounding variables. No significant interactive effects between alcohol consumption and smoking on the marginal bone loss or tooth loss could be found.

Discussion

The subjects of the present study represent a stratified sample from the population of the County of Stockholm during the period from 1970 to 1990. Two longitudinal dental health variables were used in the analyses studying the relationship between alcohol intake and dental health (longitudinal tooth loss and longitudinal marginal bone loss) while the majority of the dental health variables consisted of cross-sectional data from 1990. Of the subjects who were examined in 1990, 93% had answered the questions about alcohol consumption. Several studies have assessed the validity as well as the reliability of self-reports on alcohol consumption (Fitzgerald & Mulford 1987, Glovannucci et al. 1991, Webb et al. 1991, Lemmens et al. 1992, Theobald et al. 1999). Repeated measures of alcohol consumption showed a high degree of reliability (Glovannucci et al. 1991, Webb et al. 1991, Theobald et al. 1999). However, a problem in studies on alcohol consumption might be that high consumers have a tendency to underreport the consumed quantity (Webb et al. 1991, Theobald et al. 1999). The volume of alcohol consumption was used as the measure of alcohol intake because volume is regarded as a better predictor of chronic health outcomes than measuring patterns of drinking (Rehm 1998).

The alcohol consumption was significantly higher in males than in females in accordance with Swedish epidemiological data (Bergman & Källmén 2002), and significantly more females reported presence of rheumatoid arthritis. These

Table 3. Partial correlations between the dichotomized variable alcohol consumption (⩽5 pure centilitres alcohol per day, >5 cl per day) and investigated dental health variables in a multiple regression model when adjusted for confounding variables

Variable	Partial correlation coefficient	*p*
Bleeding index	0.06	NS
Number of remaining teeth	0.06	NS
Marginal bone level	0.05	NS
Longitudinal marginal bone loss	−0.03	NS
Number of surfaces with caries	0.16	<0.01
Plaque index	0.07	NS
Calculus index	0.11	0.04
Number of surfaces with restorations	0.09	NS
Number of teeth with apical lesions	0.18	<0.01
Longitudinal tooth loss	−0.06	NS

conditions may have resulted in significantly lower alcohol intake in individuals with rheumatoid arthritis.

The volume of alcohol consumption was measured at the follow-up examination while the longitudinal tooth loss and longitudinal marginal bone loss were calculated between baseline and the follow-up examination. Individual drinking often varies by life-stage and the variation may be irregular (Damström Thakker 1998). Thus, individuals may have changed the volume of alcohol intake over time, and the variable alcohol consumption in 1990 is an approximate measure of the total alcohol consumption over 20 years. However, a majority of the individuals reported that their alcohol consumption had been unchanged during the last 10 years. The consumed amounts of alcohol during the first 10 years after baseline are unknown data. In addition, a problem in studies with subjects evaluating their alcohol intake might be under-reported volumes of alcohol consumption. The smoking habits also vary over time, and an earlier study on the same population reported that the percentage of smokers in the sample was reduced from 51% to 31% between 1970 and 1990 (Jansson & Lavstedt 2002).

The radiographic assessments on the intra-oral radiographs were performed by using a projection-related measurement technique, which has been adopted in several earlier studies (Lavstedt et al. 1986, Salonen et al. 1991, Eliasson & Bergström 1997, Hugoson & Laurell 2000, Jansson et al. 2002), showing a high reproducibility of measurements.

Smoking is regarded as a well-established risk factor of periodontal disease (Albandar 2002), and because smoking was significantly correlated to alcohol consumption, it was an important confounder to the relationship between periodontal disease and alcohol use. In order to eliminate confounding effects, multiple logistic regression analysis was used and potential confounding variables were included in the analyses as independent variables if they were correlated to alcohol consumption as well as to the dependent variable. Multiple logistic regression analyses have been adopted in several earlier studies on the relationship between dental health and alcohol consumption (Shizukuishi et al. 1998, Tezal et al. 2001, 2004, Copeland et al. 2004, Torrungruang et al. 2005).

In the bivariate or the multivariate regression models of the present study, the number of remaining teeth or longitudinal tooth loss were not significantly correlated to alcohol consumption. In a longitudinal study on two adult populations (Copeland et al. 2004), alcohol consumption was found to be a significant predictor of tooth loss in men but not in women, using multivariate regression models. Klein et al. (2004) has reported that heavy drinking was significantly correlated to increased tooth loss in a univariable analysis. The present study found that the degree of marginal bone loss was not significantly associated to alcohol consumption in accordance with a cross-sectional study (Tezal et al. 2001).

In a study on individuals with liver cirrhosis (Novacek et al. 1995), measures of oral hygiene and periodontal conditions were worse in alcoholics with or without cirrhosis than in healthy subjects and non-alcoholic patients with cirrhosis. In addition, the alcoholics had significantly fewer remaining teeth than patients without alcohol abuse and healthy controls. The severity and duration of liver disease was not found to have any influence on dental and periodontal conditions. It was concluded that dental and periodontal diseases in alcoholics appear to be caused primarily by bad oral hygiene and poor dental care. The risk for impaired oral and dental health due to excessive alcohol intake was also studied on individuals undergoing treatment for alcohol use (Araujo et al. 2004). They found significant levels of dental caries, gingivitis, tooth erosion and plaque accumulation. A majority of the participants of the study described their dental health as fair or poor.

The influence of lifestyle factors, including alcohol use, on periodontal pocket depth was analysed in 55-year-old individuals in Finland (Sakki et al. 1995). A positive significant correlation was reported between the amount of alcohol intake and the depth of the periodontal pockets.

In a study on workers in Japan (Shizukuishi et al. 1998), no significant association between alcohol and periodontitis was found with linear or logistic multiple regression analyses, while one-way variance analysis showed a significantly stronger relationship between alcohol consumption and periodontal health status for subjects who consumed more than 60 g or more of alcohol per day compared with subjects who consumed less alcohol. A cross-sectional investigation of risk indicators of periodontal disease (Torrungruang et al. 2005) found significantly more severe periodontitis with increasing alcohol consumption in a univariate analysis, while in a multivariate analysis including confounders, no significant association between alcohol intake and the degree of periodontitis was found. Thus, for individuals with excessive consumption of alcohol, a significant association with periodontitis was found when confounders were not included in the model.

In the present study, excessive alcohol consumption was found to have a significant association with the number of caries lesions but not on periodontal conditions. In addition, individuals with the highest alcohol consumption visited dentists or dental hygienists more irregularly than individuals with a lower alcohol consumption which may have resulted in more decayed tooth surfaces, apical lesions and calculus. Risk for caries includes lifestyle-related factors (Selwitz et al. 2007) while the evidence supporting an inherited susceptibility to dental caries is limited (Shuler 2001). In contrast, studies in twins suggest that 38–82% of the population variance

in clinical measures of periodontal diseases may be attributed to genetic factors (Michalowicz et al. 1991). Consequently, caries as well as periodontitis are multifactorial diseases but lifestyle and behaviour appear to have more impact on caries than on periodontitis. This difference between the two common oral diseases according to influence of aetiological factors may have resulted in a significantly stronger association between the lifestyle factor alcohol consumption and caries than between alcohol intake and periodontal conditions.

The reported results from different studies differ significantly according to the relationship between alcohol consumption and dental or periodontal status. These differences may be a consequence of methodological issues and the aetiology of dental and periodontal diseases. The alcohol consumption pattern varies between populations (Damström Thakker 1998), and the approach used to measure alcohol consumption may influence the results. The mode of interview and the alcohol quantity–frequency methods have impact on the reliability and validity of the data. In addition, the multifactorial aetiology emphasizes the importance of using multivariable statistical methods including potential confounders to the relationship.

Classic methods of detection of risk indicators and risk factors have often been based on statistical significance in linear or logistic regression models. These methods may produce inconsistent results hard to interpret in terms of clinical significance. In the present study, the correlation coefficients between alcohol consumption and the dental variables are low and range between 0.10 and 0.18, elucidating that statistically significant associations may be without clinical significance at individual level.

In conclusion, this study does not support an association between alcohol consumption and periodontal disease. However, individuals with high alcohol consumption had significantly more teeth with decayed surfaces and apical lesions indicating that lifestyle-related factors may influence dental health.

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Clinical Relevance

Scientific rationale for the study: Earlier studies have presented conflicting results regarding the role of alcohol consumption as a risk indicator or risk factor of periodontal disease. The present study investigated the influence of alcohol intake on dental health including periodontal conditions.

Principal findings: Our results do not support the hypothesis that alcohol consumption is a risk indicator or risk factor of periodontal disease. However, the subjects with the highest alcohol consumption had more irregular dental visits, more tooth surfaces with caries, more calculus and more teeth with apical lesions.

Practical implications: The results indicate that lifestyle-related factors may influence the oral conditions and that individuals with high alcohol consumption may be regarded as risk patients for an impaired dental health.