## Amount and type of alcohol consumption and missing teeth among community-dwelling older adults: findings from the Copenhagen Oral Health Senior study

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#### Keywords

alcohol drinking; dentition; aged; epidemiology.

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#### Introduction

Alcohol consumption is an integrated part of European culture. To many Europeans, it is an essential component of the diet, and alcohol is served at a majority of social events. In recent years, research has revealed that moderate alcohol consumption of, especially, wine (1) has many health benefits, e.g., a lower risk of cardiovascular disease and all-cause mortality (2). This effect is seen especially

## Abstract

**Objectives:** To study if an association between total weekly intake of alcohol, typespecific weekly alcohol intake, alcoholic beverage preference, and the number of teeth among older people exists.

Methods: A cross-sectional study including a total of 783 community-dwelling men and women aged 65-95 years who were interviewed about alcohol drinking habits and underwent a clinical oral and dental examination. Multiple regression analyses were applied for studying the association between total weekly alcohol consumption, beverage-specific alcohol consumption, beverage preference (defined as the highest intake of one beverage type compared with two other types), and the number of remaining teeth ( $\leq$ 20 versus >20 remaining teeth).

**Results:** The odds ratio (OR) of having a low number of teeth decreased with the total intake of alcohol in women, with ORs for a low number of teeth of 0.40 [95 percent confidence interval (CI) 0.22-0.76] in women drinking 1-14 drinks per week and 0.34 (95 percent CI 0.16-0.74) in women with an intake of more than 14 drinks per week compared with abstainers. Similar relations could also be obtained for type-specific alcohol intake of wine and for wine and spirits preference among women. Men who preferred beer showed a decreased risk for a low number of teeth compared with men with other alcohol preferences.

**Conclusion:** In this study, alcohol consumption, wine drinking, and wine and spirits preference among women were associated with a higher number of teeth compared with abstainers. Among men, those who preferred beer also had a higher number of teeth.

among older persons (3). It is, however, also evident that an excessive intake of alcohol can seriously damage health.

With respect to oral health, alcohol is among the most important risk factors for oral cancer (4). Also, several studies have found strong associations between heavy drinking and poor oral health (5). However, poor oral health of alcohol abusers is most often a result of the abuser lifestyle and neglect of oral dental habits rather than an effect of the alcohol on oral tissue (6). It is also well known that alcohol consumption can cause erosions of teeth due to the acidity of some alcoholic beverages (7). Among alcohol-containing beverages, wine, especially, has a low pH value, which makes erosions among wine drinkers quite common (8). Studies on the relation between alcohol consumption and number of teeth are few and inconclusive. Some studies showed that alcohol consumption is related to having fewer remaining teeth (9-12), while other studies conclude that those who consume alcoholic beverages are less likely to lose teeth than those who do not consume alcohol (12,13). A recent study in two US populations showed that alcohol consumption can be both a risk factor for tooth loss and have a protective effect against tooth loss (14), while another recent study found no correlation between tooth loss and alcohol consumption (15).

The prevalence of older people who drink alcoholic beverages on a regular basis is increasing (16) probably because the present cohorts of older people have had a regular alcohol consumption during the adult life and continue this habit into old age. Despite the increase in alcohol consumption among older adults, the amount consumed is lower than in the population at large. Older people are more vulnerable to the adverse consequences of alcohol than younger people even at lower levels of alcohol because of physiological changes associated with aging. It is possible, therefore, that the effect of the alcohol on oral health is more pronounced in older persons compared with younger individuals. In spite of this, only a few studies concerning the relationship between alcohol and oral health include older people (65+) in general and persons drinking moderate amounts of alcohol in particular.

The aging process increases the risk of oral diseases and tooth loss, and many oral conditions such as caries and periodontitis are therefore often prevalent in older persons. The consequences of oral diseases are significant and may lead to reduced quality of life. Therefore, more knowledge about the relationship between alcohol consumption and oral health may contribute to a deeper understanding of the background of oral health in aged persons. Furthermore, because especially moderate wine consumption is associated with reduced morbidity and mortality from a variety of chronic diseases, one may speculate if the beneficial effect of wine is also positively related to oral health. If so, it is likely to assume that persons who prefer to drink wine also have a better oral health than persons who prefer other types of beverages.

This study examines the associations between alcohol consumption and oral health in a population of communitydwelling older people. More specifically, we analyzed whether number of teeth was associated with total weekly intake of alcohol, type-specific weekly alcohol intake, and beverage preference.

### Methods

The present study was based on persons who had participated in the Copenhagen City Heart Study (CCHS), which is an ongoing, longitudinal, population-based study of the general adult population residing primarily in Østerbro, an area in central Copenhagen, Denmark. CCHS consists of a simple random sample of men and women aged 20 years and older who today have been examined four times starting in 1976-1978 (baseline), 1981-1983 (1. follow-up), 1991-1994 (2. follow-up), and 2001-2003 (3. follow-up), respectively. At each examination, the participants completed a questionnaire concerning medical history, socioeconomic status, and lifestyle habits, and they underwent a thorough physical examination program. A detailed description of the study procedure has been published previously (17). The present oral health study took place from March 2004 to August 2005 at the School of Dentistry, University of Copenhagen. Among the subjects of the third follow-up of the CCHS who wished to continue in the project, and who still lived in Copenhagen or in Zealand, 1,918 men and women aged 65+ years were invited by letter to participate in the present oral health study. This number covered the maximum possible number of participants available from CCHS. Of these, 783 persons (40.8 percent) participated in the study and constitute the Copenhagen Oral Health Senior cohort (COHS). The age range of the participants was 65-95 years.

Participants and nonparticipants were compared with regard to education, income, and lifestyle, using data from the third wave of the parent study, CCHS. It was not possible to compare the two groups healthwise, as the parent study focuses on specific diseases, and there are no obvious variable available, which reflects the participants' health in general. Nonparticipants of both genders had higher proportions of persons who were older and had low educational level, and low income compared with participants. Female nonparticipants also had higher proportions of persons with low alcohol consumption and sedentary lifestyle, and of smokers. The study was conducted in accordance with the Helsinki Declaration and was approved by the Ethical Committees for the Copenhagen and the Frederiksberg municipalities (KF 01-144/01).

#### Interview and clinical oral health examination

A trained and experienced dental assistant interviewed the study participants in a quiet and unhurried environment. The interviewer used a structured questionnaire on lifestyle habits (alcohol consumption, smoking, and physical activity), dental habits, self-rated health, functional ability, and social relations. Prior to the study, a health and medicine questionnaire was sent to the participants by mail and the completed questionnaire was returned when the clinical oral examination was performed. All clinical oral examinations were performed by the same dentist (KH). Number of remaining teeth, including third molars, was registered for each participant and included in the tooth count. Standard dental equipment was used and no radiographs were taken.

Table 1 Variables and Covariates Used for Analyses

Collection of unstimulated whole saliva was performed by the spitting method (18).

#### **Variables and covariates**

As shown in Table 1, the outcome measure in this study was the dental status expressed as the number of remaining teeth

	Categorization
Variables	
Dental status	Total number of teeth, dichotomized as $\geq$ 20 versus <20 remaining teeth.
Total weekly alcohol intake	Participants were asked about their average weekly intake of beer, wine, and spirits. A variable of total weekly alcohol intake was constructed by summing up values for the different types of beverages grouped into three categories: a) abstainers: <1; b) moderate drinkers: 1-14 beverages for women and 1-21 beverages for men; and c) heavy drinkers: >14 beverages per week for women and >21 beverages per week for men. One beverage contains 12 g of alcohol.
Type-specific weekly intake	The wine, beer, and spirits variables were each grouped into three categories: a) 0 drinks per week; b) >0.6 drinks per week; and c) >6 drinks per week
Deverage professor	b) >0-0 utilities per week, and c) >0 utilities per week.
Beverage preference	Those who preference was constructed by comparing weekly alconol intake of wine, beer, and spirits. Those who preferred wine were participants who drank more wine than beer or spirits. Those who preferred beer and spirits were categorized in a similar manner. The participants were categorized as having "mixed preference" if the number of weekly intake of two types of alcohol was equal.
Covariates	
Age	a) Young–old: 65-<72; b) old: $\geq$ 72-<79; and c) oldest-old: $\geq$ 79.
Educational level after secondary school*	a) <1 year; b) 1-3 years; and c) >3 years.
Household income per year*	a) <200,000 DKK; b) 200,000-400,000 DKK; and c) >400,000 DKK.
Marital status	a) Married or living together versus b) living alone.
Smoking habits	a) Current smokers; b) past smokers; or c) never smokers.
Physical leisure time activity	<ul> <li>a) Almost sedentary; b) light physical activity for 2-4 hours a week; c) light physical activity for more than 4 hours a week; and d) highly vigorous physical activity for more than 4 hours a week. The variables were further dichotomized into "sedentary" (a) versus "light to hard activity" (b, c and d).</li> </ul>
Medications	a) 0-2 medications versus b) >2 medications.
Saliva flow rates	Normal (≥0.2 mL/min) versus subnormal (<0.2 mL/min).
Self-rated health	Very good/good versus fair/poor.
Dental visits	The frequency of dental visits categorized as "once a year or more" versus "less than once a year."
Diversity of social relations	Six categories of persons (children, grand/great-grandchildren, relatives, confidants, acquaintances and neighbors) with whom the participant had personal contact at least once a week. High diversity = 2-6 different network categories/week versus little diversity = 0-1 different network category/week.
Social participation	The participants were asked about a) paying visits to others; b) receiving visits at home; and c) participation in social activities outside the home. For each of these three items, one point was assigned for having done so weekly and the participants were dichotomized into groups with low social participation (0-1 point) versus high participation (2-3 points).
Functional ability	The Mobility-Tiredness (Mob-T) scale: The participants were asked whether they felt tired after performing the following activities: transfer, walk indoors, get outdoors, walk outdoors in nice weather, walk outdoors in poor weather, and manage stairs (19). The scale counts the number of activities where the participants reported no tiredness – each activity without tiredness is given 1 point. The variable was dichotomized: 6 points versus <6 points. High-scale score thus describes better function.

Variables marked with \* are data obtained from the research records from the third follow-up of the Copenhagen City Heart Study. In 2004, 200,000 DKK were approximately equivalent to 27,000 euro and 400,000 DKK were approximately equivalent to 54,000 euro. Alcohol intake from beer, wine, and spirits was summed to calculate the total weekly alcohol intake and grouped into three categories based on the Danish sensible drinking limits. Current smokers were defined as those who reported regular smoking of cigarettes, cigars, cheroots, or pipe; "Occasional" smokers were defined as nonsmokers. Levels of activity during leisure time were based on a questionnaire constructed by Saltin and Grimby (19) with minor modifications. Medications were obtained from a questionnaire including 15 medication categories. The variable was defined as the total number of medications taken by each subject per day (both prescription and over-the-counter drugs). DKK, Danish krone.

dichotomized as  $\geq 20$  versus <20 remaining teeth, and the independent variables were alcohol consumption in terms of total weekly alcohol intake, type-specific intake of wine, beer, and spirits as well as beverage preference. Table 1 also describes variables and covariates being tested and shows how the variables and covariates were dichotomized. In brief, covariates included the sociodemographic variables (age, educational level, household income, and marital status), the health-related behaviors (smoking habits and leisure time physical activity), the health factors (medication intake, saliva flow rates, self-rated health, and dental visits), the social relations (diversity of social relations and social participation), and finally, the functional ability rated by the Mobility-Tiredness Scale (Mob-T).

#### **Statistical analyses**

Because men and women showed different drinking patterns, a gender-specific complete case analysis was performed. The cut points between the alcohol categories were chosen, so that the categories were similar to the sensible drinking limits in Denmark, i.e., a maximum of 14 drinks per week for women and 21 drinks per week for men. It is important to emphasize that drinking above sensible drinking limits in the present study does not refer to alcoholism and alcohol dependence, but only to a category defining the amount of alcohol consumed per week. Thus, the term "heavy drinkers" simply refers to an alcohol intake above the sensible drinking limits in Denmark. In addition, all analyses were adjusted for confounders that would account for a lifestyle related to alcoholism and alcohol dependence including income, cohabiting, dental habits, and more. The analyses included chi-squared tests, one-way analysis of variance, and multivariate logistic regression. Furthermore, we tested first-order interaction between smoking and alcohol consumption (alpha = 0.05). Chi-squared tests were used to investigate the univariate associations with nonparticipation (analysis not shown). The 95 percent confidence interval (CI) was chosen. The statistical software package SAS version 9.1 (SAS Institute Inc., Cary, NC, USA) was used.

## Results

#### **Study population**

As a result of the complete-case approach, 26 percent of cases were excluded prior to analyses because of missing observations. Characteristics of the remaining participants according to total number of teeth are presented in Table 2. In general, both male and female participants with a low number of teeth (defined as <20 teeth) were older and had a higher proportion of persons with low socioeconomic status (low education, low income), and unhealthy lifestyle (current smokers and sedentary lifestyle – the latter only significant for women) compared with participants with a high number of teeth (defined as  $\geq$ 20 teeth). Furthermore, the low-tooth group had a higher proportion of participants who visited the dentist less than once per year and who took more than four types of medication. Female participants in the low-tooth group had a higher proportion of participants who had a low weekly alcohol intake and who were abstainers. Male participants in the low-tooth group had a higher proportion of participants who had a low weekly alcohol intake and who were abstainers. Male participants in the low-tooth group had a higher proportion of participants who had a poor/fair self-rated health. The mean number of beverages per week for heavy drinkers was 38 [standard deviation (SD) = 16] for men and 22 (SD = 10) for women.

## Relation between total weekly alcohol consumption and number of teeth

The analysis showed lower odds of having <20 teeth with higher alcohol consumption for women (Table 3). Thus, women who consumed moderate amounts of alcohol had lower odds for having fewer than 20 teeth compared with abstainers [adjusted odds ratio (OR) = 0.40 CI = 0.22-0.76] and women who were heavy drinkers had even lower odds for having few teeth (adjusted OR = 0.34 CI = 0.16-0.74). No relation was found between total weekly alcohol consumption and number of teeth for men.

### Relation between type-specific weekly intake of wine, beer, and spirits and number of teeth

The analysis showed that female wine drinkers who drank more than six glasses of wine per week had a lower odds for having fewer teeth (adjusted OR = 0.44 CI = 0.20-0.96) (Table 4). No relations were found between type-specific weekly intake of wine, beer, and spirits and number of teeth for men; however, men who drank more than six beverages of beers per week had a borderline significant lower odds for having few teeth.

# Relation between beverage preference and number of teeth

Men who preferred to drink beer had a lower odds for having a lower number of teeth compared with abstainers (adjusted OR = 0.26 CI = 0.07-0.93) (Table 5). Women who preferred to drink wine had a lower odds for having few teeth compared with abstainers (adjusted OR = 0.41 CI = 0.22-0.77). The same phenomenon occurred for the female spirits preference group – with an even lower odds for having a lower number of teeth compared with abstainers (adjusted OR = 0.13CI = 0.04-0.43).

Table 2	Characteristics of	Participants	According to	Total Number	of Teeth

		Men		Women			
	<20 teeth	≥20 teeth		<20 teeth	≥20 teeth		
Characteristics	% (n)	% (n)	Р	% (n)	% (n)	Р	
Age (mean $\pm$ SD)	77 ± 7	73 ± 6	<0.01	77 ± 6	75 ± 6	< 0.01	
Weekly alcohol intake							
Abstainers	15 (21)	8 (10)	0.19	43 (70)	19 (47)	< 0.01	
Moderate drinkers	57 (80)	60 (77)		40 (65)	55 (134)		
Heavy drinkers	28 (40)	32 (41)		17 (28)	26 (64)		
Weekly beer intake							
0	23 (37)	16 (26)	0.21	54 (96)	43 (113)	0.06	
>0-6	35 (56)	43 (68)		39 (69)	47 (123)		
>6	41 (65)	41 (64)		7 (13)	11 (28)		
Weekly wine intake							
0	25 (36)	21 (30)	0.15	36 (60)	16 (41)	< 0.01	
>0-6	42 (61)	34 (48)		43 (73)	48 (122)		
>6	34 (49)	45 (63)		21 (35)	36 (92)		
Weekly spirits intake							
0	40 (62)	40 (63)	0.27	61 (107)	57 (152)	0.65	
>0-6	39 (61)	46 (71)		29 (51)	33 (88)		
>6	21 (32)	14 (22)		9 (16)	10 (26)		
Preferred alcohol type	_ · (/	(==/		- ()	( /		
Abstainers	15 (21)	7 (10)	0.07	44 (73)	19 (47)	<0.01	
Beer	34 (49)	35 (48)	0.07	8 (14)	8 (19)	(0.01	
Wine	34 (48)	47 (65)		36 (60)	58 (145)		
Spirits	8 (11)	6 (8)		5 (9)	10 (25)		
Mixed	10 (14)	6 (8)		6 (10)	5 (13)		
	10(11)	0 (0)		0 (10)	5 (15)		
	25 (41)	7 (12)	<0.01	37 (67)	18 (51)	<0.01	
Medium	56 (91)	58 (92)	<0.01	51 (93)	55 (153)	<0.01	
High	10 (20)	25 (55)		12 (22)	27 (74)		
Incomo	15 (50)	55(55)		15 (25)	27 (74)		
Low	56 (01)	20 (62)	<0.01	75 (125)	50 (125)	<0.01	
Modium	22 (52)	20 (62)	20.01	21 (20)	27 (09)	<0.01	
High	33 (33) 11 (19)	29 (02) 22 (26)		21 (50)	37 (90) 13 (3E)		
	11(10)	22 (30)		5 (0)	15 (55)		
Voc	12 (66)	2E (EE)	0.10	77 (141)	CC (170)	0.01	
No	42 (00)	55 (55) 65 (102)	0.19	77 (141)	24 (02)	0.01	
NU Creating babits	56 (90)	05 (102)		25 (41)	54 (95)		
Non smoker	7 (11)	19 (20)	<0.01	21 (E7)	AE (122)	-0.01	
NUTI STIOKEI	7 (11)	10 (29)	<0.01	20 (57) 20 (E1)	45 (125)	<0.01	
Current smoker	37 (60)	20 (31)		28 (ST) 41 (75)	10 (42)		
EX-SITIOKEI	50 (90)	62 (99)		41 (75)	39 (106)		
Realth Denavior	20 (46)	26 (40)	0.50	27 (65)	25 (67)	0.01	
Sedentary	29 (40)	20 (40)	0.50	37 (00)	ZD (07)	0.01	
Active Calica flacts	/ 1 ( 1 1 1 )	74 (112)		03 (111)	75 (199)		
Saliva nov	20 (40)	24 (FF)	0.40	(2) (112)		0.10	
Subnormal	30 (48)	34 (SS) 66 (10F)	0.40	02 (112)	22 (122) 45 (122)	0.18	
Normal Madiaina intelue	70(112)	(105)		38(70)	45 (123)		
	70 (114)	01 (120)	0.00	(7/122)	76 (212)	0.02	
0-4 types	70(114)	81 (130)	0.02	07 (123)	70 (ZTZ) 24 (CC)	0.03	
>4 types	30 (48)	19 (30)		33 (00)	24 (00)		
Dental visits habit	24 (FF)	11 (10)	.0.01	20 (52)	4 (11)	.0.01	
<1 per year	34 (55)	11(18)	<0.01	29 (53)	4(11)	<0.01	
≥ i per year	66(107)	89 (142)		71 (130)	96 (267)		
Self-rated nealth	26 (42)	15 (25)	0.05	21 (57)	25 (70)	0.25	
Poor/fair	26 (42)	15 (25)	0.05	31 (57)	25 (70)	0.25	
Good	52 (84)	56 (89)		53 (96)	55 (152)		
very good	22 (35)	29 (46)		15 (28)	20 (55)		
Social participation	57 (00)	50 (05)	0.54	24 (62)			
Low	57 (92)	53 (85)	0.51	34 (62)	42 (117)	0.08	
High	43 (70)	47 (75)		66 (121)	58 (161)		
Diversity in social relations	co ()	50 (57)			FD (( ) ->		
Low	62 (100)	58 (92)	0.44	54 (98)	52 (145)	0.77	
High	38 (62)	42 (68)		46 (85)	48 (133)		
Mobility, tired							
Score <6	24 (33)	17 (25)	0.14	30 (46)	21 (52)	0.04	
Score = 6 (max)	76 (106)	83 (124)		70 (107)	79 (197)		

Univariate associations were investigated by chi-squared test for categorical variables, and nonparametric one-way ANOVA for mean values for noncategorical variables. For definition of the groups please see Table 1.

SD, standard deviation; ANOVA, analysis of variance.

		Men				Women			
	Crude		А	Adjusted†		Crude		Adjusted†	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Total weekly alcohol consumption		( <i>n</i> = 230)				( <i>n</i> = 330)			
Abstainers	1	-	1	-	1	-	1	_	
Moderate drinking	0.53	(0.22-1.28)	0.39	(0.11-1.34)	0.36*	(0.21-0.61)	0.40*	(0.22-0.76)	
Heavy drinking	0.49	(0.19-1.25)	0.37	(0.10-1.35)	0.30*	(0.16-0.58)	0.34*	(0.16-0.74)	

Table 3 Odds Ratios (95% CI) for Having Less Than 20 Teeth by Total Weekly Alcohol Consumption

\* Significant within 95% CI.

+ Adjusted for: Age, educational level, income, marital status, smoking, leisure time physical activity, saliva flow rate, dental visits, self-rated health, social participation, diversity of social relations, Mob-T, and medications. For definition of the groups please see Table 1. OR, odds ratio; CI, confidence interval.

#### **Regarding all analyses**

No significant interactions were found between smoking and alcohol consumption on the multiplicative scale, neither in the analysis considering total weekly alcohol consumption, type-specific alcohol consumption, or beverage preference.

## Discussion

The present study investigated whether various aspects of alcohol consumption were related to oral health, assessed by the number of teeth, among a group of Danish communitydwelling older persons. The first important finding was that women who consumed alcohol were more likely to have more teeth compared with abstainers, and that women with the highest total weekly alcohol intake were those with the lowest odds for having a low number of teeth. This finding is in accordance with a recent Japanese study (20), which concluded that tooth loss was significantly less for current elderly female drinkers compared with female nondrinkers. The finding that alcohol consumption is associated with a higher number of teeth compared with abstainers has also been suggested by two other Japanese studies (12,13), although these studies were conducted among younger males. In the present study, the same tendency was seen for men, but the findings were not statistically significant. Whether women are more susceptible to the benefits of alcohol or if they generally are more likely to drink lower amounts is still unknown.

Table 4 Odds Ratios (95% CI) for Having Less Than 20 Teeth by Type-Specific Weekly Intake of Wine, Beer, and Spirits

	Men					Wo	men		
		Crude	ļ	Adjusted		Crude		Adjusted	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Drinks per week									
Beer +=	(n = 243)	)			(n = 336)				
0	1	_	1	_	1	-	1	-	
>0-6	0.53	(0.26-1.07)	0.46	(0.17-1.22)	0.64	(0.41-1.02)	0.91	(0.49-1.67)	
>6	0.79	(0.39-1.58)	0.37	(0.14-1.00)	0.56	(0.24-1.31)	0.68	(0.24-1.91)	
Wine †¶	(n = 243)	)			(n = 336)				
0	1	_	1	_	1	-	1	-	
>0-6	1.17	(0.59-2.31)	1.40	(0.53-3.69)	0.51*	(0.30-0.89)	0.74	(0.36-1.50)	
>6	0.70	(0.35-1.36)	1.25	(0.47-3.36)	0.28*	(0.15-0.52)	0.44*	(0.20-0.96)	
Spirits †§	(n = 243)	)			( <i>n</i> = 336)				
0	1	-	1	-	1	-	1	-	
>0-6	1.09	(0.63-1.90)	1.10	(0.52-2.32)	0.84	(0.52-1.36)	0.92	(0.49-1.73)	
>6	1.80	(0.85-3.80)	0.99	(0.35-2.78)	0.94	(0.43-2.04)	0.89	(0.34-2.35)	

\* Significant within 95% CI.

+ Adjusted for: age, educational level, income, marital status, smoking, leisure time physical activity, saliva flow rate, dental visits, self-rated health, social participation, diversity of social relations, Mob-T, and medications.

**‡** Beer also adjusted for wine and spirits.

¶ Wine also adjusted for beer and spirits.

§ Spirits also adjusted for beer and wine.

OR, odds ratio; CI, confidence interval.

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		Μ	en		Women			
	Crude		Adjusted		Crude		Adjusted	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Beverage preference†		(n =	243)		( <i>n</i> = 336)			
Abstainers	1	_	1	_	1	_	1	-
Beer preference	0.51	(0.20-1.29)	0.26*	(0.07-0.93)	0.49	(0.20-1.17)	0.47	(0.17-1.28)
Wine preference	0.36*	(0.14-0.89)	0.37	(0.11-1.26)	0.30*	(0.18-0.50)	0.41*	(0.22-0.77)
Spirits preference	0.88	(0.25-3.09)	0.36	(0.07-1.90)	0.23*	(0.09-0.60)	0.13*	(0.04-0.43)
Mixed preference	0.84	(0.25-2.83)	0.26	(0.05-1.34)	0.48	(0.18-1.31)	0.53	(0.15-1.86)

Table 5 Odds Ratios (95% CI) for Having Less Than 20 Teeth by Beverage Preference

\* Significant within 95% CI.

+ Adjusted for: age, educational level, income, marital status, smoking, leisure time physical activity, saliva flow rate, dental visits, self-rated health, social participation, diversity of social relations, Mob-T, and medications.

OR, odds ratio; CI, confidence interval; Mob-T, Mobility-Tiredness Scale.

The second important finding of the present study was that women who drank more than six glasses of wine per week had a lower OR for having a low number of teeth compared with abstainers. In the literature, there is a strong interest in beverage-specific health effects, indicating that the beneficial effect of alcohol consumption is seen especially among wine drinkers (1). Studies also suggest that wine drinking is associated with higher socioeconomic status (21) and healthy dietary habits (22). In the present study, a higher proportion of women preferred wine to other kinds of alcoholic beverages compared with men. Therefore, the present findings could be a result of socioeconomic status and a healthier lifestyle rather than an effect of the alcohol itself. We have tried to take this into account in the multivariate logistic analysis by adding relevant covariates. The result of the adjusted analysis still showed a relation between wine drinking and number of teeth. Another explanation of the beneficial effects of alcohol drinking may be that because beer, wine,, and spirits have different effects on health, it could be that compounds in the different types of beverages (other than ethanol) may play a role, and maybe women are more responsive to the nonalcoholic components of the beverages than to the ethanol itself.

A study from 2007 demonstrated that wine *in vitro* acts as an antimicrobial agent against oral streptococci and *Streptococcus pyogenes*, and therefore, it might be active in caries prevention (23). It has also been suggested that there is a correlation between the consumption of wine and oral health in terms of reduced microbial plaque deposition and lower counts of the cariogenic oral bacteria such as *Streptococcus mutans* and lactobacilli (24). The study argues that some food items, including wine, may prevent adhesion of oral bacteria to hard surfaces tissue and that components belonging to the polyphenol family are responsible for such activity *in vitro*.

The third important finding was that women who preferred to drink wine had lower odds for having a low number

of teeth compared with women who preferred beer or women who had mixed preferences. Studies have shown that subjects who prefer wine have healthier dietary habits than those who prefer beer or spirits or have mixed preference (25), although one study did not find this association in older persons (26). In the present study, it was not possible to adjust for dietary habits because such data were not available. It can not be excluded that dietary habits may confound the relation between those who prefer wine and number of teeth. Regarding spirits, an interesting finding was that women who preferred spirits compared with other types of beverages also had a lower OR for having a low number of teeth. Furthermore, men who preferred beer likewise had a lower OR for having a low number of teeth. Several limitations to this study should be taken into consideration. Almost 60 percent of the invited persons did not participate in the study. Nonrespondence is often related to lower socioeconomic status and ill health (27). Because of this, they tend to be different from the target population, and this can create a deviation between the association found in a study and the "real" association in the target population. In the present study, nonparticipation was related to lower alcohol consumption and to lower socioeconomic position. We do not have information about the nonparticipant's dental status, but other studies have shown that people who choose not to participate also tend to have a poorer oral health than participants (28). The possibility of selection bias therefore cannot be excluded. It is interesting that even though the effects seemed comparable in some analyses, the ORs for men were not significant, while those for women were significant. However, for most analyses, the difference in significance of the OR results between men and women was due to the lower number of male participants who only made up 42 percent of the population.

Another limitation is that the CCHS was not designed for the present purpose. This means that we do not have any data regarding oral health from the earlier waves. Consequently, we are not able to infer causality of alcohol on the dentition and adjust for past oral health and dental behaviors. Neither was it possible to register the time and reason for tooth loss and for previous dental habits and use of dental services. The participants did not remember such information and the answers may therefore not be valid. Nevertheless, tooth loss is an essential indicator of oral health in the adult population (29) because tooth loss is the common final outcome of most dental diseases. Furthermore, tooth loss can substantially affect chewing ability, health-related quality of life, and nutrition (29). In this context, the presence of at least 20 natural teeth is an often used definition of a functional dentition (30). Hence, number of teeth was chosen as the variable describing the oral health of the participants. Oral hygiene habits were assessed in the interview. Because the majority of subjects (i.e., 98 percent of the population) fell within the same group of toothbrushing twice a day, this variable had no explanatory power on tooth loss, and therefore, oral hygiene habits were not included in the analyses.

Analyses of the total weekly alcohol consumption at different points of time (registered at the baseline and the three follow-up waves of CCHS) and subsequent number of teeth were performed. This was done because alcohol consumption normally is a lifestyle habit initiated in young adulthood, and this habit continues throughout life. A person reporting the level of alcohol consumption only from one single wave is therefore only telling a small part of the history of lifetime alcohol consumption. The results of the crude analyses were that alcohol consumption registered at the three different points in time and subsequent number of teeth showed a similar association as the results of the present study; however, these associations disappeared in the adjusted analyses (data not shown). These results suggest that there is no relation between distant alcohol consumption and subsequent number of teeth, but care should be taken when interpreting these results. Even though tooth loss is highly time dependent and often is a result of the cumulated adverse effects from a whole lifetime, we do not know the exact time for the tooth loss. Hence, we cannot conclude - or exclude that a high number of remaining teeth is caused by alcohol consumption.

Despite these limitations, the main strength of this study is its relatively large sample size and the richness of data collected from the parent Copenhagen City Heart Study and the COHS cohort. This gives us the ability to control for numerous covariates, which is ideal when studying tooth loss, because tooth loss mainly is caused by substantial dental problems, which also reflect health behavior and socioeconomics in a broader sense.

Furthermore, older persons represent a group with a considerable risk of oral diseases. Despite this, information on the risk factors for oral diseases of the older segments of the Danish population is limited. The present study contributes to the knowledge and understanding of the relation between alcohol consumption and oral health and may therefore be useful in the planning of preventive dental services.

In summary, the results of this study indicate that alcohol drinking is associated with a higher number of teeth in the female older population compared with abstinence. However, with a nonparticipation rate of almost 60 percent, which was associated with high age, low education, and low income for both men and women, the COHS cohort is a selected group of older persons, and the findings cannot be generalized to other populations. Nevertheless, the finding that both total and specific alcohol consumption is related to the number of teeth should be invested further. Therefore, there is a need for more research into the association between alcohol consumption and tooth loss among older people. The findings of this study need to be confirmed in a correct prospective setting in order to clarify the causal direction of the association.

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