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Cigarette Smoking, Tooth Loss, and Chronic Obstructive Pulmonary Disease: Findings From the Behavioral Risk Factor Surveillance System

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Abstract

Background—Cigarette smoking and tooth loss are seldom considered concurrently as determinants of chronic obstructive pulmonary disease (COPD). This study examines the multiplicative effect of self-reported tooth loss and cigarette smoking on COPD among United States adults aged ≥18 years.

Methods—Data were taken from the 2012 Behavioral Risk Factor Surveillance System (n = 439,637). Log-linear regression–estimated prevalence ratios (PRs) are reported for the interaction of combinations of tooth loss (0, 1 to 5, 6 to 31, or all) and cigarettes smoking status (never, former, or current) with COPD after adjusting for age, sex, race/ethnicity, marital status, educational attainment, employment, health insurance coverage, dental care utilization, and diabetes.

Results—Overall, 45.7% respondents reported having ≥1 teeth removed from tooth decay or gum disease, 18.9% reported being current cigarette smokers, and 6.3% reported having COPD. Smoking and tooth loss from tooth decay or gum disease were associated with an increased likelihood of COPD. Compared with never smokers with no teeth removed, all combinations of smoking status categories and tooth loss had a higher likelihood of COPD, with adjusted PRs ranging from 1.5 (never smoker with 1 to 5 teeth removed) to 6.5 (current smoker with all teeth removed) (all $P < 0.05$).

Conclusions—Tooth loss status significantly modifies the association between cigarette smoking and COPD. An increased understanding of causal mechanisms linking cigarette smoking, oral health, and COPD, particularly the role of tooth loss, infection, and subsequent inflammation, is essential to reduce the burden of COPD. Health providers should counsel their patients about cigarette smoking, preventive dental care, and COPD risk.

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Keywords

Epidemiology; inflammation; oral health; pulmonary disease; chronic obstructive; tobacco; tooth loss

In the United States, chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality.[1,2] National medical costs attributable to COPD are projected to increase from $32.1 billion in 2010 to $49.0 billion in 2020.[3] Although cigarette smoking contributes to nearly 80% of COPD cases, a sizeable proportion of never smokers have COPD.[4,5] Identifying risk factors for COPD other than cigarette smoking and developing evidence-based interventions may lead to decreased COPD-attributable costs.

Cigarette smoking has been causally linked with COPD.[6] Accumulating evidence suggests that oral health is involved in the etiology of certain systemic conditions, including COPD.[7–11] Previous epidemiologic studies involving oral health and COPD have examined oral factors such as alveolar bone loss, oral debris and calculus, plaque, and periodontal disease.[8,12–19] Fewer studies, however, have examined the interaction between cigarette smoking and oral health on COPD.[12,15,19,20]

Therefore, this study examines the associations of cigarette smoking and tooth loss on COPD using population-based survey data from the 2012 Behavioral Risk Factor Surveillance System (BRFSS). Consistent with evidence on the well-established association between cigarette smoking and COPD,[6] it was hypothesized that tooth loss caused by infection would significantly modify the association between cigarette smoking and the likelihood of having COPD.

MATERIALS AND METHODS

Data Source and Study Population

BRFSS is an annual state-based, random-digit-dialed telephone survey of non-institutionalized United States adults aged ≥18 years, administered annually by state health departments.[21] The 2012 BRFSS data used in this analysis reflect recent changes in weighting methodology (ranking) and include both landline and cell phone respondents from the 50 states and the District of Columbia.[21] BRFSS completes nearly 500,000 adult interviews annually and includes questions on sociodemographic characteristics, chronic diseases, health behaviors, and access to health care. BRFSS estimates have been found to be reliable and valid.[22] It was determined that human subjects review was not needed for this study because the BRFSS data are publicly available. For BRFSS, age at time of interview is recorded as 18 to 98 years with 99 indicating anyone older than 98 years. Of 439,637 respondents, mean age of 177,701 men and 261,936 women were 45.8 years and 47.4 years, respectively.

Study Variables

Current cigarette smokers were respondents who reported smoking ≥100 cigarettes during their life-time and reported smoking “every day” or “some days” at the time of the interview.

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Former smokers were respondents who reported ever smoking ≥100 cigarettes but reported smoking “not at all” at the time of the interview. Never smokers were respondents who reported smoking <100 cigarettes during their lifetimes.

Tooth loss was assessed by the question, “How many of your permanent teeth have been removed because of tooth decay or gum disease? Include teeth lost to infection, but do not include teeth lost for other reasons such as injury or orthodontics.” If wisdom teeth were removed because of tooth decay or gum disease, they were included in the count for lost teeth. Responses to the question were: none; 1 to 5; ≥6 but not all; or all.

COPD was identified among respondents who answered yes to the question “Has a doctor, nurse, or other health professional ever told you that you had COPD, chronic obstructive pulmonary disease, emphysema, or chronic bronchitis?”

Characteristics that were assessed included the following: age group (18 to 24, 25 to 44, 45 to 64, 65 to 74, or ≥75 years); sex; race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic Asian, non-Hispanic Native Hawaiian or other Pacific Islander, non-Hispanic American Indian or Alaskan Native, non-Hispanic other race only, non-Hispanic multiracial, or Hispanic); marital status (married, previously married, or never married); educational attainment (did not graduate high school, graduated high school or completed the general educational development certificate, some college or technical school, or graduated college or technical school); employment (employed, unemployed, homemaker/student, retired, or unable to work); health insurance coverage (yes or no); dental care utilization (within the past year, within the past 2 years, within the past 5 years, ≥5 years ago, or don’t know); and diabetes, not including gestational diabetes (yes or no).

Statistical Methods

To account for the complex sampling design of BRFSS, all analyses were conducted using software.‡ All estimates were weighted to represent the sampled population. Results were considered significant at $P<0.05$, with no adjustment for multiple testing. Selected characteristics and differences in these characteristics by tooth loss and cigarette smoking were examined using χ^2 tests. The age-standardized prevalence of COPD using the projected year 2000 United States population for all possible combinations of tooth loss and smoking status categories was also estimated.[23] The adjusted weighted prevalence ratios (PRs) and corresponding 95% confidence intervals (CIs) for the likelihoods of having COPD associated with tooth loss and smoking status were calculated using log-linear regression models. Log-linear regression models can be used to estimate prevalence ratios for binary outcomes with cross-sectional data.[24] Multivariable log-linear regression models included the following relevant covariates available in BRFSS that were risk factors for the outcome and also related to the exposures of interest: age group, sex, race/ethnicity, marital status, educational attainment, employment, health insurance coverage, dental care utilization, and diabetes (excluding gestational diabetes).

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RESULTS

The distributions of selected characteristics are presented by tooth loss from tooth decay or gum disease and by smoking status (Table 1). As expected, the proportion of respondents aged 18 to 24 years declined and the proportions of older adults increased with the number of teeth lost. More than one-half of never smokers (53.2%) and current smokers (55.1%) were aged 18 to 24 years in contrast to 29.0% of former smokers. The proportion of employed adults declined, whereas the proportion of retired adults increased with the number of teeth lost. A higher proportion of never smokers (58.8%) were employed in contrast to 55.6% of current smokers and 50.8% of former smokers. Health insurance coverage was most common among those with all teeth lost (88.2%) and was less common among current smokers (70.7%). Dental care utilization within the past year was most common among those without any teeth removed (69.7%) and among never smokers (70.1%). The proportion of those with COPD increased with number of teeth lost and was highest among current smokers (13.0%) compared with former smokers (9.2%) and never smokers (2.8%). The proportion of never smokers declined and the proportion of current smokers increased with increasing number of teeth lost.

The mean age of those reporting to have COPD was 56.6 years. Among never smokers, the age-adjusted prevalence of COPD was lowest among those without any teeth removed (2.0%) and highest among people with all teeth removed (9.6%) (Fig. 1). Among former smokers, the age-adjusted prevalence of COPD was lowest among those without any teeth removed (4.3%) and highest among people with all teeth removed (19.7%). Likewise, the age-adjusted prevalence of COPD was lowest among those without any teeth removed (9.2%) and highest among people with all teeth removed (26.8%) among current smokers. The age-adjusted prevalence of COPD was also consistently higher among women than men in all categories (data not shown); for example, among current smokers with all teeth removed, the prevalence of COPD was higher among women (34.1%) than men (19.0%).

Adjusted PRs for the likelihood of having COPD associated with smoking status and tooth loss after taking into account first age and then age plus other important covariates are presented in Table 2. Former smokers (multivariable adjusted PR 2.1; 95% CI 2.0 to 2.3) and current smokers (multivariable adjusted PR 3.2; 95% CI 3.0 to 3.4) had a significantly higher likelihood of having COPD compared with never smokers. Additionally, adults with one to five teeth removed (multivariable adjusted PR 1.4; 95% CI 1.3 to 1.4), those with six to 31 teeth removed (multivariable adjusted PR 2.0; 95% CI 1.8 to 2.1), and those with all teeth removed (multivariable adjusted PR 2.1; 95% CI 1.9 to 2.3) had a significantly higher likelihood of having COPD compared with people without any teeth removed.

Table 3 shows adjusted PRs for the likelihood of having COPD associated with various combinations of smoking status and tooth loss in comparison with adults who never smoked and had no tooth loss, after taking into account first age and then age plus other important covariates. A statistical multiplicative interaction was found at $P < 0.05$ between cigarette smoking status and tooth loss on the relationship of either variable to COPD; thus, a variable was created with all possible combinations of tooth loss and smoking status categories as a predictor. Additionally, statistical multiplicative sex interactions at $P < 0.05$ for relationships

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of either cigarette smoking or tooth loss with COPD were found. Therefore, a variable of all combinations of tooth loss and smoking was created. Adding other covariates to the log-linear model attenuated the association such that age was not the major confounding factor in the associations. In comparison with never smokers without any teeth removed, current smokers with all teeth removed (multivariable adjusted PR 6.5; 95% CI 5.8 to 7.2) had the highest likelihood of having COPD. The magnitudes of these associations were similar for women and men.

DISCUSSION

This epidemiologic study provides evidence on the association among smoking status, oral health, and COPD and provides new evidence on the modifying effect of tooth loss from tooth decay or gum disease. Current smokers with all teeth removed were almost seven times more likely to report COPD than never smokers without tooth loss. Remarkably, never smokers with one to five teeth removed were significantly more likely to have COPD than never smokers without any tooth loss. These findings suggest that the associations between cigarette smoking and COPD become stronger with increasing tooth loss. Hence, to promote overall health, greater attention may be needed to promote factors that enhance good oral health, including good oral hygiene, barrier-free access to preventive and therapeutic dental care, and enhanced education at a population level about the importance of proper oral health in maintaining pulmonary or systemic health.[25–27]

The relationships among tooth loss, cigarette smoking, and COPD are very complex. Although dental caries and periodontitis are the main causes of tooth loss, it should be acknowledged that tooth retention and replacement, in addition to smoking status, are influenced by socioeconomic status and access to care, as well as the value individuals place on oral health.[28–33] Therefore, independence from these factors cannot be completely ruled out. Attention to oral health is particularly important among tobacco users, considering that common risk factors exist for tooth loss and tobacco use (e.g., low socioeconomic status). In addition, tobacco is used orally, and several oral conditions, including dental caries and periodontal disease, have been linked with use of tobacco products.[34–37] Dentists, dental hygienists, and other allied oral health professionals should be observant for oral signs of tobacco use and should counsel their patients to quit smoking.[38,39] Guidelines for tobacco dependence treatment recommend that all health care professionals (including dentists, physicians, nurses, pharmacists, and other allied professionals) use an evidence-based strategy known as the five A’s to help patients quit.[39] This involves: 1) asking all patients if they use tobacco, 2) advising tobacco users to quit, 3) assessing interest in quitting, 4) assisting those interested in quitting with smoking cessation aids, and 5) arranging for follow-up to assess relapse. Other evidence-based interventions to reduce tobacco consumption at the population level have been previously outlined and include warning about the dangers of tobacco use, increasing tobacco prices, implementing and enforcing smoke-free laws in public places, and enforcing prohibitions on tobacco advertising, promotion, and sponsorship.[40]

Cigarette smoking has been well established to be the most important risk factor for COPD.[6,41] However, the finding that tooth loss modifies the relationship between cigarette

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smoking and COPD is novel and could be explained by several mechanisms. First, considering that the tooth loss assessed in this study was specifically defined as relating to infection of dental hard or soft tissues (i.e., dental caries or periodontal disease) rather than injury, it is possible that the extent of tooth loss might reflect the history or underlying degree of dental disease. Specifically, chronic periodontal disease is a leading cause of important local and systemic inflammatory effects, including levels of C-reactive protein and interleukin (IL)-1 and IL-6.[42–45] In the presence of widespread periodontal disease with systemic involvement, such inflammatory markersmay exert a synergistic effect with toxins from cigarette smoke to exacerbate inflammatory changes within tissues and organs.

Dentition plays a critical role in mastication and bolus formation, and the occlusion provided by posterior teeth or dentures provides jaw stabilization and helps in swallowing.[46] It has been suggested that tooth loss may impair chewing, bolus formation, and swallowing, thus increasing bolus time in the oral cavity, valleculae, and hypopharynx, increasing the risk of aspiration, including oral pathogens, which could exacerbate existing respiratory conditions. In this study, however, these associations could not be explored because of the inherent limitations of the cross-sectional design and lack of information on tooth replacement with dental implants and removable or complete dentures, which may explain why there were small differences between the estimates for people with six to 31 teeth removed and those with all teeth removed. Clinical swallowing studies are needed to better explore the relationship among oral health conditions, cigarette smoking, and COPD, especially since studies have detected oral bacteria in the sputum of patients with COPD.[47]

Additionally, considering the strong role of smoking duration in the initiation and progression of several chronic disease conditions, it cannot be definitively ruled out that cigarette smoking is a common exposure for both COPD and tooth loss from tooth decay or gum disease. If this were the case, the dose–response interaction noted between smoking status and extent of tooth loss in the development of COPD could be because long-time smokers may be more likely to have more extensive tooth loss and also to develop COPD. Indeed, the present results showed that former and current smokers had a significantly higher prevalence of both complete tooth loss and COPD compared with never smokers. However, even among never smokers, people with greater tooth loss were more likely to develop COPD than those with no tooth loss—indicating that tooth loss caused by infection might be etiologically implicated in COPD. The detection of effect modification supports causal inference by clarifying the degree of tooth loss that contributes most and least to the effect of cigarette smoking on COPD.[48] Interactions are also important for identifying high-risk groups and developing interventions. More research is needed to elucidate the etiopathologic underpinnings of tooth loss in COPD development.

The findings are subject to at least five limitations. First, the cross-sectional study design does not permit determination of a temporal sequence of cigarette smoking, tooth loss, and COPD; thus, cause-and-effect relationships cannot be established. Second, data were not available on the positions of missing teeth, a factor that could influence jaw stabilization, food manipulation, bolus formation, and overall swallowing function. Similarly, no assessments were made as to whether individuals wore dentures at the time of the study to compensate for tooth loss. Third, the information on cigarette smoking, tooth loss, COPD,

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and other variables was collected through self-report and was not validated by biomarkers or medical records and might be subject to misreporting. For example, although the BRFSS question specified tooth loss from infectious causes (i.e., dental caries or periodontal disease), it is possible that respondents might have reported tooth loss from other etiologies (e.g., congenital, trauma, or orthodontic reasons). Fourth, there may be residual confounding, especially residual confounding by socioeconomic status and access to care. However, this is unlikely to substantively alter the results for this study because a range of these factors (i.e., educational attainment, employment, health insurance coverage, and dental care utilization) were included in the adjusted models.[49,50] Finally, the 2012 BRFSS lacked questions on other forms of combustible tobacco use, marijuana use, and secondhand smoke exposure, and this study examined only cigarette smoking. In addition, among cigarette smokers, no data were collected on the duration or intensity of smoking; hence, this study was unable to adjust for pack-years of smoking, a potential confounder in the relationship between tooth loss and COPD.

CONCLUSIONS

In summary, current smokers with all teeth removed were almost seven timesmore likely to report COPD than never smokers without any tooth loss after adjustment for sociodemographic characteristics. Furthermore, never smokers with one to five teeth removed also were significantly more likely to have COPD than never smokers without any teeth removed. Enhanced efforts to incorporate population-based tobacco prevention and control and oral health–promotion strategies to prevent COPD are needed.

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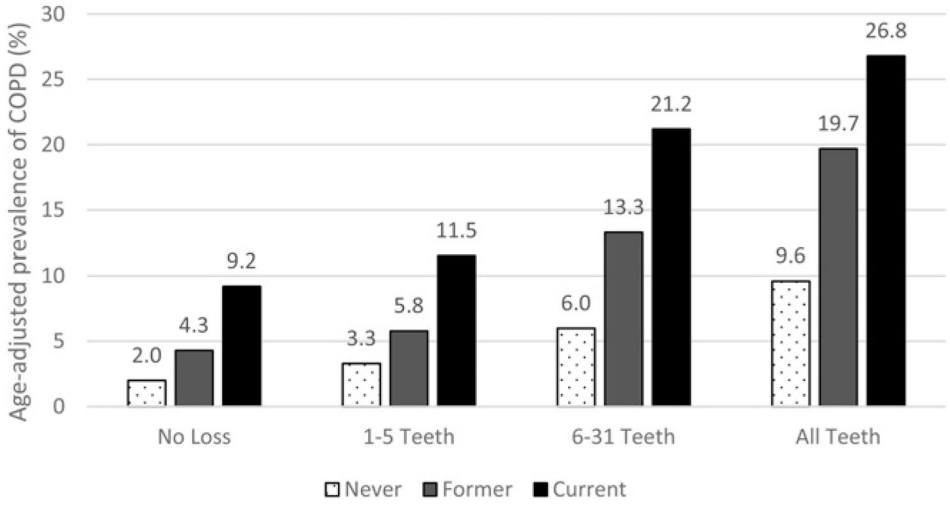

Figure 1.

Age-adjusted percentages of COPD among adults aged ≥18 years, by tooth loss and cigarette smoking status: BRFSS, 2012.

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Table 1

Distribution of Selected Characteristics (% [95% CI]) Among 439,637 Adults Aged ≥ 18 Years, by Tooth Loss and Cigarette Smoking Status: BRFSS, 2012

		Teeth Lost				Cigarette Smoking*		
Characteristic	**n**	**None**	**1 to 5**	**6 to 31**	**All**	**Never**	**Former**	**Current**
n	439,637	207,213	137,833	60,400	34,191	239,920	127,507	72,210
Sex†‡								
Men	177,701	48.9 (48.4 to 49.3)	48.6 (48.1 to 49.2)	46.8 (46.0 to 47.7)	46.0 (44.9 to 47.1)	43.1 (42.6 to 43.5)	55.9 (55.3 to 56.4)	54.7 (54.0 to 55.4)
Women	261,936	51.1 (50.7 to 51.6)	51.4 (50.8 to 51.9)	53.2 (52.3 to 54.0)	54.0 (52.9 to 55.1)	56.9 (56.5 to 57.4)	44.1 (43.6 to 44.7)	45.3 (44.6 to 46.0)
Age group, years†‡								
18 to 24	125,812	63.4 (63.0 to 63.8)	37.5 (36.9 to 38.1)	14.5 (13.8 to 15.2)	6.5 (5.9 to 7.2)	53.1 (52.7 to 53.6)	29.0 (28.4 to 29.6)	55.1 (54.4 to 55.8)
25 to 44	79,175	17.1 (16.8 to 17.4)	21.8 (21.4 to 22.3)	19.8 (19.1 to 20.6)	13.1 (12.3 to 13.9)	17.9 (17.6 to 18.2)	18.1 (17.7 to 18.6)	21.2 (20.6 to 21.8)
45 to 64	96,691	11.2 (11.0 to 11.4)	19.9 (19.5 to 20.3)	25.8 (25.1 to 26.6)	24.0 (23.0 to 25.0)	13.8 (13.6 to 14.1)	21.4 (21.0 to 21.9)	15.5 (15.0 to 15.9)
65 to 74	77,803	5.2 (5.1 to 5.4)	12.5 (12.2 to 12.8)	21.3 (20.7 to 21.9)	27.8 (26.8 to 28.8)	8.1 (7.9 to 8.3)	18.1 (17.8 to 18.5)	6.3 (6.0 to 6.6)
≥75	60,156	3.1 (3.0 to 3.2)	8.3 (8.1 to 8.5)	18.6 (18.0 to 19.2)	28.6 (27.6 to 29.5)	7.0 (6.8 to 7.1)	13.4 (13.0 to 13.7)	1.9 (1.8 to 2.0)
Race/ethnicity†‡								
White, non-Hispanic	341,508	66.1 (65.7 to 66.6)	61.0 (60.4 to 61.6)	66.4 (65.5 to 67.3)	73.7 (72.5 to 74.9)	59.9 (59.4 to 60.3)	74.8 (74.2 to 75.4)	67.6 (66.9 to 68.4)
Black, non-Hispanic	36,764	9.3 (9.1 to 9.6)	13.4 (12.9 to 13.8)	15.7 (15.1 to 16.4)	13.1 (12.2 to 14.0)	12.6 (12.2 to 12.9)	7.5 (7.2 to 7.9)	13.1 (12.6 to 13.6)
Asian, non-Hispanic	8,541	5.1 (4.8 to 5.4)	4.0 (3.7 to 4.4)	2.8 (2.3 to 3.5)	1.3 (0.8 to 2.1)	6.0 (5.7 to 6.3)	2.4 (2.2 to 2.7)	1.9 (1.7 to 2.2)
Native Hawaiian or Pacific Islander, non-Hispanic	1,575	0.2 (0.2 to 0.3)	0.3 (0.2 to 0.4)	0.2 (0.1 to 0.3)	0.1 (0.1 to 0.2)	0.3 (0.2 to 0.3)	0.2 (0.1 to 0.2)	0.3 (0.2 to 0.4)
American Indian or Alaskan Native, non-Hispanic	6,335	0.8 (0.8 to 0.9)	1.0 (0.9 to 1.1)	1.5 (1.3 to 1.7)	1.8 (1.5 to 2.1)	0.7 (0.7 to 0.8)	1.0 (0.9 to 1.1)	1.8 (1.6 to 2.0)
Other race, non-Hispanic	2,840	0.5 (0.4 to 0.5)	0.4 (0.4 to 0.5)	0.4 (0.4 to 0.5)	0.4 (0.3 to 0.6)	0.4 (0.4 to 0.5)	0.4 (0.3 to 0.4)	0.6 (0.5 to 0.7)
Multiracial, non-Hispanic	8,530	1.5 (1.4 to 1.6)	1.3 (1.2 to 1.4)	1.7 (1.5 to 2.0)	1.5 (1.3 to 1.8)	1.3 (1.2 to 1.3)	1.4 (1.3 to 1.6)	2.1 (1.9 to 2.3)
Hispanic	33,544	16.4 (16.0 to 16.8)	18.6 (18.0 to 19.1)	11.2 (10.5 to 11.9)	8.0 (7.3 to 8.9)	18.9 (18.5 to 19.3)	12.3 (11.8 to 12.8)	12.6 (12.0 to 13.2)
Marital status†‡								
Married	232,976	49.1 (48.6 to 49.5)	53.5 (52.9 to 54.1)	49.2 (48.3 to 50.1)	45.1 (44.0 to 46.2)	51.0 (50.6 to 51.4)	59.1 (58.5 to 59.7)	36.1 (35.5 to 36.8)
Previously married§	128,598	12.4 (12.1 to 12.6)	22.2 (21.8 to 22.7)	36.0 (35.2 to 36.8)	44.8 (43.7 to 45.9)	15.8 (15.5 to 16.1)	23.3 (22.8 to 23.7)	25.5 (24.9 to 26.1)

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Characteristic	n	Teeth Lost				Cigarette Smoking*		
		None	1 to 5	6 to 31	All	Never	Former	Current
Never married//	78,063	38.6 (38.1 to 39.0)	24.3 (23.7 to 24.8)	14.9 (14.2 to 15.6)	10.1 (9.4 to 11.0)	33.2 (32.8 to 33.6)	17.6 (17.1 to 18.2)	38.3 (37.6 to 39.1)
Educational attainment†‡								
Did not graduate high school	38,013	10.0 (9.6 to 10.3)	16.5 (15.9 to 17.0)	24.1 (23.3 to 24.9)	35.0 (33.8 to 36.1)	12.2 (11.9 to 12.6)	14.0 (13.5 to 14.5)	22.9 (22.2 to 23.6)
Graduated high school	127,966	24.5 (24.1 to 24.9)	31.6 (31.0 to 32.1)	36.1 (35.3 to 36.9)	37.3 (36.3 to 38.3)	25.7 (25.4 to 26.1)	29.4 (28.9 to 29.9)	35.6 (35.0 to 36.3)
Some college or technical school	119,908	32.3 (31.9 to 32.8)	30.7 (30.2 to 31.2)	27.8 (27.0 to 28.5)	21.4 (20.4 to 22.4)	30.4 (30.0 to 30.8)	32.1 (31.5 to 32.6)	30.5 (29.9 to 31.2)
Graduated college or technical school	153,750	33.2 (32.8 to 33.5)	21.3 (20.9 to 21.7)	12.0 (11.6 to 12.5)	6.3 (5.8 to 6.9)	31.7 (31.3 to 32.0)	24.5 (24.1 to 24.9)	11.0 (10.6 to 11.3)
Employment†‡								
Employed	222,336	64.5 (64.1 to 65.0)	55.0 (54.4 to 55.6)	33.9 (33.1 to 34.8)	21.2 (20.2 to 22.2)	58.8 (58.4 to 59.3)	50.8 (50.2 to 51.3)	55.6 (54.9 to 56.3)
Unemployed	24,686	7.5 (7.3 to 7.8)	9.0 (8.6 to 9.3)	8.4 (7.9 to 8.9)	5.4 (4.8 to 6.0)	6.7 (6.5 to 7.0)	6.1 (5.8 to 6.5)	13.9 (13.4 to 14.5)
Homemaker/student	40,834	16.2 (15.9 to 16.6)	9.8 (9.4 to 10.2)	7.6 (7.1 to 8.1)	7.2 (6.7 to 7.8)	16.7 (16.4 to 17.1)	7.3 (7.0 to 7.6)	9.0 (8.5 to 9.4)
Retired	119,772	8.6 (8.4 to 8.7)	19.3 (18.9 to 19.6)	33.9 (33.2 to 34.7)	45.7 (44.6 to 46.8)	13.4 (13.2 to 13.6)	28.8 (28.4 to 29.3)	8.8 (8.4 to 9.1)
Unable to work	32,009	3.2 (3.0 to 3.3)	7.0 (6.7 to 7.3)	16.2 (15.5 to 16.9)	20.6 (19.6 to 12.5)	4.3 (4.1 to 4.5)	7.0 (6.7 to 7.3)	12.8 (12.3 to 13.2)
Health insurance coverage†‡	388,802	82.1 (81.7 to 82.5)	79.3 (78.8 to 79.9)	83.1 (82.4 to 83.8)	88.2 (87.4 to 88.9)	83.1 (82.7 to 83.4)	87.0 (86.5 to 87.5)	70.7 (69.9 to 71.4)
Dental care utilization†‡								
Past year	297,780	69.7 (69.3 to 70.1)	67.2 (66.7 to 67.8)	56.4 (55.6 to 57.3)	23.8 (22.8 to 24.8)	70.1 (69.7 to 70.5)	66.0 (65.4 to 66.5)	49.7 (49.0 to 50.4)
Past 2 years	45,491	11.0 (10.7 to 11.3)	12.6 (12.2 to 13.0)	13.4 (12.8 to 14.0)	11.1 (10.4 to 11.9)	11.3 (11.0 to 11.6)	10.9 (10.5 to 11.2)	14.1 (13.6 to 14.6)
Past 5 years	40,041	9.0 (8.7 to 9.2)	10.5 (10.2 to 10.9)	13.6 (13.0 to 14.2)	14.9 (14.1 to 15.7)	8.9 (8.6 to 9.1)	9.9 (9.5 to 10.2)	14.7 (14.2 to 15.2)
≥5 years	51,112	8.6 (8.4 to 8.9)	8.7 (8.3 to 9.0)	15.5 (14.9 to 16.2)	46.8 (45.7 to 47.9)	8.2 (7.9 to 8.4)	12.2 (11.8 to 12.5)	19.6 (19.1 to 20.2)
Don't know¶	5,213	1.7 (1.5 to 1.8)	1.0 (0.9 to 1.1)	1.0 (0.9 to 1.2)	3.4 (3.0 to 3.9)	1.5 (1.4 to 1.7)	1.2 (1.0 to 1.3)	1.8 (1.6 to 2.1)
Diabetes†‡	54,397	5.6 (5.4 to 5.7)	11.6 (11.2 to 11.9)	21.5 (20.8 to 22.3)	26.0 (25.0 to 27.0)	8.5 (8.3 to 8.7)	14.7 (14.3 to 15.1)	8.9 (8.5 to 9.3)
COPD†‡	34,819	3.0 (2.8 to 3.1)	6.1 (5.9 to 6.4)	15.6 (15.0 to 16.2)	23.7 (22.8 to 24.7)	2.8 (2.6 to 2.9)	9.2 (8.9 to 9.5)	13.0 (12.6 to 13.5)
Cigarette smoking*‡								
Never	239,920	65.7 (65.3 to 66.1)	52.2 (51.6 to 52.7)	35.0 (34.2 to 35.8)	28.1 (27.0 to 29.2)			
Former	127,507	19.5 (19.2 to 19.8)	27.6 (27.1 to 28.1)	35.8 (35.1 to 36.6)	39.9 (38.8 to 41.0)			

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Characteristic	n	Teeth Lost				Cigarette Smoking*		
		None	1 to 5	6 to 31	All	Never	Former	Current
Current	72,210	14.8 (14.5 to 15.2)	20.3 (19.8 to 20.7)	29.2 (28.3 to 30.0)	32.0 (31.0 to 33.1)			

*Never = respondents who smoked <100 cigarettes during their lifetime; former = respondents who smoked ≥100 cigarettes and reported smoking not at all at the time of interview; current = respondents who smoked ≥100 cigarettes and reported smoking every day or on some days at the time of interview.

†Statistically significant difference in distribution by smoking status (χ^2, $P \leq 0.001$).

‡Statistically significant difference in distribution by number of teeth removed (χ^2, $P \leq 0.001$).

§Includes those divorced, widowed, or separated.

//Includes members of unmarried couples.

¶Includes those not sure, reporting never, and refusing to answer.

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Table 2

Relationship of Tooth Loss and Cigarette Smoking Status to COPD Among Adults Aged ≥18 years (PR [95% CI]): BRFSS, 2012

	All		Women		Men	
Category	**Adjusted for Age**	**Multivariable Adjusted**	**Adjusted for Age**	**Multivariable Adjusted**	**Adjusted for Age**	**Multivariable Adjusted**
Cigarette smoking						
Never	1.0 (referent)	1.0 (referent)	1.0 (referent)	1.0 (referent)	1.0 (referent)	1.0 (referent)
Former	2.5 (2.4 to 2.6)	2.1 (2.0 to 2.3)	2.5 (2.3 to 2.7)	2.1 (1.9 to 2.2)	2.9 (2.6 to 3.2)	2.3 (2.1 to 2.5)
Current	5.1 (4.8 to 5.4)	3.2 (3.0 to 3.4)	5.3 (4.9 to 5.6)	3.2 (3.0 to 3.4)	5.5 (4.9 to 6.2)	3.3 (2.9 to 3.7)
Tooth loss						
None	1.0 (referent)	1.0 (referent)	1.0 (referent)	1.0 (referent)	1.0 (referent)	1.0 (referent)
1 to 5	1.8 (1.7 to 1.9)	1.4 (1.3 to 1.4)	1.8 (1.6 to 1.9)	1.3 (1.2 to 1.5)	1.8 (1.6 to 2.0)	1.4 (1.2 to 1.5)
6 to 31	4.0 (3.7 to 4.2)	2.0 (1.8 to 2.1)	3.9 (3.6 to 4.2)	1.9 (1.7 to 2.0)	4.1 (3.7 to 4.6)	2.1 (1.8 to 2.3)
All	5.7 (5.4 to 6.2)	2.1 (1.9 to 2.3)	5.8 (5.3 to 6.3)	2.1 (1.9 to 2.3)	5.7 (5.1 to 6.4)	2.1 (1.9 to 2.4)

Age-adjusted values include only cigarette smoking or tooth loss and age group. Multivariable-adjusted values obtained from log-linear regression models include cigarette smoking and tooth loss categories as a predictor and age group, sex, race/ethnicity, marital status, educational attainment, employment, health insurance coverage, dental care utilization, and diabetes as covariates. Sex-stratified models are also shown.

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Table 3

Relationship of All Possible Combinations of Tooth Loss and Cigarette Smoking Status to COPD Among Adults Aged ≥ 18 Years (PR [95% CI]): BRFSS, 2012

	Tooth Loss							
	None		1 to 5		6 to 31		All	
Cigarette Smoking	Adjusted for Age	Multivariable Adjusted	Adjusted for Age	Multivariable Adjusted	Adjusted for Age	Multivariable Adjusted	Adjusted for Age	Multivariable Adjusted
All								
Never	1.0 (referent)	1.0 (referent)	1.7 (1.5 to 1.9)	1.5 (1.3 to 1.7)	2.8 (2.5 to 3.2)	1.9 (1.7 to 2.2)	3.4 (2.8 to 4.2)	1.8 (1.5 to 2.2)
Former	2.3 (2.0 to 2.5)	2.1 (1.9 to 2.4)	3.2 (2.9 to 3.6)	2.7 (2.5 to 3.0)	6.5 (5.9 to 7.2)	4.4 (4.0 to 5.0)	9.1 (8.2 to 10.0)	4.9 (4.4 to 5.5)
Current	4.2 (3.7 to 4.7)	3.4 (3.0 to 3.8)	5.9 (5.3 to 6.6)	4.4 (4.0 to 5.0)	10.8 (9.8 to 12.0)	6.2 (5.5 to 6.9)	13.9 (12.5 to 15.3)	6.5 (5.8 to 7.2)
Females								
Never	1.0 (referent)	1.0 (referent)	1.8 (1.5 to 2.0)	1.6 (1.3 to 1.8)	2.9 (2.5 to 3.4)	2.0 (1.7 to 2.3)	3.5 (2.7 to 4.4)	1.9 (1.5 to 2.4)
Former	2.3 (2.0 to 2.6)	2.1 (1.8 to 2.4)	3.4 (3.0 to 3.8)	2.7 (2.4 to 3.1)	6.8 (6.0 to 7.7)	4.3 (3.8 to 4.9)	9.5 (8.4 to 10.7)	4.9 (4.3 to 5.5)
Current	4.8 (4.1 to 5.5)	3.7 (3.2 to 4.3)	6.2 (5.5 to 7.0)	4.4 (3.9 to 5.0)	10.8 (9.6 to 12.1)	6.0 (5.3 to 6.7)	14.9 (13.3 to 16.8)	6.8 (6.0 to 7.8)
Males								
Never	1.0 (referent)	1.0 (referent)	1.5 (1.2 to 1.9)	2.2 (1.8 to 2.9)	3.3 (2.6 to 4.3)	1.6 (1.2 to 2.1)	2.6 (1.9 to 3.5)	1.5 (1.1 to 2.0)
Former	2.4 (2.0 to 2.9)	2.1 (1.7 to 2.6)	3.4 (2.8 to 4.1)	6.9 (5.8 to 8.3)	10.9 (9.1 to 13.1)	4.5 (3.7 to 5.4)	9.6 (8.0 to 11.5)	5.0 (4.1 to 6.1)
Current	3.9 (3.1 to 4.8)	3.1 (2.5 to 3.8)	6.0 (4.9 to 7.3)	11.5 (9.5 to 13.9)	14.9 (12.3 to 18.3)	6.5 (5.3 to 8.0)	13.0 (10.8 to 15.7)	6.0 (4.9 to 7.3)

Age-adjusted values obtained from log-linear regression models include all possible combinations of cigarette smoking and tooth loss categories as a predictor and age group. Multivariable-adjusted values obtained from log-linear regression models include all possible combinations of cigarette smoking and tooth loss categories as a predictor and age group, sex, race/ethnicity, marital status, educational attainment, employment, health insurance coverage, dental care utilization, and diabetes as covariates. Sex-stratified models are also shown.

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