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Comorbid depression/anxiety and teeth removed: Behavioral Risk Factor Surveillance System 2010

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Abstract

Objective—The purpose of this study was to examine the association between participants 1) who reported having had clinical diagnoses of depression and anxiety with 6+ teeth removed and 2) who reported having had clinical diagnoses of depression and anxiety with edentulism.

Methods—The Behavioral Risk Factor Surveillance System (BRFSS) Survey 2010 was used for the study. Analyses involved using SAS 9.3 to determine variable frequencies, Rao–Scott chi-square bivariate analyses, and Proc Surveylogistic for the logistic regressions on complex survey designs. Participants eligibility included being 18 years or older and having complete data on depression, anxiety, and number of teeth removed.

Results—There were 76 292 eligible participants; 13.4% reported an anxiety diagnosis, 16.7% reported a depression diagnosis, and 8.6% reported comorbid depression and anxiety. The adjusted logistic regression models were significant for anxiety and depression alone and in combination for 6+ teeth removed (AOR: anxiety 1.23; 95% CI: 1.10, 1.38; P = 0.0773; AOR: depression 1.23; 95% CI: 1.10, 1.37; P = 0.0275; P < 0.0001; and AOR: comorbid depression and anxiety 1.30; 95% CI: 1.14, 1.49; P = 0.0001). However, the adjusted models with edentulism as the outcome failed to reach significance.

Conclusions—Comorbid depression and anxiety are associated independently with 6+ teeth removed compared with 0–5 teeth removed in a national study conducted in United States. Comorbid depression and anxiety were not shown to be associated with edentulism as compared with any teeth present.

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Author contributions RCW designed and organized the project, analyzed the data, and drafted the manuscript. MAW substantially contributed to the conception and design, wrote sections of the discussion and revised and approved the final version. DWM assisted with the design and analysis, critically revised the manuscript, and approved the final version.

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Introduction

The extraction of teeth due to caries or periodontitis remains a significant public health challenge. Tooth removal results in oral-facial changes in bone, nerve, and muscle tissue. With the loss of occluding pairs of teeth, there is a diminished ability to chew, a potential for limiting food choices, and a potential for poor nutrition (1). Having teeth removed also may affect esthetics, the ability to speak, and the ability to obtain work and may give rise to embarrassment (2). Researchers reported that having teeth removed is associated with lower quality of life (QOL), particularly oral health related quality of life (OHRQOL) (1–6). Risk factors include those involving microbes and cells (biofilm characteristics, genetics, salivary production, etc.), the status of a tooth or teeth (dental caries, periodontal diseases, abfractions, abrasion, erosion, etc.), the status of the individual (oral hygiene, smoking, medications/drugs, diet, illnesses, stress, psychosocial predisposition, etc.), and community, national, and global factors (availability of resources, policies in place, etc.) (7, 8).

Researchers have associated depression with oral conditions (6, 9, 10). Depressive symptoms include episodes of sadness, emptiness, diminished interest, unintended weight change, insomnia or hypersomnia, psychomotor agitation or retardation, loss of energy, feeling worthless, being indecisive or having diminished capacity to think, and having recurrent thoughts of death or suicide (11). In the United States, 4.1% of the population has major depression, and 9.1% has a 'depressive disorder, not otherwise specified' (12). Decreased immune function was associated with depression, and decreased immune function has implications for chronic diseases and conditions, including oral conditions (13).

Anxiety is also associated with oral healthcare outcomes including dental avoidance (14, 15). Anxiety (the negative anticipation of future threats) and fear (the response to a real or perceived imminent threat with sympathetic nervous system activation) are observed in dental settings (11). In the United States, 18.1% of the population reported anxiety (16). Of the people with anxiety, 22.8% reported severe anxiety (4.1% of the US adults) (16). The prevalence is higher in women than in men and in non-Hispanic Whites than in non-Hispanic Blacks (17). Anxiety disorders are the leading mental health disorder and have high medical expenditures (18).

Depression and anxiety are associated with negative impacts on QOL (18, 19). People with both clinically significant depression and anxiety often have greater severity of diseases in general, less asthmatic control (if they have asthma), longer hospital stays, more visits to primary care physicians, and use more steroid medications and are less compliant in following medical instructions (19). Higher anxiety scores (related to dentistry) are associated with poorer oral health outcomes (20,21). In addition to the impact on health and QOL, an estimated \$150 billion in annual cost is associated with mental health disorders (8).

Although periodontal diseases and the occurrence of depression and anxiety have been studied and have been shown to be linked by some researchers (9, 10, 22), such results were not supported by other researchers working with older adults (23). Additionally, there are a limited number of researchers who have investigated people who had teeth removed and depression and anxiety. Researchers in one US study linked depression and anxiety with

tooth loss (8) which was supported in a study of nonsmoking men on depression and edentulism (24); however, other studies assessing current levels of depression and tooth loss did not find such a link (25–27).

To the knowledge of the researchers for this study, the comorbid conditions of depression and anxiety have not been examined in relation to having teeth removed. There is a critical need to know whether such an association exists so that interventions may be developed to improve oral health in people impacted with depression and anxiety. The rationale for this study is that there is a gap in the knowledge of the extent to which comorbidity of depression and anxiety affects teeth removal. The research hypothesis is that comorbid depression and anxiety are positively related to teeth removal.

Materials and methods

The West Virginia University Institutional Review Board has acknowledged this research as nonhuman subject research (protocol number 1501547680). The aims for this study were to use a large national data source to compare participants with 6+ teeth removed to participants with 0–5 teeth removed and also to compare participants who are edentulous with participants who have any teeth for associations with:

- 1) The comorbidity of depression and anxiety.
- 2) Depression and/or anxiety.
- 3) Depression alone.
- 4) Anxiety alone.

Researchers have used various definitions of teeth removed for dichotomous analysis (28). Nakagaki et al. (29) and Gomes et al. (30) compared people with 20 or more natural teeth and fewer than 20 natural teeth considering 20 or more teeth as a functional dentition; Joshipura et al. (31) compared people with 25 or more teeth with people with 24 teeth at baseline. For this study, the selection of the dichotomy at 6+ teeth removed was based on methodology of the National Oral Health Surveillance System's use of 'Lost 6 or more teeth' in data presentation at <http://www.cdc.gov/nohss/> (32), and the potential miscount of teeth removed for reasons other than caries or periodontal disease such as for orthodontic treatment, impactions, or lack of space. The dichotomy of edentulism and any teeth present was used in many research designs (33–39) and was also used in this study design.

This study is a cross-sectional, secondary data analysis of data from the Behavioral Risk Factor Surveillance System 2010 (BRFSS 2010), a publicly available, de-identified data set. Interviewers, under the auspices of the Centers for Disease Control and state health departments, were educated in protocol. To assure representation and adequate sampling the data collection, calls were conducted 7 days a week, in the day and in the evening, and over each month of the year following study rotation procedures (40).

The survey had a complex design with weights to adjust for selection probability, nonresponse, and non-telephone coverage in an independent probability sample. BRFSS 2010 was conducted in 48 states, the District of Columbia, Guam, the US Virgin Islands,

and the Commonwealth of Puerto Rico. Calls were made to noninstitutionalized US adults, age 18 years and above. Cellular phones were not included in the BRFSS 2010. The BRFSS 2010 survey had 451,075 participants, all of whom provided consent to the BRFSS interviewers. The BRFSS design and protocols are presented in detail online (40).

The inclusion criteria for this study were that the participants had complete response data to the BRFSS questions relating to teeth removed, ever having been diagnosed for anxiety, and ever having been diagnosed for depression; that is, they provided a response to the interviewer other than refusal, not knowing, or not being sure. In 2010, the Anxiety and Depression module of questions were presented in 13 states: Arizona, Georgia, Hawaii, Indiana, Louisiana, Mississippi, Missouri, Nevada, Puerto Rico, South Carolina, Vermont, Wisconsin, and Wyoming. Weighting information for use with module data is provided at the BRFSS Web site (40). In the 13 states that used the depression/anxiety module in 2010, there were 83 171 participants. There were 4,450 participants (weighted percent = 5.7%; standard error, 0.2) who had data missing concerning depression or anxiety. There were 1,593 participants (weighted percent = 1.2%; SE, 0.1) who had data missing concerning teeth. Patterns of data missingness are important in oral health research and have implications for data quality and outcomes (41). The final sample size used in this study was 76,292.

Dependent variable: teeth removed

Participants were asked, during the BRFSS 2010 telephone interview, '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 are removed because of tooth decay or gum disease, they should be included in the count for lost teeth.' (40). Data were collected in the BRFSS survey not as continuous numbers, but as the response categories of none, 1–5, 6+ (but not all), and all. For each of the categories in the BRFSS data set, there were 53.86% of participants who reported no teeth removed, 29.99% who reported 1–5 teeth removed, 10.07% who reported 6+ (but not all), and 4.89% who reported all teeth removed.

Polytomous analysis with the four categories of teeth removed (no teeth removed, 1–5 teeth removed, 6+ but not all teeth removed, and all teeth removed) resulted in a Score statistic of <0.0001 (which should have been >0.05 to not violate the assumptions required to use polytomous analysis). Therefore, the data were dichotomized to 0–5 teeth removed and 6+ teeth removed to conduct the logistic regression, which was in keeping with the methodology used by the National Oral Health Surveillance System (32). Logistic regression was also conducted with the data dichotomized with edentulous participants compared with participants with any teeth while recognizing the limitations of the small edentate sample size.

Key independent variables: comorbidity of depression and anxiety

The variable for anxiety was defined as a positive or negative response to the BRFSS questions: 'Has a doctor or other healthcare provider EVER told you that you had an anxiety disorder (including acute stress disorder, anxiety, generalized anxiety disorder, obsessive-

compulsive disorder, panic disorder, phobia, posttraumatic stress disorder, or social anxiety disorder?' The variable for depression was defined as a positive or negative response to the question 'Has a doctor or other healthcare provider EVER told you that you have a depressive disorder (including depression, major depression, dysthymia, or minor depression)?' The participants who responded 'yes' or 'no' were included in this study. The variable, comorbidity, was defined as both conditions being present. Comorbidity was the key variable. The variable, 'depression and/or anxiety', was defined as either or both conditions being present. This variable was used in separate analyses to help explain variations due to associations which exist between anxiety and depression.

Other factors

In this study, the following factors were included as having associations with teeth removed: sex (female versus male), race/ethnicity (other, and non-Hispanic Blacks versus non-Hispanic Whites), age (50 years and above versus 18–49 years), education (less than high school, high school graduate, less than college or technical degree versus college or technical degree or above), income (< \$15 000, \$15 000–\$24 999, \$25 000–\$34 999, \$35 000 – < \$50 000 versus \$50 000 and above), dental visit within the year (no versus yes), smoking (current, or former smoker versus never smoker), physical activity (no versus yes), diabetes (no versus yes), and BMI (overweight, or obese versus normal). Diabetes was included as a known risk factor for periodontal diseases and as such, a potential risk factor for teeth removed. The data analyses were conducted using SAS 9.3® to determine variable frequencies, Rao-Scott chi-square bivariate analysis, and Proc Surveylogistic for the logistic regression for complex survey designs and weights in the BRFSS 2010.

The data were analyzed with unadjusted and adjusted multivariable logistic regressions on: 1) 6+ teeth removed compared with 0–5 teeth removed and 2) edentulism with any teeth present. Significance was established a priori as 0.05. Separate analyses were conducted for the variables relating to depression and anxiety (analyses with comorbidity, anxiety alone, depression alone, and depression and/or anxiety).

The sample was restricted to individuals who responded to questions about having had a diagnosis of depression/anxiety and the number of missing teeth; therefore, missing data had the potential to influence the results. There was the potential that individuals who did not receive a diagnosis for depression/anxiety, but did have depression/anxiety were misclassified by the lack of a diagnosis. To determine the influence of missing data on comorbid depression and anxiety in the logistic regressions, sensitivity analyses were conducted with the missing data 1) included as a separate category and 2) included with the 'no' category in the unadjusted logistic regression on 6+ teeth and also on edentulism.

Results

There were 76,292 participants in this study with 13,670 (16.7%; standard error, 0.3) reporting depression, 10,171 reporting anxiety (13.4%; standard error 0.2), 17,215 (21.6%; standard error 0.3) reporting depression and/or anxiety, and 6,626 (8.6%; standard error 0.2) reporting comorbid depression and anxiety. The sample was 51.5% female, 68.7% non-Hispanic White, 40.1% age 30–49 years, and 34.1% educated to college or technical degree

or above. Additional details of the distribution of respondents' characteristics are presented in Table 1.

The bivariate relationships with teeth removed are presented in Table 2. The distribution of teeth removed is significantly different among individuals who had comorbid depression and anxiety and those who did not ($P < 0.0001$).

Other significant bivariate relationships with teeth removed were fewer teeth present for females, non-Hispanic Blacks, older age, less education, less income, not having a dental visit within the year, smoking, diabetes, not being physically active, and having a BMI 30.

Table 3 includes the logistic regression models for the association between comorbid depression and anxiety on 6+ teeth removed. In increasing order, the crude, unadjusted odds ratios (ORs) were 1.55 (95% CI: 1.44, 1.66) for depression and/ or anxiety, 1.58 (95% CI: 1.46, 1.71) for anxiety alone, 1.64 (95% CI: 1.52, 1.77) for depression alone, and 1.91 (95% CI: 1.72, 2.11) for the comorbidity of depression and anxiety indicating that the strongest association was with the comorbidity. In the adjusted models, the associations weakened, but remained statistically significant with adjusted odds ratios (AORs) of 1.23 (95% CI: 1.11, 1.36) for depression and/or anxiety, 1.23 (95% CI: 1.10, 1.38) for anxiety alone, 1.23 (95% CI: 1.10, 1.37) for depression alone, and 1.30 (95% CI: 1.14, 1.49) for the comorbidity of depression and anxiety.

Table 4 includes the logistic regression models for the association between comorbid depression and anxiety on edentulism. In increasing order, the unadjusted ORs were as follows: 1.30 (95% CI: 1.18, 1.43) for depression and/or anxiety, 1.37 (95% CI: 1.24, 1.52) for depression alone, 1.39 (95% CI: 1.24, 1.56) for anxiety alone, and 1.61 (95% CI: 1.41, 1.85) for the comorbidity of depression and anxiety. The strongest association was with the comorbidity. In the adjusted models, the associations weakened and were no longer statistically significant with an AOR of 1.04 (95% CI: 0.86, 1.25) for depression and/or anxiety, 0.95 (95% CI: 0.82, 1.09) for depression alone, 1.05 (95% CI: 0.90, 1.23) for anxiety alone, and 1.04 (95% CI: 0.86, 1.25) for the comorbidity of depression and anxiety.

Data missingness was considered. There were 5.7% (weighted) missing data on depression or anxiety; standard error, 0.2 (4450 participants). There were 1.2% (weighted) missing data concerning tooth count; standard error, 0.1 (1,593 participants).

To determine the influence that comorbid missing data had on the unadjusted OR for the removal of 6+ teeth, as well as on the OR for edentulism, sensitivity analyses were conducted. In the sensitivity analysis with the comorbid missing data included as a separate category, the unadjusted OR on the removal of 6+ teeth did not change. Similarly, in sensitivity analysis with the comorbid missing data included as a separate category, the unadjusted OR on edentulism did not change.

In sensitivity analysis with the comorbid missing data included within the 'no' comorbidity category, the unadjusted OR on the removal of 6+ teeth had a 3.5% change from 1.91 to 1.98 (95% CI: 1.73, 2.11; $P < 0.0001$). Similarly, in sensitivity analysis with the comorbid

missing data included as a separate category, the unadjusted OR on edentulism had a 12% change from 1.61 to 1.83 (95% CI 1.10, 1.37; $P = 0.0003$).

Discussion

The results of this study of a representative sample of US adults are that relationships exist between 1) 6+ teeth removed and the comorbid presentation of depression and anxiety, 2) 6+ teeth removed and depression and/or anxiety, 3) 6+ teeth removed and depression alone, and 4) 6+ teeth removed and anxiety alone. The strengths of the relationships in adjusted analyses were AORs of 1.30, 1.23, 1.23, and 1.23, respectively, when the comparisons were made with 6+ teeth removed compared with 0–5 teeth removed as the referent category. These results indicate a clinically important relationship.

However, when comparisons were made with edentulism and some teeth present with comorbid depression and anxiety, unadjusted ORs were significant, but AORs were not significantly different between the participants who were edentulous and the participants who had some teeth present.

This study's results concerning 6+ teeth removed are consistent with the findings of previous research (8, 21). In a national study of 80 486 noninstitutionalized adults in 16 states, the AOR for an association between 6 and 31 teeth removed and current depression was 1.83, the AOR for the occurrence of depression during the lifetime was 1.27, and the AOR for the occurrence of anxiety during the lifetime was 1.54 as compared with adults who did not have any teeth removed (8).

In another study, researchers evaluated the influence of missing teeth with depression as the outcome (21). They developed a hybrid structural equation model of depression and decayed and missing teeth (21). A variable consisting of decayed and missing teeth was associated with depression via indirect pathways (standardized indirect effects = 0.44), oral health quality of life, and anxiety (21). Although this current study is evaluating the relationship of comorbid depression and anxiety on teeth removed rather than the relationship of missing teeth on depression, both this study and the previous study show positive associations. This current study extends the prior literature beyond confirming prior findings by addressing comorbidity and depression and/or anxiety in the analyses.

The results of the comorbidity of depression and anxiety in people who are edentulous compared with people who had some teeth were not significant in the adjusted analysis. Having a larger edentulous sample size potentially could have impacted the results.

Comparative studies of the comorbidity of depression and anxiety with edentulism were not available with the literature searches using 'edentulism', 'depression', and 'anxiety' as key words. Although not studying the comorbidity of depression and anxiety, Saman et al. determined that edentulism was associated with depression using BRFSS 2006 data (42). Their study differed from this study in the data source, focus, and variables chosen (rurality and depression were the primary independent variables and they created computed variables for health service deficits and socioeconomic status). Anttila et al. studied a sample of 780 older adults in Finland and determined that edentulism was associated with depressive

symptoms in nonsmoking men (24). Their study differed from this study as it included older adult participants from one city in Finland using the Zung Self-Rating Depression Scale. However, Shamrany reported that edentulism was not associated with depression in data from the Canadian Community Health Survey Cycle 2.1 (43).

Biological mechanisms by which comorbid depression and anxiety may influence the outcome of having 6+ teeth removed may be through the link of depression, anxiety, and stressors in immunity. Changes in biomarkers of immunity occur with depression. Depression is associated with an increase in leukocytosis (relative neutrophilia and lymphopenia), small increases in the CD4 T-cell lymphocyte to CD8 T-cell lymphocyte ratio, increased serum haptoglobin, increased prostaglandin E2, and increased interleukin-6, decreased natural killer cell (NK) cytotoxicity, and decreased lymphocyte proliferation response to mitogen (13). Similar biomarkers have a role in increased periodontal disease severity, which may also lead to having teeth removed.

Behavioral considerations might moderate the relationship of depression and oral health, according to recent research (6). A study of 399 dental patients from one school of dentistry had a correlation of a higher score on the Center of Epidemiological Studies Depression Scale and the Michigan Oral Health-Related Quality of Life Scale ($r = 0.46$; $P < 0.001$) and a higher correlation with poor oral health, an outcome measured as the number of decayed teeth ($r = 0.13$; $P = 0.025$) (6). The authors suggested lack of motivation and deficits in self-efficacy which occur with depression impact normal life in general and have an effect on daily oral infection control (brushing and flossing) and affect oral health outcomes (6).

Oral health has been described as being affected by late-life depression through factors: disinterest in oral hygiene, reduced central serotonin resulting in a desire for intense sweets, reduced taste perception, reduced saliva from increased anticholinergic activity, and high concentration of lactobacillus (44, 45). If an older adult with late-life depression is using antidepressant medications, xerostomia is more likely due to the medication's effect on blocking of the parasympathetic stimulation of the salivary glands, resulting in complications such as sialadenitis, gingivitis, and stomatitis (44). If the medication is a long-term use heterocyclic, there often is an increased desire for carbohydrates; and if the medication is a selective serotonin reuptake inhibitor, the medications increase extrapyramidal levels of serotonin, inhibit dopaminergic pathways that are responsible for movement, and may result in movement disorders including clenching/bruxing with the potential of subluxating compromised teeth (44). These same pathways may potentially be responsible for having teeth removed in other adults with depression and not just older adults with late-life depression.

This study is subject to the limitations imposed by the cross-sectional design: causality and temporality cannot be established or inferred, and there may be a bidirectional relationship occurring. Teeth removed may have preceded either of the exposure variables given that severity and duration of both the exposure and outcome were unavailable for inclusion in data analysis. The possibility for exposure misclassification is high as some individuals with symptoms of depression/anxiety may not have been diagnosed by a healthcare provider.

Furthermore, individuals who reported a diagnosis did not report when diagnosis was made, the duration of their diagnosis, and severity of diagnosis or medication usage.

The data collected in the BRFSS 2010 were oral responses to questions posed over the telephone from 13 states and in 1 year. It is possible that the participants responded with answers that they considered right or appropriate (social desirability bias) or did not have accurate recall (recall bias). The sample was restricted to individuals who responded to questions on depression/anxiety and the number of removed teeth; therefore, the missing data have the potential to influence the data. In sensitivity analysis in which a missing-data category was created for the missing comorbidity data, there was no change in the unadjusted OR for either 6+ teeth removed as the outcome or edentulism as the outcome. If all comorbidity data belonged to the 'no' category, the OR for 6+ teeth removed increased 3.5%, and the OR for edentulism increased 12%. As using a missing indicator category may bias the results (46, 47), several sensitivity analyses were conducted with similar results, and the percent of missing data for depression and/or anxiety (5.7%) and for tooth count (1.2%) are minimal.

The study also has the limitation of having data which resulted from posing a categorical question about teeth removed to the participants. Therefore, continuous data were not available and this study was limited by the designed categories imposed in the BRFSS data collection (no teeth removed, 0–5 teeth removed, 6+ but not all teeth removed, and edentulism). Due to the small sample of edentulous participants responding in the survey, the edentulous category was collapsed into the BRFSS '6+, but not all' category. Using a dichotomy of 0–5 and 6+ teeth removed posed the possibility that the '6+ teeth removed' category could have individuals with 0 teeth to individuals with potentially 26 teeth, if wisdom teeth were removed due to caries or periodontal disease, which is a study limitation.

The study has several strengths in that it was a large, nationally representative study conducted by the Centers for Disease Control and Prevention and state health departments and it has been conducted for many years. Also the sample size was large enough to adjust for many other variables than just the variables of interest; however, future studies may wish to include variables relating to access to care, insurance, or other healthcare coverage as potential factors.

Depression, anxiety, and oral health are major public health issues. Having an increased number of teeth removed in individuals who have comorbid depression and anxiety is a concern. Comorbid depression and anxiety may continue to impact having more teeth removed, and having an increased number of teeth removed may exacerbate depression and anxiety. The directionality of, and mechanisms involved in these relationships remain to be elucidated. Clinically, patients diagnosed with comorbid depression and anxiety should be cautioned about the possible oral (and other) health implications of those disorders and encouraged to seek regular oral health care.

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Table 1

Sample Characteristics, Behavioral Risk Factor Surveillance System, 2010; N=76,292

	Number	Population Estimate	weighted percentage	Standard Error
Teeth removed				
0	30,867	20,341,013	53.1	.3
1–5	25,223	11,585,502	30.3	.3
6+ (not all)	12,602	4,179,947	10.9	.2
All	7,600	2,188,788	5.7	.1
Comorbid Depression and Anxiety				
Yes	6,626	3,284,899	8.6	.2
No	69,666	35,010,350	91.4	.2
Depression				
Yes	13,670	6,402,001	16.7	.3
No	62, 622	31,893,249	83.3	.3
Anxiety				
Yes	10,171	5,145,721	13.4	.2
No	66,121	33,149,529	86.6	.2
Depression <i>and/or</i> Anxiety				
Yes	17,215	8,262,822	21.6	.3
No	59,077	30,032,428	78.4	.3
Sex				
Female	48,009	19,704,979	51.5	.4
Male	28,283	18,590,270	48.5	.4
Race/ethnicity				
NHW	53,790	26,052,106	68.7	.3
NHB	9,758	4,808,398	12.7	.2
Hispanic	5,903	4,727,977	12.5	.2
Other	5,834	2,344,719	6.2	.2
Age				
19–29 years	4,588	6,556,122	17.2	.3
30–49 years	19,226	15,283,726	40.1	.4
50–59 years	16,804	7,032,718	18.5	.2
60–69 years	17,303	4,835,231	12.7	.2
70+ years	17,845	4,406,310	11.6	.1
Education				
<HS	8,266	3,823,672	10.0	.2
HS graduate	23,428	871,194	28.5	.3
Some col/tech	20,328	10,472,884	27.4	.3
Coll/tech	24,145	13,055,285	34.1	.3
Income				
<\$15,000	9,175	3,549,054	10.7	.2
\$15,000–24,999	12,840	5,757,341	17.4	.3

	Number	Population Estimate	weighted percentage	Standard Error
\$25,000–34,999	8,182	3,819,716	11.6	.2
\$35,000–49,999	9,914	4,748,374	14.4	.3
\$50,000	25,583	15,157,937	45.9	.4
Dental visit within the year				
Yes	51,253	26,116,024	68.4	.3
No	24,741	12,055,163	31.6	.3
Smoking status				
Current	12,494	7,089,133	18.6	.3
Former	22,896	830,535	24.6	.3
Never	40,595	21,701,080	56.8	.3
Diabetes				
Yes	12,216	569,920	11.6	.2
No	64,011	33,849,599	88.4	.2
Physical activity				
Yes	54,295	28,174,786	73.6	.3
No	21,913	10,092,893	26.4	.3
Body Mass Index in kilograms/meter ²				
<25	25,147	12,778,390	34.6	.3
25 to <30	26,625	13,340,792	36.1	.3
30	21,721	10,844,294	29.3	.3

Abbreviations: SE, standard error of percent; NHW, non-Hispanic White; NHB, non-Hispanic Black; +, and above; <, less than; HS, high school; coll/tech, college technical school; ≥, greater than or equal to; and DM includes pre-diabetes, gestational diabetes and current diabetes.

The data are from the states which provided the Anxiety and Depression module of questions in 2010: Arizona; Georgia; Hawaii; Indiana; Louisiana; Mississippi; Missouri; Nevada; Puerto Rico; South Carolina; Vermont; Wisconsin; and Wyoming.

Table 2

Categories of teeth removed versus depression and/or anxiety and other variables of interest: Rao Scott Chi Square Analysis, Behavioral Risk Factor Surveillance System, 2010 Number of teeth removed, weighted %, standard error of row percent

Teeth removed:	0	wt %,(SE)	1-5	wt %,(SE)	6+	wt %,(SE)	all	wt %,(SE)	p-value
Comorbid Depression and Anxiety									<.0001
Yes	2077	41.2(1.2)	2187	33.2(1.1)	1553	17.2(.8)	809	8.4(.5)	
No	28790	54.2(.4)	23036	30.9(.3)	11049	10.3(.2)	6791	5.5(.1)	
Depression and/or Anxiety									<.0001
Yes	6177	46.5(.7)	5636	31.7 (.7)	3539	14.8(.5)	1863	6.9(.3)	
No	24690	54.9(.4)	19587	29.8(.4)	9063	9.8(.2)	5737	5.4(.1)	
Depression									<.0001
Yes	4800	45.2 (.8)	4460	31.9 (.8)	2888	15.6(.5)	1522	7.2(.3)	
No	26067	54.7(.4)	20763	29.9(.3)	9714	10.0(.2)	6078	5.4(.1)	
Anxiety									<.0001
Yes	3454	44.8(1.0)	3363	32.5 (.9)	2204	15.3(.6)	1150	7.4(.4)	
No	27413	54.4(.4)	21860	29.9(.3)	10398	10.2(.2)	6450	5.5(.1)	
Sex									<.0001
Female	19310	52.3(.4)	15578	29.7(.4)	8086	11.6(.2)	5037	6.3(.1)	
Male	11557	54.0(.6)	9647	30.8(.5)	4516	10.2(.3)	2563	5.1(.2)	
Race/ethnicity									<.0001
NHW	23314	56.3(.4)	17174	27.5(.4)	8035	10.3(.2)	5267	5.9(.1)	
NHB	2489	41.4(1.0)	3465	36.3(.9)	2526	15.4(.5)	1278	6.9(.3)	
Hispanic	2033	46.9(1.1)	2341	39.4(1.0)	1025	10.1(.5)	504	3.6(.3)	
Other	2716	56.5(1.5)	1946	29.9(1.3)	805	9.2(.6)	367	4.5(.4)	
Age									<.0001
19-29 years	3567	78.8(.9)	927	19.3(.9)	70	1.3(.3)	24	0.6(.2)	
30-49 years	11522	63.0 (.6)	5939	5.7(.6)	1369	5.7(.3)	369	1.6(.1)	
50-59 years	6812	43.0(.7)	6240	37.0(.7)	2711	14.6(.4)	1041	5.4(.3)	
60-69 years	5063	30.4(.6)	6299	36.1(.6)	3756	21.3(.5)	2185	12.2(.4)	
70+ years	3672	21.9(.5)	5638	30.9(.5)	4592	26.0(.5)	3943	21.1(.4)	
Education									<.0001
<HS	1355	29.2(1.2)	2220	31.7(1.0)	2355	21.5(.8)	2336	17.7(.6)	
HS graduate	7036	43.1(.7)	8294	34.0(.6)	4957	14.9(.3)	3141	8.0(.2)	
Some coll/tech	8419	53.5(.7)	7207	31.9(.6)	3235	10.6(.4)	1467	3.9(.2)	
Coll/tech	14018	68.2(.6)	7458	25.3(.5)	2032	4.7(.2)	637	1.7(.1)	
Income									<.0001
< \$15,000	1798	30.6(1.0)	2746	34.7(1.0)	2620	21.0(.8)	2011	13.7(.5)	
\$15,000-24,999	3355	38.5(.9)	4335	33.7(.8)	3020	17.0(.5)	2130	10.9(.4)	
\$25,000-34,999	2657	42.9(1.1)	3089	35.7(1.0)	1574	14.1(.6)	862	7.3(.5)	
\$35,000-49,999	4053	49.0(1.0)	3648	34.6(.9)	1558	11.7(.5)	655	4.7(.3)	
\$50,000	14971	67.4(.5)	8023	25.8(.5)	2032	5.4(.2)	557	1.5(.1)	

Teeth removed:	0	wt %,(SE)	1-5	wt %,(SE)	6+	wt %,(SE)	all	wt %,(SE)	p-value
Dental visit within the year									<.0001
Yes	23833	58.0(.4)	18477	30.9(.4)	7411	9.1(.2)	1532	2.1(.1)	
No	6972	42.6(.6)	6715	29.1(.6)	5133	14.8(.4)	5921	13.4(.3)	
Smoking status									<.0001
Current	3629	40.6(.9)	4174	35.0(.8)	2790	15.7(.6)	1901	8.7(.3)	
Former	7566	43.1(.6)	7608	32.0(.6)	4696	16.1(.4)	3026	8.8(.3)	
Never	19559	61.6(.4)	13338	27.9(.4)	5062	7.1(.2)	2636	3.4(.1)	
Diabetes									<.0001
Yes	2858	30.8(.9)	3971	33.6(.8)	3202	22.7(.6)	2185	12.9(.4)	
No	27988	56.0(.4)	21235	29.8(.3)	9384	9.4(.2)	5404	4.8(.1)	
Physical activity									<.0001
Yes	24533	57.5(.4)	18044	29.2(.4)	7656	9.1(.2)	4062	4.2(.1)	
No	6309	40.9(.7)	7155	33.1(.6)	4927	16.0(.4)	3522	10.0(.3)	
Body Mass Index in kilograms/meter ²									<.0001
<25	11674	60.0(.6)	7531	26.0(.5)	3534	8.6(.3)	2408	5.4(.2)	
25 to <30	10725	52.5(.6)	9070	31.0(.5)	4345	11.0(.3)	2485	5.4(.2)	
30	7326	45.8(.7)	7697	34.1(.6)	4313	13.7(.4)	2385	6.4(.2)	

Abbreviations: wt, weighted; SE, standard error of percent; NHW, non-Hispanic White; NHB, non-Hispanic Black; +, and above; <, less than; HS, high school; coll/tech, college technical school; and ≥, greater than or equal to.

Table 3

Logistic regression on teeth removed: Behavioral Risk Factor Surveillance System, 2010

	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Depression <i>and</i> Anxiety (comorbidity)		
6+ teeth removed	1.91 (1.73, 2.11)	1.30 (1.14, 1.49)
0–5 teeth removed	referent	referent
Depression <i>and/or</i> Anxiety		
6+ teeth removed	1.55 (1.44, 1.66)	1.23 (1.11, 1.36)
0–5 teeth removed	referent	referent
Anxiety alone		
6+ teeth removed	1.58 (1.46, 1.71)	1.23 (1.10, 1.38)
0–5 teeth removed	referent	referent
Depression alone		
6+ teeth removed	1.64(1.52, 1.77)	1.23 (1.10, 1.37)
0–5 teeth removed	referent	referent
Anxiety and Depression, separate categories, same model	AOR _{anxiety}	
6+ teeth removed		1.13 (0.99, 1.30)
0–5 teeth removed		referent
	AOR _{dep}	
6+ teeth removed		1.16 (1.02, 1.32)
0–5 teeth removed		referent

Abbreviations: OR = Odds ratio; AOR = Adjusted odds ratio; CI = confidence interval.

The adjusted model includes: sex (male v. female); education (less than high school, high school graduate, less than college or technical degree v. college or technical degree or above), age (50 years and above v. 18–49 years), income (less than \$15000, \$15000–\$24999, \$25000–\$34999, \$35000–less than \$50000 v \$50000 and above), diabetes (yes v no), dental visit within the year (no v yes), smoking (current, or former smoker v. never smoker), physical activity (no v. yes), and BMI (overweight, or obese v. normal).

Table 4

Logistic regression on edentulism: Behavioral Risk Factor Surveillance System, 2010

	Unadjusted OR (95%CI)	Adjusted OR (95%CI)
Depression <i>and</i> Anxiety (comorbidity)		
edentulous	1.61 (1.41, 1.85)	1.04 (0.86, 1.25)
dentate	referent	referent
Depression <i>and/or</i> Anxiety		
edentulous	1.30 (1.18, 1.43)	0.96 (0.84, 1.09)
dentate	referent	referent
Anxiety alone		
edentulous	1.39 (1.24, 1.56)	1.05 (0.90, 1.23)
dentate	referent	referent
Depression alone		
edentulous	1.37(1.24, 1.52)	0.95 (0.82, 1.09)
dentate	referent	referent
Anxiety and Depression, separate categories, same model	AOR _{anxiety}	
edentulous		1.12 (0.94, 1.33)
dentate		referent
	AOR _{dep}	
edentulous		0.90(0.77, 1.05)
dentate		referent

Abbreviations: OR = Odds ratio; AOR = Adjusted odds ratio; CI = confidence interval.

The adjusted model includes: sex (male v. female); education (less than high school, high school graduate, less than college or technical degree v. college or technical degree or above), age (50 years and above v. 18–49 years), income (less than \$15000, \$15000–\$24999, \$25000–\$34999, \$35000–less than \$50000 v \$50000 and above), diabetes (yes v no), dental visit within the year (no v yes), smoking (current, or former smoker v. never smoker), physical activity (no v. yes), and BMI (overweight, or obese v. normal).