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Update on Prevalence of Periodontitis in Adults in the United States: NHANES 2009 – 2012

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Abstract

This report describes prevalence, severity, and extent of periodontitis in the US adult population using combined data from the 2009–2010 and 2011–2012 cycles of the National Health and Nutrition Examination Survey (NHANES).

Methods—Estimates were derived for dentate adults 30 years and older from the civilian non-institutionalized population. Periodontitis was defined by combinations of clinical attachment loss (CAL) and periodontal probing depth (PPD) from six sites per tooth on all teeth, except third molars, using standard surveillance case definitions. For the first time in NHANES history, sufficient numbers of Non-Hispanic Asians were sampled in 2011–2012 to provide reliable estimates of their periodontitis prevalence.

Results—In 2009–2012, 46% of US adults representing 64.7 million people had periodontitis, with 8.9% having severe periodontitis. Overall, 3.8% of all periodontal sites (10.6% of all teeth)

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had PPD≥4 mm and 19.3% of sites (37.4% teeth) had CAL≥3 mm. Periodontitis prevalence was positively associated with increasing age and was higher among males. Periodontitis prevalence was highest in Hispanics (63.5%) and Non-Hispanic blacks (59.1%), followed by Non-Hispanic Asian Americans (50.0%), and lowest in Non-Hispanic whites (40.8%). Prevalence varied two-fold between the lowest and highest levels of socioeconomic status, whether defined by poverty or education.

Conclusion(s)—This study confirms a high prevalence of periodontitis in US adults aged 30 years and older. Prevalence was greater in Non-Hispanic Asians than Non-Hispanic whites, although lower than other minorities. The distribution provides valuable information for population-based action to prevent periodontitis in US adults.

Keywords

NHANES; Periodontal Disease; Periodontitis; Epidemiology; Surveillance

Introduction

Periodontal disease is highly prevalent among adults in the US and is an important dental public health problem.[1] The monitoring and reduction of moderate and severe periodontitis in the adult US population through national disease surveillance and health promotion activities is part of the Healthy People 2020 national health objective[2] and is an important strategic objective of the Centers for Disease Control and Prevention (CDC).[3,4]

The burden of periodontitis in the adult US population is currently assessed through the National Health and Nutrition Examination Survey (NHANES). Since 1999, NHANES has been a continuous, annual survey capable of producing national estimates on selected health characteristics within two-year periods. However, the protocol for assessing periodontitis has varied. Beginning in 2009 and ending in 2014, NHANES will have applied a Full Mouth Periodontal Examination (FMPE) protocol to collect probing measurements from six sites per tooth for all teeth (except third molars).[1] The FMPE optimizes clinical measurements for surveillance of periodontitis and represents better accuracy in detecting cases of periodontitis compared with estimates derived from Partial Mouth Periodontal Examination (PMPE) protocols followed in previous NHANES surveys, such as 1999–2004 or 1988–1994 as illustrated earlier.[5–9] Also, the FMPE protocol optimizes the use of standard case definitions for surveillance of periodontitis and minimizes misclassification of periodontitis cases and can be applied to various case definitions due to the comprehensive measurements.[10–14] Using the FMPE protocol, it was estimated in 2009–10 that 47% of US dentate adults aged 30 years and older (representing approximately 65 million adults) had periodontitis, with 38% of the adult population 30 years and older and 64% of adults 65 years and older having either severe or moderate periodontitis.[1] These initial findings revealed a much higher burden of periodontitis in US adults than previously reported.[1]

In this report, we provide updated prevalence estimates using combined data from the NHANES survey periods 2009–2010 and 2011–2012. Based on a larger sample size, the four-year combined data provide more stable estimates, especially for smaller subpopulations. Importantly, the 2011–2012 data provide the first occasion at which

NHANES data generated reliable estimates of periodontitis among Non-Hispanic Asian-Americans.

Materials and Methods

This study used data from NHANES 2009–2012. NHANES is a stratified multistage probability sample of the civilian non-institutionalized population in the 50 states of the US and the District of Columbia. NHANES oversamples different sub-populations to improve estimate accuracy, and in 2011–2012, Non-Hispanic Asian Americans were oversampled. The technical details of the survey, including sampling design, periodontal data collection protocols, and data availability can be accessed at: www.cdc.gov/nchs/nhanes.htm. Oral health data collection protocols were approved by the Centers for Disease Control and Prevention (CDC) National Center for Health Statistics (NCHS) Ethics Review Board (an Institutional review Board equivalent) and all survey participants provided written informed consent.

All periodontal examinations were conducted in a mobile examination center (MEC) by trained examiners who were registered dental hygienists in 2009 – 10 and licensed dentists in 2011 – 2012. All dental examiners were trained and calibrated by the survey's reference examiner. Examiners made two measurements at each periodontal site: gingival recession [distance between the free gingival margin (FGM) and the cemento-enamel junction (CEJ)] and probing pocket depth (PPD) [distance from FGM to the bottom of the sulcus or periodontal pocket]. Measurements were made at six sites per tooth (mesio-, mid-, and disto-buccal; mesio-, mid-, and disto-lingual) for all teeth, excluding third molars. A periodontal probe (Hu-Friedy PCP 2™) with 2-4-6-8-10-12mm graduations was positioned parallel to the long axis of the tooth at each site and measurements were rounded to the lower whole millimeter. Data were recorded directly into a NHANES oral health data management program that instantly calculated clinical attachment loss (CAL) as the difference between PPD and recession. Bleeding upon probing and the presence of dental furcations were not assessed. The periodontal protocol for NHANES 2009 – 2012 was restricted to adults aged 30 years or older with one or more natural teeth and no health condition requiring antibiotic prophylaxis before periodontal probing. A total of 9,402 adults at least 30 years old participated in NHANES MEC examinations. Among these, 1,631 were excluded from the oral health assessment due to medical conditions or for other reasons did not complete their oral examination, while 7,771 persons underwent complete oral examinations, including who were 705 edentulous. Periodontal measurements were collected for the remaining 7,066 participants representing a weighted population of approximately 141.0 million civilian non-institutionalized American adults aged 30 years or more.

Prevalence of periodontitis was calculated using three approaches. First, prevalence was reported using the suggested CDC/AAP case definitions for surveillance of periodontitis.[15, 16] *Severe periodontitis* was defined as having two or more interproximal sites with ≥ 6 mm CAL (not on the same tooth) AND one or more interproximal site(s) with ≥ 5mm PPD. Second, *other periodontitis* comprised two lesser amounts of disease: moderate periodontitis, defined as two or more interproximal sites with ≥ 4 mm clinical CAL (not on the same tooth) OR two or more interproximal sites with PPD ≥ 5 mm, also not on the same

tooth; and mild periodontitis, defined as ≥ 2 interproximal sites with ≥ 3mm CAL and ≥ 2 interproximal sites with ≥ 4mm PPD (not on the same tooth) or 1 site with ≥ 5mm. These subgroups are not truly ordinal as the label suggest because many of the "moderate" cases had insufficient pocket depth to qualify as "mild and we have therefore combined them and used the label "other" periodontitis. Finally, *Total periodontitis* was defined as the presence of severe or other periodontitis.

For comparison with other national and international studies published, we also applied definitions by the European Federation of Periodontology (EFP) definitions for severe and incipient periodontitis.[18] Secondly, we reported the severity and extent of PPD and CAL using measurements from all six sites per tooth. Severity was also reported as the mean and prevalence of CAL and PPD cut-points ranging from 3mm to 7mm. Extent of disease was reported by specific PPD and CAL values at 5, 10, and 30 percent of sites and teeth, respectively.

Education was classified as less than high school, high school graduate, or General Education Development high school equivalency test (GED), and greater than high school. Smoking status was constructed from responses to two questions: (1) Have you smoked at least 100 cigarettes in your entire life? and (2) Do you now smoke cigarettes? Respondents who reported smoking every day or some days and had smoked at least 100 cigarettes were categorized as current smokers; respondents who reported currently not smoking but having smoked more than 100 cigarettes in the past were categorized as former smokers; and respondents who reported having smoked fewer than 100 cigarettes ever were categorized as non-smokers.

Poverty status was based on family income, family size, and the number of children in the family -- and for families with two or fewer adults, on the age of the adults in the family. The poverty level was based on definitions originally developed by the Social Security Administration that include a set of income thresholds, which vary by family size and composition. Families or individuals with incomes below their appropriate thresholds were classified as below the poverty level. These thresholds are updated annually by the US Census Bureau. Additional information can be located at: http://aspe.hhs.gov/poverty/11poverty.shtml.

Age and sex (male/female) were as collected by NHANES. For our report, age was stratified as 30 −34, 35 −49, 50 – 64 and 65+ years old. Race/ethnicity was self-reported in four groups: non-Hispanic Whites, non-Hispanic Blacks, Hispanics (a combination of Mexican-Americans and other Hispanics), and Non-Hispanic Asian American. Education was classified as less than high school, high school graduate or General Education Development (GED) high school equivalency test, and greater than high school. Marital status was reported as married, widowed, divorced, separated, never married and living with a partner.

Applying MEC examination weights, data were analyzed using SAS-callable SUDAAN software (release 10.0; Research Triangle Institute, Research Triangle Park, N.C.) to adjust for the effects of the sampling design, including the unequal probability of selection.

Results

Overall, 44.7% (SE: ±2.4) of adults age 30 years and older in the US had periodontitis during 2011–2012 (Table 1). This estimate was statistically consistent with the 47.2% (SE: ±2.1) reported for NHANES 2009 – 10 cycle. For the combined period of 2009 – 2012 (representing about 141 million adults 30 years and older), the prevalence of periodontitis was 45.9% (Table 1). The mean number of teeth per subject was 24.0 (range 1–28). Sixteen subjects with only one tooth were categorized as not having periodontitis as per the CDC/AAP case definitions because of the requirement for measures from more than one tooth. When the previously used NHANES III and NHANES 2001 – 2004 PMPE protocols were applied to the 2009 – 2012 NHANES data, 18.8% and 26.3% adults age 30 years or older were estimated to have some type of periodontitis, respectively. During 2009 – 2012, the distribution of periodontitis in the adult US population based on the CDC/AAP case definitions was 8.9% for severe periodontitis and 37.1% for other periodontitis (Table 2). Similarly, when periodontitis was classified by the EFP definitions, an estimated 12.0 % and 65.8% were detected for severe and incipient periodontitis, respectively.

The distributions of total periodontitis by race/ethnicity, as well as by socioeconomic and smoking status, are also shown in Table 1. We report results by self-reported race and ethnicity in the four groups for which statistical reliability was adequate. Within the race/ethnic sub-groups, data from 2011–2012 provide the first estimate of a prevalence of 50.0% total periodontitis among Non-Hispanic Asian Americans. For the combined 2009 – 2012 period, periodontitis prevalence was highest in Hispanics (63.5%) and Non-Hispanic blacks (59.1%), and least among Non-Hispanic whites (40.8%). In addition, prevalence was highest among adults with less than high school education, adults below 100% of the Federal Poverty Levels (FPL), and current smokers.

In 2009–2012, 8.9% of adults 30 years and older had severe periodontitis (Table 2). Within socio-demographic groups studied, severe periodontitis was more prevalent among adults age 50 years and older, males, Hispanics and Non-Hispanic blacks, those not completing high school, people living below 200% of the federal poverty level, and current smokers. These risk indicators showed a similar pattern for severe periodontitis when disease was classified by the EFP definition. Table 2 also shows the 2011 – 2012 distribution of periodontitis by case definitions among Non-Hispanic Asian Americans, namely approximately 12% had severe periodontitis and 38% had other periodontitis.

The distribution of attachment loss in 2009 – 2012 by selected thresholds is presented in Table 3. Nearly 88% had one or more sites with CAL ≥ 3 mm, with the estimates reaching the highest prevalence (96.4%) among adults 65+ years, closely followed by widows (95.6%) and smokers (93.6%). Overall, 14.7% of adults age 30 years and older had the most severe attachment loss, i.e., CAL ≥ 7 mm, and the highest prevalence was seen in adults with less than a high school education (27.9%) and current smokers (27.0%). Mean attachment loss for the total adult population surveyed was 1.72 mm in 2009–2012. Results from 2011–2012 indicate that Non-Hispanic Asian Americans experience a mean attachment loss of 1.95mm and 15.4% had CAL ≥ 7mm.

Table 4 shows the distribution of probing depth in 2009 – 2012 by selected thresholds. Approximately 42% of adults had PPD ≥ 4mm at one or more sites. In contrast, the highest prevalence of PPD ≥ 4mm was seen among smokers (63.1%), closely followed by Hispanics (62.7%) and adults living below 100% of the federal poverty level (59%). The highest prevalence of the most severe pocket depths, i.e., PPD ≥ 7mm, was in Hispanics (11.9%) and current smokers (6.8%). Mean probing depth for the total adult population examined was 1.61 mm in 2009–2012. About 5% of Non-Hispanic Asian Americans had a PPD ≥ 7mm and the mean PPD was 1.54 mm in 2011–2012.

The severity and extent of attachment loss and probing depth in 2009 – 2012 is shown in Table 5. At the probing site level, 58.2% of all adults had CAL ≥ 3mm in at least 5% of their probed sites, whereas 21.3% had at least 30% of their probed sites affected by CAL ≥ 3mm. For PPD, 17.0% had PPD ≥ 4mm in at least 5% of their probed sites, while 3.1% had at least 30% of probed sites affected by PPD ≥ 4mm. At the tooth-level, 80.1% of adults had at least 5% of their teeth with CAL ≥ 3mm, while 47.4% had at least 30% of their teeth affected by CAL ≥ 3mm. For PPD, 32.8% had at least 5% of their teeth affected by PPD ≥ 4mm, whereas 12.5% had at least 30% of their teeth affected by PPD ≥ 4mm.

Discussion

Based on CDC/AAP case definitions for periodontitis, the results from this study indicate that about half of non-Hispanic Asian American adults have periodontitis compared to 60% of Hispanic and non-Hispanic blacks. Non-Hispanic Asian Americans had mean pocket depth prevalence similar to non-Hispanic whites and mean attachment loss prevalence similar to Hispanics.

NHANES 2009 – 2012 estimated that about 46% of the U.S. dentate adults aged 30 years and older (representing approximately 141.0 million adults) had periodontitis, with 8.9% having severe periodontitis and 37.1% having “other” periodontitis which was less severe. About 88% had CAL ≥ 3mm and 42% PPD ≥ 4mm at one or more sites. These findings are consistent with our previous report based on 2009 – 2010 NHANES,[1] signifying a much higher prevalence of periodontitis in the adult US population than previously reported. These US estimates appear to be much lower than those reported from certain European populations. For example, a large population based study in West Pomerania in the former East Germany used the original CDC/AAP no/mild, moderate, and severe case definitions[16] among 3,255 persons aged 20–79 years, assessing four sites on all teeth other than third molars in two quadrants (half-mouth).[19] They found 20.0% (versus 8.9% in NHANES 2009–2012) with *severe* and 35.3% (versus 30.9%) *moderate* periodontitis, leaving less than half (44.7%) the population with only mild or no periodontitis.[19] This is in spite of inclusion of individuals up to ten years younger than the NHANES participants and exclusion of those 80 years and older.

Our findings confirm disparities in the burden of periodontitis by socio-demographic segments of the population. Beginning in 2011 – 2012, for the first time in any US national examination survey, NHANES oversampled Non-Hispanic Asian-Americans to generate more stable prevalence estimates in that sub-population. Among racial and ethnic groups,

Hispanics had the highest prevalence of periodontitis, closely followed by Non-Hispanic blacks, then Non-Hispanic Asian Americans, and Non-Hispanic Whites had the lowest. The prevalence of periodontitis increased with increasing poverty levels and lower education, with about 62% of persons with less than 100% of FPL having periodontitis. Overall, the highest prevalence of periodontitis in the adult US population was seen among Hispanics, adults with the lowest education, with less than 100% of FPL, and current smokers. These socio-demographic patterns remain consistent with findings from previous NHANES,[1,20] although more detailed multivariable analyses controlling for factors associated with prevalence of periodontitis will be required to confirm these observations.

Strengths and Limitations

The greatest strengths of this report are the large dataset combined from two nationally representative NHANES survey cycles and the unprecedented application of a full-mouth periodontal examination protocol that together result in the hitherto most valid representation of persons, teeth, and sites assessed. Examining all 28 teeth is superior to assessing only index teeth (or their replacements) or all seven teeth in random quadrants (excluding the third molars) in estimating disease prevalence.[9,10,13,14] Moreover, the gold standard in clinical periodontal examinations is clinical assessment for periodontal measures at six sites around each tooth. NHANES 2009–2012 applied this gold standard and assessed both periodontal probing depth and location of the cemento-enamel junction (CEJ) in order for clinical attachment loss to be calculated. This protocol allows estimation of the true presence of periodontitis, as periodontitis is defined as a combination of probing depth and attachment level/loss. Examining all teeth and probing six sites on each for both PPD and CEJ optimize the potential to capture true disease. Additionally, the comprehensive FMPE optimizes the utilization of standard case definitions for surveillance of periodontitis and is hence more likely to capture true disease. Collectively, these factors ensure minimal misclassification of disease status in the population and produce a historic dataset that is highly superior to previous NHANES data for surveillance and epidemiologic research alike.

However, several factors may still have led to underestimation of disease prevalence. Notably, using conservative case definitions that do not incorporate measurements from all six sites may underestimate disease. For example, the conservative CDC/AAP case definitions are based on only measurements from the four interproximal sites due to the assumption that those sites are most often affected. Thus, measurements from the mid-buccal and the mid-lingual sites -- that potentially could indicate furcation involvement -- are not included in the prevalence calculations. Besides, neither bleeding on probing (indicative of active inflammation) nor furcation involvement were assessed, although such measures could provide additional information regarding periodontal disease status when applying different case definitions. Our prevalence estimates only include gingivitis that may accompany periodontitis cases detected, but do not include individuals with gingivitis only, due to lack of measurements of gingivitis. Hence, the prevalence of cases that include all forms of periodontal disease would likely be even higher. No data were collected around third molars so any disease present on those teeth was automatically missed. Finally, exclusion of individuals for medical reasons, incomplete oral examinations for any reason,

and not sampling institutionalized persons, for instance nursing home residents, may have introduced some selection bias.

In conclusion, this study confirms the high burden of periodontitis in the US with nearly half (45.9%) the population aged 30 years and older affected. A better understanding of the factors influencing these findings and the disparities among socio-demographic groups is important for public health action to prevent and control periodontitis in US adults. Also, our findings will provide a firm baseline for comparison with future NHANES studies to determine trends in periodontitis in US adults.

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Table 1

Prevalence of total penodontitis using NHANES 2009–2012 data by selected characteristics and individual NHANES cycles for persons 30 years and older in the United States 2009–2010 and 2011–2012.

	NHANES 2009–2010				NHANES 2011–2012				NHANES 2009–2012 (NHANES 2009–2010 & 2011–2012)			
	N	Weighted N Million	Total Periodontitis %±SE	Total Periodontitis Age Standardized %±SE	N	Weighted N Million	Total PD %±SE	Total Periodontitis Age Standardized %±SE	N	Weighted N Million	Total PD %±SE	Total Periodontitis Age Standardized %±SE
NHANES 2009–2012	3,743	137.1	47.2±2.1	47.7±1.9	3,323	144.8	44.7±2.4	45.2±2.2	7,066	141.0	45.9±1.6	46.47±1.5
¶ NHANES III Protocol	3,733	136.8	19.5±1.9	19.6±1.8	3,310	144.6	18.2±1.1	18.211.1	7,043	140.7	18.8±1.1	18.87±1.1
∝ NHANES 2001–2004 Protocol	3,733	136.8	27.1±2.0	27.3±1.9	3,311	144.6	25.6±1.3	25.5±1.4	7,044	140.7	26.3±1.2	26.3±1.2
Age (Mean No. Teeth: 24.0)												
30–34 years (26.5 teeth)	435	16.7	24.4±2.7	St*	411	17.7	25.3±2.6	St*	846	17.2	24.8±1.9	St*
35–49 years (25.5 teeth)	1,352	54.0	36.6±1.6	St*	1,143	54.0	37.8±2.9	St*	2,495	54.0	37.2±1.7	St*
50–64 years (23.2 teeth)	1,128	43.4	57.2±2.6	St*	1,086	48.4	48.7±3.5	St*	2,214	45.9	52.7±2.3	St*
65±years (20.6 teeth)	828	22.9	70.1±3.0	St*	683	24.7	66.0±3.0	St*	1,511	23.8	68.0±2.2	St*
Sex												
Male	1,872	67.5	56.4±2.1	56.8±1.9	1,643	70.5	53.4±2.4	53.9±2.3	3,515	69.0	54.9±1.6	55.3±1.5
Female	1,871	69.6	38.4±2.4	38.8±2.2	1,680	74.3	36.5±2.6	36.9±2.3	3,551	72.0	37.4±1.8	37.8±1.6
Race/Ethnic Group												
Hispanics	673	10.9	66.72.3	70.4±1.8	355	11.1	60.4±2.3	66.6±2.4	1,028	11.0	63.5±1.7	68.4±1.5
Non-Hispanic Asian American*	n/a	n/a	n/a	n/a	478	7.6	50.0±3.7	51.9±3.8	n/a	n/a	n/a	n/a
Non-Hispanic White	1,792	95.1	42.6±3.0	41.5±2.6	1,226	98.8	39.0±2.7	38.2±2.2	3,018	97.0	40.8±2.1	39.8±1.8
Non-Hispanic Black	673	15.0	58.6±3.1	59.7±3.0	839	15.3	59.7±3.2	59.9±2.8	1,512	15.1	59.1±2.2	59.8±2.0
Education												
< High school	1,030	23.8	66.9±2.4	66.7±2.3	754	22.3	67.1±2.4	66.8±2.4	1,784	23.1	67.0±1.7	66.7±1.7
High school	815	29.6	53.5±3.2	53.6±3.0	699	29.4	57.9±2.9	57.9±2.9	1,514	29.5	55.7±2.2	55.7±2.1
>High school	1,889	83.3	39.3±2.3	40.5±2.2	1,868	93.2	35.2±2.2	36.2±2.0	3,757	88.3	37.2±1.6	38.1±1.5
Poverty Level												
< 100% FPL	625	13.5	65.4±2.5	67.6±2.9	632	17.4	59.8±2.1	60.9±2.0	1,257	15.5	62.2±1.6	63.7±1.6
100–199% FPL	901	22.7	57.4±3.0	59.3±3.0	782	27.1	56.6±2.5	57.8±2.7	1,683	24.9	57.0±2.0	58.3±2.0

	NHANES 2009–2010				NHANES 2011–2012				NHANES 2009–2012 (NHANES 2009–2010			
	N	Weighted N Million	Total Periodontitis %±SE	Total Periodontitis Age Standardized %±SE	N	Weighted N Million	Total PD %±SE	Total Periodontitis Age Standardized %±SE	N	Weighted N Million	Total PD %±SE	Per Stan
200–499% FPL	905	37.7	50.2±2.5	49.7±2.6	755	37.4	46.2±4.9	46.0±4.3	1,660	37.6	48.2±2.7	4
≥400% FPL	960	52.4	35.4±3.0	35.2±2.3	888	54.3	30.7±1.8	30.7±1.5	1,848	53.4	33.0±1.8	3
Marital status												
Married	2,196	88.5	44.2±2.2	44.3±2.1	1,853	88.1	39.5±2.3	39.9±2.1	4,049	88.4	41.9±1.7	4
Widowed	292	7.6	62.2±4.5	44.1±6.9	233	7.0	60.2±5.6	51.8±7.2	525	7.3	61.3±3.6	4
Divorced	472	16	49.4±2.8	49.6±2.9	402	18.1	57.4±4.5	55.3±4.0	874	17.1	53.6±2.7	5
Separated	145	3.4	60.9±5.9	65.5±6.8	151	4.2	60.3±7.9	65.9±6.4	296	3.8	60.6±5.1	6
Never married	390	13	45.7±2.9	56.2±2.8	431	16.6	44.1±3.7	49.1±3.8	821	14.8	44.8±2.5	5
Living with partner	245	8.1	57.6±4.2	60.4±4.5	250	10.8	51.2±5.2	55.6±5.1	495	9.5	54.0±3.5	5
Smoking status												
Current smoker	728	23.2	64.2±2.6	68.7±2.6	610	25.9	68.7±2.5	72.4±2.2	1,338	24.6	66.6±1.8	7
Former smoker	957	35.7	52.5±3.1	46.5±2.6	812	38.3	45.0±3.4	42.1±2.8	1,769	37.1	48.7±2.5	4
Non smoker	2,058	78.1	39.8±2.1	41.4±2.0	1,898	80.5	36.8±2.1	38.3±1.8	3,956	79.3	38.3±1.5	3

Age standardized, standardized to age distribution of the 2000 US population; CAL, clinical attachment loss; PPD, periodontal probing depth; SE, standard error; total periodontitis, sum of prevalence of mild, moderate, and severe periodontitis according to the CDC/AAP case definitions;[15] weighted, source population represented applying mobile examination center (MEC) weights, FPL, federal poverty level. NHANES, National Health and Nutrition Examination Survey;

[*] Oversampling of Non-Hispanic Asian Americans only inNHANES 2011–2012. St*age standardized age groups

[¶] NHANES III protocol, NHANES III protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocols used in NHANES III and 1999–2000 using PPD and CAL measurements only from two sites per tooth (mid-buccal and mesio-buccal sites) from all teem other man third molars in two randomly selected quadrants; NHANES 2001–2004 protocol;

[∞] NHANES 2001–2004 protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocol used in NHANES 2001–2004 using measurements of PPD and CAL only from three sites per tooth (mid-buccal, mesio-buccal, and disto- buccal sites) from all teem other than third molars in two randomly selected quadrants.

Table 2

Prevalence of severe penodontitis by CDC/AAP and EFP case definitions using NHANES 2009 – 2012 by selected characteristics for adults 30 years and older

	N	Weighted N (in millions)	Periodontitis (CDC/AAP Case Definitions[15])				Periodontitis (EFP Case Definitions[18])			
			Severe %	SE	Other %	SE	Severe %	SE	Incipient %	SE
NHANES 2009–2012	7,066	141.0	8.9	0.6	37.1	1.5	12.0	0.7	65.8	1.0
¶ NHANES III Protocol	7,043	140.7	1.6	0.2	17.2	1.0	6.5	0.5	39.8	1.4
∝ NHANES 2000–2004 Protocol	7,044	140.7	3.1	0.4	23.2	1.0	7.9	0.5	42.4	1.4
Age (Mean:24.0 teeth)										
30–34 years (26.5 teeth)	846	17.2	2.2	0.5	22.7	1.8	2.1	0.5	51.9	2.6
35–49 years (25.5 teeth)	2,495	54.0	7.5	0.8	29.7	1.4	8.1	0.7	16.0	1.5
50–64 years (23.2 teeth)	2,214	45.9	11.9	1.0	40.8	2.2	15.8	1.2	70.0	1.5
65+years (20.6 teeth)	1,511	23.8	11.0	1.4	57.0	2.2	20.6	1.6	71.0	1.7
Sex										
Male	3,515	69.0	13.3	0.9	41.6	1.7	16.5	0.9	68.1	1.3
Female	3,551	72.0	4.7	0.5	32.7	1.7	7.6	0.6	63.6	1.1
Race/Ethnic Group										
Hispanics	1,028	11.0	15.8	1.7	47.7	1.9	16.8	1.4	70.3	1.6
Non-Hispanic Asian American*	478	7.6	12.1	2.0	37.8	2.6	12.6	2.5	73.0	2.1
Non-Hispanic White	3,018	97.0	6.8	0.7	34.0	1.9	9.9	0.9	65.4	1.4
Non-Hispanic Black	1,512	15.1	15.6	1.4	43.5	1.5	19.2	1.6	61.6	1.5
Education										
< High school	1,784	23.1	17.1	1.5	49.9	1.7	24.7	1.6	62.5	1.7
High school	1,514	29.5	11.9	0.9	43.8	2.0	17.7	1.4	65.3	1.6
>High school	3,757	88.3	5.7	0.6	31.4	1.6	6.8	0.6	66.8	1.3
Poverty Level										
< 100% FPL	1,257	15.5	14.9	1.2	47.4	2.0	21.7	1.6	64.4	1.7
100–199% FPL	1,683	24.9	13.7	1.4	43.3	2.3	19.3	1.3	64.2	1.6
200–499% FPL	1,660	37.6	8.0	0.9	40.1	2.4	11.1	1.1	65.5	1.6
≥400% FPL	1,848	53.4	4.9	0.7	28.0	1.6	5.9	0.7	66.4	1.6
Marital status										

	N	Weighted N (in millions)	Periodontitis (CDC/AAP Case Definitions[15])				Periodontitis (EFP Case Definitions[18])			
Married	4,049	88.4	7.4	0.6	34.4	1.6	10.1	0.6	65.0	1.0
Widowed	525	7.3	11.1	1.5	50.2	3.4	23.5	2.6	67.0	2.2
Divorced	874	17.1	12.5	1.6	41.1	3.2	15.8	2.1	67.9	2.9
Separated	296	3.8	17.3	3.9	43.3	4.4	19.7	3.5	65.4	3.4
Never married	821	14.8	7.8	1.2	37.0	2.0	9.5	1.1	67.6	2.0
Living with partner	495	9.5	12.7	1.7	41.3	3.3	14.2	1.8	66.3	3.1
Smoking status										
Current smoker	1,338	24.6	18.9	1.7	47.7	2.1	25.6	1.8	62.0	2.0
Former smoker	1,769	37.1	9.5	1.0	39.2	2.4	13.5	1.2	66.9	1.6
Non smoker	3,956	79.3	5.5	0.6	32.8	1.3	7.0	0.6	66.4	1.2

Age standardized, standardized to age distribution of the 2000 US population; CAL, clinical attachment loss; PPD, periodontal probing depth; SE, standard error; total periodontitis, sum of prevalence of mild, moderate, and severe periodontitis according to the CDC/AAP case definitions;[15] weighted, source population represented applying mobile examination center (MEC) weights, FPL, federal poverty level. NHANES, National Health and Nutrition Examination Survey;

[*] Oversampling of Non-Hispanic Asian Americans only in NHANES 2011–2012.

[¶] NHANES III protocol, NHANES III protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocols used in NHANES III and 1999–2000 using PPD and CAL measurements only from two sites per tooth (mid-buccal and mesio-buccal sites) from all teeth other than third molars in two randomly selected quadrants; NHANES 2001–2004 protocol,

[∞] NHANES 2001–2004 protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocol used in NHANES 2001–2004 using measurements of PPD and CAL only from three sites per tooth (mid-buccal, mesio-buccal, and disto- buccal sites) from all teeth other man third molars in two randomly selected quadrants.

Table 3

Prevalence of clinical attachment loss (CAL) by severity and overall mean CAL by selected characteristics for persons 30 years and older, United States, NHANES 2009 – 2012

	Severity of Clinical Attachment Loss (CAL)										Mean CAL mm	SE
	≥3mm	SE	≥4mm	SE	≥5mm	SE	≥6mm	SE	≥7mm	SE		
Total	88.1	0.8	60.8	1.6	40.9	1.4	24.2	1.0	14.7	0.6	1.72	0.03
Age (Mean:24.0 teeth)												
30–34 years (26.5 teeth)	72.3	1.8	32.6	2.3	16.4	1.8	8.3	1.0	3.2	0.7	1.23	0.04
35–49 years (25.5 teeth)	85.7	1.1	51.8	2.2	32.4	1.9	17.0	1.2	10.4	0.8	1.52	0.04
50–64 years (23.2 teeth)	92.6	1.3	71.4	1.8	49.0	2.0	30.1	1.8	18.8	1.0	1.94	0.06
65+ years (20.6 teeth)	96.4	0.7	81.5	1.8	62.3	1.7	40.7	1.8	24.7	1.5	2.14	0.06
Sex												
Male	92.0	0.9	68.4	1.6	49.2	1.5	30.6	1.2	19.4	0.9	1.95	0.04
Female	84.4	1.1	53.6	1.9	33.0	1.7	18.0	1.1	10.1	0.7	1.50	0.03
Race/Ethnic Group												
Hispanics	95.0	0.9	71.6	1.6	52.1	2.5	33.9	2.0	21.8	1.7	2.01	0.06
Non-Hispanic Asian American*	92.9	0.8	65.0	3.3	41.2	3.2	27.4	3.1	15.4	2.0	1.95	0.11
Non-Hispanic White	86.6	1.2	57.2	2.0	37.0	1.8	20.5	1.3	11.8	0.8	1.62	0.04
Non-Hispanic Black	90.0	1.3	69.7	2.1	51.1	2.0	35.7	2.0	23.7	1.5	2.09	0.08
Education												
< High school	93.7	0.9	77.0	1.7	59.8	1.8	42.0	2.3	27.9	1.6	2.35	0.07
High school	90.2	1.1	68.2	2.0	48.9	1.7	30.8	1.8	20.4	1.0	1.95	0.05
>High school	86.0	1.0	54.1	1.7	33.2	1.5	17.4	1.0	9.3	0.6	1.48	0.03
Poverty Level												
< 100% FPL	92.4	1.4	71.8	1.6	52.4	1.4	35.2	1.6	23.2	1.4	2.25	0.06
100–199% FPL	92.9	0.9	68.4	1.5	48.3	1.7	32.2	1.6	21.4	1.2	2.04	0.05
200–499% FPL	87.4	1.2	63.0	2.7	43.2	2.7	24.9	2.1	14.5	1.2	1.69	0.05
≥400% FPL	84.8	1.4	51.3	2.0	31.0	1.7	15.6	0.9	8.4	0.7	1.43	0.03
Marital status												
Married	86.8	0.9	56.7	1.7	37.6	1.4	21.6	1.0	12.8	0.6	1.62	0.03
Widowed	95.6	1.2	79.7	2.3	59.1	3.1	38.8	2.3	24.0	2.0	2.15	0.08

	Severity of Clinical Attachment Loss (CAL)										Mean CAL mm	SE
	≥3mm	SE	≥4mm	SE	≥5mm	SE	≥6mm	SE	≥7mm	SE		
Divorced	92.2	1.1	69.2	3.2	47.2	2.9	29.2	2.1	19.2	2.1	1.93	0.07
Separated	92.0	2.2	73.6	2.9	57.0	4.3	35.0	4.4	23.7	3.3	2.12	0.13
Never married	86.7	1.6	60.0	2.8	36.1	3.0	20.8	2.4	11.4	1.4	1.68	0.06
Living with partner	88.2	2.3	65.2	3.7	47.0	3.6	28.4	2.5	18.0	2.1	1.92	0.09
Smoking status												
Current smoker	93.6	1.0	75.2	1.4	58.3	1.8	41.6	1.9	27.0	1.6	2.40	0.08
Former smoker	89.6	1.1	65.8	2.3	43.9	2.5	27.8	2.0	16.4	1.3	1.78	0.06
Non smoker	85.8	0.9	54.1	1.8	34.1	1.4	17.2	1.0	10.0	0.6	1.49	0.03

age standardized, standardized to age distribution of the 2000 US population; CAL, clinical attachment loss; FPL, federal poverty level; mean CAL is average attachment loss in millimeters of all assessed sites; NHANES, National Health and Nutrition Examination Survey; NHANES III protocol, NHANES III protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocols used in NHANES III and 1999–2000 of using PPD and CAL measurements only from two sites per tooth (mid-buccal and mesio-buccal sites) from all teeth other than third molars in two randomly selected quadrants; NHANES 2001–2004 protocol, NHANES 2001–2004 protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocol used in NHANES 2001–2004 using measurements of PPD and CAL only from three sites per tooth (mid-buccal, mesio-buccal, and disto-buccal sites) from all teeth other than third molars in two randomly selected quadrants; PPD, periodontal probing depth; SE, standard error; total periodontitis, sum of prevalence of mild, moderate, and severe periodontitis according to the CDC/AAP case definitions.[15]

* Oversampling of Non-Hispanic Asian Americans only in NHANES 2011–2012.

Table 4

Prevalence of periodontal probing depth (PPD) by severity and overall mean PPD by selected characteristics for persons 30 years and older in the United States, NHANES 2009–2012

	Severity of periodontal probing depth (PPD)										Mean PPD mm	SD
	≥3mm	SE	≥4mm	SE	≥5mm	SE	≥6mm	SE	≥7mm	SE		
Total	79.6	1.2	42.1	1.3	19.6	1.0	10.2	0.8	4.1	0.4	1.61	0.02
Age groups												
30–34'	71.0	2.4	32.3	2.3	12.0	1.2	5.9	1.0	1.8	0.5	1.47	0.03
35–49'	77.6	1.4	39.2	1.8	18.1	1.3	9.4	1.0	3.8	0.5	1.60	0.03
50–64'	83.1	1.7	46.1	1.9	22.7	1.4	12.0	1.1	5.0	0.7	1.66	0.03
65+	83.8	1.8	48.3	2.4	22.7	2.0	11.9	1.4	4.7	0.8	1.64	0.03
Gender												
Male	85.3	1.4	50.6	1.3	26.4	1.2	14.4	1.1	6.3	0.7	1.76	0.03
Female	74.1	1.4	34.0	1.5	13.1	0.9	6.2	0.7	2.0	0.4	1.46	0.02
Race/Ethnic Group												
Hispanics	91.5	1.1	62.7	2.4	35.9	2.9	21.6	2.4	11.9	2.0	1.95	0.05
Non-Hispanic Asian American*	80.5	3.0	45.4	3.0	22.9	2.6	12.3	1.8	5.1	0.9	1.54	0.07
Non-Hispanic White	76.9	1.6	36.9	1.6	15.6	1.2	7.5	0.8	2.6	0.3	1.52	0.03
Non-Hispanic Black	86.5	1.3	56.8	1.8	31.8	2.2	18.6	1.8	8.2	1.0	1.89	0.05
Education												
< High school	86.4	1.4	59.4	1.6	32.3	2.5	17.5	1.6	7.4	1.1	1.96	0.05
High school	83.7	2.1	50.1	2.1	25.6	1.4	13.4	1.3	5.0	0.7	1.71	0.04
>High school	76.5	1.3	34.9	1.5	14.3	1.1	7.2	0.7	3.0	0.4	1.48	0.02
Poverty Level												
< 100% FPL	87.9	1.1	59.0	1.6	30.6	1.6	16.1	1.4	6.2	1.1	1.92	0.03
100–199% FPL	84.8	1.4	53.1	1.7	25.1	1.9	14.1	1.5	6.0	0.8	1.80	0.04
200–499% FPL	80.8	1.5	42.9	2.3	20.4	1.9	10.5	1.1	4.3	0.6	1.59	0.03
>=400% FPL	73.0	2.1	30.2	1.7	12.2	1.3	5.6	0.7	2.3	0.4	1.43	0.03
Marital status												
Married	77.8	1.3	38.3	1.5	16.9	1.0	8.2	0.6	3.4	0.3	1.55	0.03
Widowed	80.5	2.7	45.8	3.5	23.0	2.7	12.9	1.8	5.1	1.3	1.66	0.04

	Severity of periodontal probing depth (PPD)										Mean PPD mm	SD
	≥3mm	SE	≥4mm	SE	≥5mm	SE	≥6mm	SE	≥7mm	SE		
Divorced	82.5	1.7	50.5	2.9	24.5	1.6	13.6	1.7	5.6	1.1	1.69	0.04
Separated	87.7	3.5	55.9	4.3	31.3	4.8	19.4	3.7	6.9	1.3	1.89	0.08
Never married	81.8	1.9	42.4	3.0	18.3	2.3	9.7	1.4	4.2	0.9	1.64	0.04
Living with partner	84.5	2.8	54.0	3.4	31.5	2.6	17.9	2.3	5.7	1.4	1.79	0.06
Smoking status												
Current smoker	88.7	1.4	63.1	1.7	34.6	2.2	18.5	2.1	6.8	1.1	1.99	0.05
Former smoker	80.5	1.4	43.5	2.2	18.6	1.4	10.4	1.1	4.9	0.7	1.58	0.03
Non smoker	76.4	1.5	35.0	1.6	15.5	1.0	7.6	0.7	2.9	0.4	1.51	0.03

age standardized, standardized to age distribution of the 2000 US population; CAL, clinical attachment loss; FPL, federal poverty level; NHANES, National Health and Nutrition Examination Survey; NHANES III protocol, NHANES III protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocols used in NHANES III and 1999–2000 of using PPD and CAL measurements only from two sites per tooth (mid-buccal and mesio-buccal sites) from all teeth other than third molars in two randomly selected quadrants; NHANES 2001–2004 protocol, NHANES 2001–2004 protocol applied to NHANES 2009–2012 data: prevalence estimates based on the PMPE protocol used in NHANES 2001–2004 using measurements of PPD and CAL only from three sites per tooth (mid-buccal, mesio-buccal, and disto-buccal sites) from all teeth other than third molars in two randomly selected quadrants; PPD, periodontal probing depth; SE, standard error; total periodontitis, sum of prevalence of mild, moderate, and severe periodontitis according to the CDC/AAP case definitions;[15] weighted, source population represented applying mobile examination center (MEC) weights.

*Oversampling of Non-Hispanic Asian Americans only in NHANES 2011–2012.

Table 5

Prevalence and extent of penodontal probing depth (PPD) and clinical attachment loss (CAL) by severity and selected characteristics for persons 30 years and older in the United States, NHANES 2009–2012

	Extent	Severity									
		≥ 3mm		≥ 4mm		≥ 5mm		≥6mm		≥ 7mm	
Site-specific:		%	SE	%	SE	%	SE	%	SE	%	SE
PPD:	≥5% sites	44.9	2.2	17.0	0.9	6.3	0.6	2.4	0.3	0.6	0.09
	≥10% sites	31.2	1.8	10.6	0.6	3.1	0.4	1.2	0.2	0.2	0.05
	≥30% sites	12.8	1.0	3.1	0.4	0.8	0.1	0.2	0.04	0.02	0.01
Mean % sites		11.9	0.7	3.8	0.2	1.2	0.1	0.5	0.05	0.1	0.01
CAL:	≥5% sites	58.2	1.6	31.8	1.4	17.3	0.8	9.7	0.5	5.3	0.4
	≥10% sites	43.8	1.6	21.9	1.0	11.7	0.6	6.4	0.4	3.6	0.3
	≥30% sites	21.3	1.0	10.0	0.7	5.0	0.4	2.9	0.3	1.6	0.2
Mean % sites		19.3	0.8	9.8	0.5	5.2	0.3	2.9	0.2	1.5	0.1
Tooth-specific:											
PPD:	≥5% teeth	70.6	1.6	32.8	1.2	14.6	0.8	7.1	0.7	2.5	0.3
	≥10% teeth	61.4	1.9	25.7	0.9	10.4	0.7	4.6	0.5	1.5	0.2
	≥30% teeth	35.5	2.0	12.5	0.7	3.9	0.4	1.5	0.2	0.3	0.05
Mean% teeth		28.4	1.3	10.6	0.5	3.7	0.3	1.6	0.2	0.5	0.05
CAL:	≥5% teeth	80.1	1.1	49.5	1.7	31.5	1.2	18.0	0.8	10.7	0.5
	≥10% teeth	73.2	1.4	42.4	1.5	24.7	0.9	13.4	0.6	7.9	0.5
	≥30% teeth	47.4	1.7	23.4	1.0	12.0	0.7	6.4	0.4	3.5	0.3
Mean % teeth		37.4	1.1	19.2	0.8	10.6	0.5	5.9	0.3	3.2	0.2

CAL, clinical attachment loss; PPD, periodontal probing depth; SE, standard error.