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Heterogeneity in Periodontitis Prevalence in the Hispanic Community Health Study/Study of Latinos

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Abstract

Purpose—To examine acculturation and established risk factors in explaining variation in periodontitis prevalence among Hispanic/Latino subgroups.

Methods—Participants were 12,730 dentate adults aged 18–74 years recruited into the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) from four U.S. field centers between 2008 and 2011. A standardized periodontal assessment measured probing pocket depth and gingival recession at six sites per tooth for up to 28 teeth. Periodontitis was defined according to the CDC/AAP case classifications developed for population surveillance. Covariates included acculturation indicators and established periodontitis risk factors. Survey estimation procedures took account of the complex sampling design. Adjusted multivariate binomial regression estimated prevalence ratios (PR) and 95% confidence limits (95% CL).

Results—Unadjusted prevalence of moderate/severe periodontitis was 38.5% and ranged from 24.7% among Dominicans to 52.1% among Cubans. Adjusted prevalence ratios for subgroups relative to Dominicans were: 1.34 (95% CL: 1.13, 1.58) among South Americans; 1.37 (95% CL: 1.17, 1.61) among Puerto Ricans; 1.43 (95% CL: 1.25, 1.64) among Mexicans; 1.53 (95% CL: 1.32, 1.76) among Cubans; and 1.55 (95% CL: 1.35, 1.78) among Central Americans.

Conclusion—Heterogeneity in prevalence of moderate/severe periodontitis among Hispanic/Latino subpopulations was not explained by acculturation or periodontitis risk factors.

MeSH heading keywords

Acculturation; American; Hispanic; Chronic Periodontitis; Effect Modifier; Epidemiologic; Epidemiology; Population Groups; Risk Factors

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INTRODUCTION

People of Hispanic/Latino origin will constitute 29% of the U.S. population by 2050 according to Pew Hispanic Center projections, while non-Hispanic whites will constitute less than 50% (1). This shift in the national demographic profile will likely have public health implications for burden of disease, its distribution and determinants.

Paradoxically given language barriers, high poverty rates and low health insurance coverage, Hispanics/Latinos enjoy health advantages. Notably, their life expectancy at birth in 2010 of 81.3 years exceeded 78.8 years for non-Hispanic whites and 74.7 years for non-Hispanic blacks (2). In addition, according to 2000–2009 cancer registry data, incidence and mortality rates for the four most common cancers—breast, prostate, colorectal, and lung/bronchus—were lower among Hispanics/Latinos than non-Hispanic whites (3).

Nonetheless Hispanics/Latinos bear a greater burden of metabolic syndrome (4, 5) and diabetes mellitus (6–8); conditions associated with periodontitis. Components of metabolic syndrome including obesity, high triglycerides, low high-density lipoprotein cholesterol, hypertension and high plasma glucose are associated with periodontal parameters of gingival bleeding, periodontal pocket depth and clinical loss of attachment (9–16). Likewise, diabetes is a major etiologic risk factor for periodontitis (17) and in people with diabetes, periodontal infection is associated with greater carotid artery intimal-medial wall thickness and elevated risk of coronary heart disease (18).

Periodontitis is characterized by inflammatory and immune host responses to pathogenic microorganisms and their byproducts. The hallmark of the disease is destruction of connective tissue and alveolar bone surrounding the teeth, which can to tooth loss if left untreated.

Prevalence of periodontitis is higher in Hispanic/Latinos than U.S. non-Hispanic whites (19), but little is known about variation in periodontal health among Hispanic/Latino subgroups. Only recently has the non-Mexican component become sufficiently large to yield reliable estimates for country of origin. This reveals substantial heterogeneity in established risk factors for periodontitis including diabetes (20, 21) anthropometric characteristics and cigarette smoking history (22). It is likely that these risk profiles alter with the acquisition of cultural characteristics of United States's society, i.e. the process of acculturation.

The aims of this epidemiologic study were to compare periodontitis prevalence among Hispanic/Latino subgroups and to determine the extent to which acculturation and established periodontitis risk factors accounted for variation in prevalence.

METHODS

Study setting, design and subjects

Details of design, implementation methods and data collection for the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) are published (23, 24). In brief, the HCHS/SOL is a multicenter, population-based prospective cohort study of Hispanic/Latino adults, sponsored by the National Heart, Lung, and Blood Institute and other affiliated

bodies of the U.S. National Institutes of Health. Its purpose is to investigate prevalence of a wide range of health conditions and to identify disease risk factors including effects of acculturation. The study employed a stratified two-stage area probability design in which household addresses were sampled within contiguous census tract districts within each of the four field centers located in the Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA. Selected households were screened for eligibility by in-person visits or telephone contact. Between March 2008 and June 2011 approximately 4,000 individuals aged 18–74 years were recruited from each field center, yielding 16,415 participants. On enrollment they completed questionnaires, underwent a standardized physical examination and 15,848 (97%) had a dental examination. The study was approved by Institutional Review Boards of all relevant institutions and participants gave written informed consent.

Periodontal Assessment and Periodontitis Case Definitions

Eighteen dental examiners conducted the periodontal assessments for dentate participants not requiring prophylactic antibiotics. Each site had its own examiners (Chicago [n=8], the Bronx [n=4], San Diego [n=4] Miami [n=2]). All examiners received calibration training together with one reference examiner. Measures of reliability were made against the standard examiner and between examiners in each center. The examination was conducted in three 1-year waves and examiners were recalibrated each year (2008–2010) against a gold standard examiner who had participated in NHANES examinations. The mean Inter-class Correlation Coefficient (ICC), Percent Agreement, and Kappa Statistic for Probing Depths within 1mm were 0.95, 95.8, and 0.94, respectively. The mean ICC, Percent Agreement and Kappa for Attachment Loss within 1mm were 0.86, 92.8 and 0.84 respectively. Probing pocket depth and recession were measured at six sites per tooth (distal-facial, mid-facial, mesial-facial, mesial-lingual, mid-lingual, distal-lingual) on all permanent teeth, excluding third molars, to calculate clinical loss of attachment. Periodontitis was classified according to the Centers for Disease Control and Prevention (CDC) and American Academy of Periodontology (AAP) definitions for mild, moderate and severe periodontitis based on measurements taken from interproximal sites (25).

Mild: 2 interproximal sites with 3mm clinical attachment loss and 2 interproximal sites with 4mm pocket depth (not on the same tooth) or 1 site with 5mm pocket depth

Moderate: 2 interproximal sites with clinical attachment loss 4 mm (not on same tooth); or 2 interproximal sites with pocket depth 5 mm (not on same tooth)

Severe: 2 interproximal sites with clinical attachment loss 6 mm (not on same tooth) and 1 interproximal site with pocket depth 5 mm

Individuals not meeting disease criteria for mild periodontitis were defined as having “periodontal health”.

Acculturation

Acculturation was measured using conventional markers of nativity status (U.S. born, foreign born), language preference (English, Spanish) and duration of U.S. residence (grouped as <10, 10–19, 20 years).

Socio-Demographic Characteristics

Participants self-identified as of Dominican, Central American, Cuban, Mexican, Puerto Rican, South American, or mixed background/other. We use the joint term Hispanic/Latino, noting that Hispanic refers to persons of Spanish-speaking background, while Latino refers more generally to Latin American background. Educational attainment was grouped as non-completion of high school; attainment of a high school diploma or equivalent; or education beyond a high school. Annual household income was grouped as: <\$15,000; \$15,000–<\$30,000; \$30,000. Subjective social status was depicted diagrammatically with a ladder on which higher rungs denote more money, higher education and better jobs (26). In univariate analysis the ladder was grouped into rungs 0–3, 4–6 and 7–10.

Anthropometric Measures

Body mass index and waist-hip ratio are markers of generalized adiposity and central adiposity respectively and predictive of diabetes (27), coronary heart disease (28), periodontitis (29, 30) and periodontal disease progression (31). Standing height was measured using a stadiometer. The Tanita body composition analyzer measured weight. Body mass index (BMI) was categorized using World Health Organization cut-points: underweight or normal (BMI < 25 kg/m²); overweight (BMI 25–< 30 kg/m²); and obese (BMI ≥ 30 kg/m²). Waist and hip circumference were recorded to the nearest centimeter and the waist-hip ratio was dichotomized at sex-specific cut-points of 0.85 for women and 0.90 for men (32).

Smoking and Diabetes

The question “Have you ever smoked at least 100 cigarettes in your entire life?” identified lifetime non-smokers and, “Do you now smoke daily, some days or not at all?” distinguished current (daily, some days) from former smokers (not at all). Coding of diabetes status took account of the laboratory measures of fasting serum glucose adjusted for fasting time, post-OGTT glucose levels), percent glycosylated hemoglobin (A1C), along with scanned/transcribed anti-diabetic medication use. Diabetes status was based on the American Diabetes Association stages of non-diabetic, pre-diabetic and diabetic (33). It also coded as diabetic any participant who reported being diabetic.

Dental Utilization

Dental care utilization was assessed with the question, “About how long has it been since you last visited a dentist?” with instruction to include visits with dental hygienists and all kinds of dental specialists. Response options were grouped (≤ 1 year; >1 year, ≤ 5 years; >5 years or not ever visited).

Statistical Methods

Of the 16,415 HCHS/SOL enrolled participants, 2,370 were omitted from analysis with insufficient periodontal information to determine case definition. Also omitted were 31 participants with undefined Hispanic/Latino background and 1,284 participants with missing data on other variables. Thus complete case analysis was conducted with 12,730 persons with no missing data.

Statistical analysis—conducted using Stata 13.0 (Stata Corporation, College Station, Texas, USA)—took account of the complex sampling design applying weights for unequal probabilities of selection, adjusting for non-response, and calculating appropriate standard errors for estimates. Consequently estimates are generalizable to the U.S. Hispanic/Latino population aged 18–74 years living in these urban geographic areas.

Periodontitis risk factors were separately described for each Hispanic/Latino group. Univariate analysis evaluated associations between covariates and each periodontitis case definition. Chi-square tests of homogeneity tested the null hypothesis of no difference in the distribution of covariates across case categories.

In multivariate analysis, moderate and severe periodontitis case classifications were combined and modeled as a single binary dependent variable. This approach is consistent with previous epidemiologic analyses (19, 34, 35) since these levels of periodontitis are of clinical importance. Binomial regression estimated prevalence ratios (PR) and 95% confidence limits (95% CL). Prevalence ratios were modeled because odds ratios overestimate the strength of etiologic associations when examining non-rare conditions. In a sequential series of models, model 1 fitted the seven Hispanic/Latino subpopulations adjusted for age and sex. Model 2 additionally adjusted for nativity status, years lived in the United States and preferred language to determine the extent to which acculturation accounted for variance. Model 3 added marital status, educational attainment and dental care utilization. Finally Model 4 additionally adjusted for periodontal risk factors of smoking, diabetes and adiposity. To investigate possible effect modifiers we included an interaction term between Hispanic/Latino subpopulations and each of smoking status, diabetes status, BMI and waist-hip ratio in the fully adjusted model.

RESULTS

Hispanic/Latino populations differed considerably in demographic, social, economic and behavioral characteristics associated with periodontitis but not in physical measures of adiposity. Differences in mean age exceeded a decade with Cubans being oldest on average (45 years) and people of mixed/other ethnicity being youngest (mean 33 years).

Only 5.8% of South Americans were born in continental U.S. (Table 1) compared with more than half of Puerto Ricans and people with mixed heritage. Dominicans were over-represented in low income households and perceived their position lowest on the social hierarchy (Table 1). Despite a youthful age structure, three-quarters of participants were in elevated risk categories of waist-hip ratio and BMI. Dominicans had the highest prevalence of lifetime non-smoking and lowest prevalence of current smokers. A two-fold difference in diabetes prevalence existed between South Americans and Puerto Ricans. Half of each Hispanic/Latino group was pre-diabetic or diabetic (Table 1). Despite their low income, the majority of Dominicans had recently utilized dental services. Central Americans were least likely to have completed high school and were least likely to have utilized dental care within the previous year (Table 1).

Two thirds of Dominicans had good periodontal health compared with less than half of people of Mexican, Central American and Cuban background (Table 2). To assist interpretation, Table 3 reports age-stratum specific prevalence estimates for Hispanic/Latino groups across each level of periodontitis. In each stratum Dominicans had the highest proportion in periodontal health. Puerto Ricans had highest overall prevalence of severe periodontitis, namely about 11%.

Prevalence of moderate and severe periodontitis was greater in men than women (Table 2), generally greater among foreign-born than native-born, and associated with Spanish language preference at all levels of severity. Prevalence was inversely associated with socioeconomic status, and positively associated with adiposity. Current and former smokers had higher periodontitis prevalence than lifetime non-smokers as did people with pre-diabetes or diabetes relative to non-diabetes.

Prevalence of combined moderate/severe periodontitis was 38.5% overall, ranging from 24.7% among Dominicans to 52.2% among Cubans. Adjustment for acculturation (Table 4 and Model 2), for marital status, educational attainment and dental care utilization (Model 3) and established periodontitis risk factors of smoking, diabetes and body composition (Model 4) only slightly attenuated estimates. In the fully adjusted model with Dominicans as the referent, prevalence of moderate/severe periodontitis was 29% higher in those mixed/other background (95%CL: -2%, 70%), 34% higher in South Americans (95% CL: 13%, 58%), 37% higher in Puerto Ricans (95% CL: 17%, 61%), 43% higher in Mexicans (95% CL: 25%, 64%), 53% higher in Cubans (95% CL: 32%, 76%), and 55% higher in Central Americans 95% CL: 35%, 78%). In short, our current knowledge about demographic, social, economic and behavioral and established risk factors for periodontitis falls short of explaining an advantage in people of Dominican background.

Finally we investigated whether Hispanic/Latino ethnicity modified the effect of risk factors on periodontitis and found significant effect modification by diabetes (test for interaction, $P=0.0043$) (Figure 1). Among Dominicans predicted probability of moderate/severe periodontitis in non-diabetics was 0.18, compared to 0.33 in pre-diabetics and 0.32 in diabetics, with adjustment for all covariates. The probabilities for all other groups fell between 0.34 and 0.44, irrespective of diabetes status. Hence being non-diabetic was protective against periodontitis only among Dominicans.

DISCUSSION

Key Findings

In cross-sectional analysis of this diverse U.S. Hispanic/Latino population, prevalence of moderate/severe periodontitis was 38.5% and varied markedly across Hispanic/Latino subgroups. Age- and sex-adjusted prevalence was highest among Central Americans and lowest among Dominicans. Adjustment for acculturation and periodontitis risk factors diminished heterogeneity, but attenuation was modest and failed to nullify the advantage of Dominican background relative to other groups. Consequently, reasons for heterogeneity in periodontitis between different Hispanic/Latino backgrounds were not attributable to acculturation or established risk factors for periodontitis. Had markers of acculturation

explained variation, then heterogeneity between groups would arguably be a temporary phenomenon of sociological interest, but with little public health importance.

Dominicans had the healthiest behavioral profile with respect to lifetime non-smoking, central adiposity and recent use of dental services, which offset the hazard of poorest socioeconomic standing. Also informative was the statistically significant effect modification by diabetes status. Simply interpreted, the protective effect against periodontitis of being non-diabetic was apparent only in Dominicans. The group with highest prevalence—Central Americans—were distinguished from other groups in being least likely to have used dental services within five years and having the smallest proportion in the high household income category. Unexpectedly, given the causal risk of smoking to periodontitis, Central Americans were second to Dominicans in highest prevalence of lifetime nonsmoking.

Although acculturation did not account for heterogeneity in periodontitis, two markers suggest it may be protective against this disease. Compared to people with short duration of U.S. residence, people with longer duration had lower prevalence of periodontitis, adjusting for all covariates, as did people with English language preference.

Comparisons with Other Studies

Our finding that duration of U.S. residence and English language were protective against periodontitis was in contrast to findings of Daviglus and colleagues (36) that these characteristics were associated with higher prevalence of 3 major cardiovascular disease risk factors in this HCHS/SOL cohort. Several possibilities may account for these differences. Firstly, indirect measures of acculturation are crude and may be unreliable, the effect of acculturation on pathophysiology is unquestionably complex, and the health impact of acculturation may vary by disease and by population group.

This study's adjusted prevalence estimate of 39.1% for moderate/severe periodontitis is lower than the estimate of 52.4% for U.S. Mexican American population in 2009–2010 NHANES analysis.(19) Both surveys applied CDC-AAP case classifications for moderate/severe periodontitis and both measured gingival recession and pocket depth at six sites per tooth for up to 28 teeth. However methodological differences limit comparisons. Firstly, the 2009–2010 NHANES protocol restricted periodontal examination to adults aged \geq 30 years and, unlike the HCHS/SOL, imposed no upper age limit. When this HCHS/SOL analysis is similarly restricted to \geq 30 years of age, prevalence is 48.9%. Secondly, the NHANES analysis was age-standardized to the age distribution of the 2000 U.S. population to overcome confounding arising from the differing age structures of racial/ethnic groups in the U.S. population. In addition, unlike the HCHS/SOL, NHANES included rural-dwelling individuals, but had fewer Hispanic/Latino participants.

This study's findings that Puerto Ricans had highest proportions of smokers and diabetics; that Mexicans had lowest high school attainment and that Dominicans had highest proportion of women, is consistent with profiles of these subpopulations in the 2000–2005 National Health Interview Survey (NHIS)(21). Such comparability strengthens the

generalizability of findings from these four study sites to the broader U.S. Hispanic/Latino population

This is the first large scale survey purposefully designed to compare oral health between Hispanic/Latino subgroups in 30 years. In 1982–84, the Hispanic Health and Nutrition Examination Survey (HHANES) assessed periodontal disease using the Periodontal Index. That index measures periodontal pockets but not attachment loss. Results showed that Fewer Cubans than Puerto Ricans and Mexicans had at least one site with periodontal probing depth of 4mm or greater (37).

Limitations

In this cross-sectional analysis of baseline data we can only infer the effect of acculturation by comparing disease and risk factor profiles in recent immigrants relative to those with longer duration of U.S. residence. We did not calculate age-standardized estimates even though age structures of Hispanic/Latino groups vary and periodontitis at moderate severity is strongly associated with age. Our purpose was to describe the true prevalence of periodontitis in this selected population, rather than an artificial prevalence for a hypothetical population. Confounding by age was addressed using two other conventional methods; use of age-stratified analysis and multivariate regression that controlled for age in years.

Conclusion

In this young, rapidly growing segment of the U.S. population, approximately 40 percent had periodontitis at clinically important levels. Considerable heterogeneity in periodontitis between Hispanic/Latino subgroups was not explained by established risk factors for periodontitis or by markers of acculturation.

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List of abbreviations

AAP	American Academy of Periodontology
BMI	Body mass index
CDC	Centers for Disease Control and Prevention
HCHS/SOL	Hispanic Community Health Study/Study of Latinos
NHANES	National Health and Nutrition Examination Survey

NHIS	National Health Interview Survey
PR	Prevalence ratios
95% CL	95% confidence limits
U.S	United States

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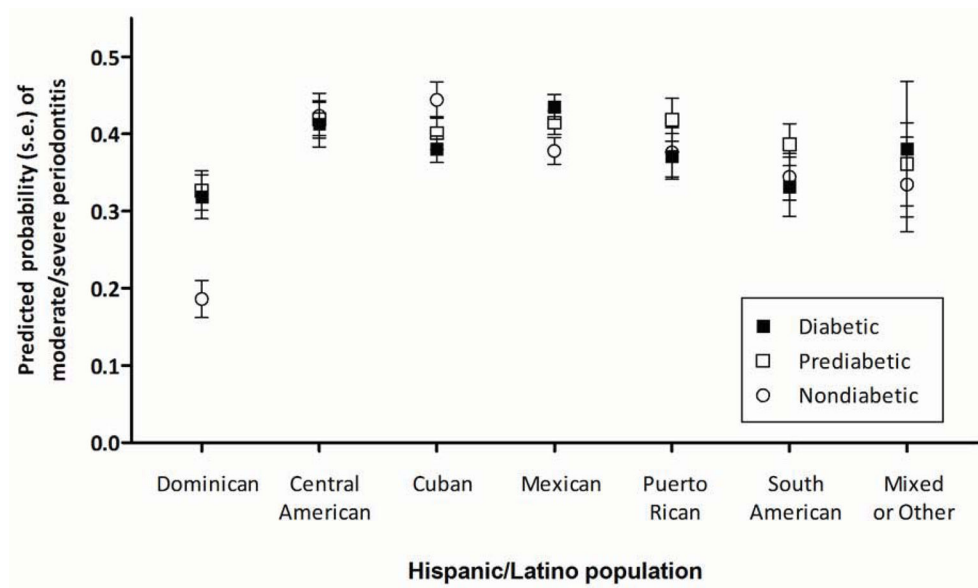
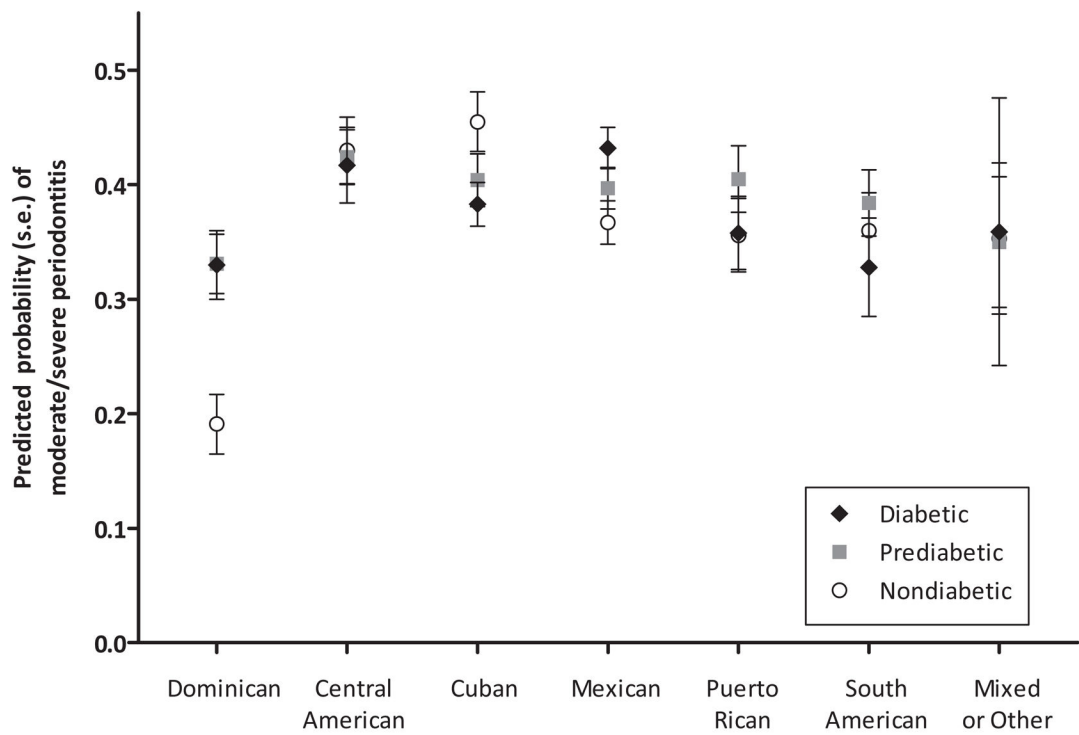


Figure 1. Hispanic/Latino ethnicity modifies the effect of diabetes on the combined categories of moderate/severe periodontitis (test for interaction, $P = 0.0043$) such that non-diabetic status was protective only among Dominicans. Estimates are predicted probabilities (standard error (s.e.)) taken from a binomial regression model fitted with a diabetes*ethnic background interaction with adjustment for age, sex, education, marital status, time since last dental

visit, nativity status, years lived in the U.S., language preference, cigarette smoking, body mass index and waist hip ratio.

Table 1

Distribution of selected characteristics (unadjusted, column percent, (standard error)) of major Hispanic/Latino sub-populations, Hispanic Community Health Study/Study of Latinos (N=12,730), 2008–2011

Characteristic	Dominican (n=1,128)	Central American (n=1,336)	Cuban (n=1,601)	Mexican (n=5,482)	Puerto Rican (n=1,935)	South American (n=874)	Mixed/other (n=374)	Total (n=12,730)
Age (years)								
18–24	21.0 (1.8)	13.8 (1.4)	9.9 (1.1)	18.8 (1.0)	16.8 (1.4)	12.9 (2.2)	32.7 (3.4)	17.0 (0.6)
25–34	23.5 (2.2)	29.7 (1.9)	16.0 (1.3)	27.1 (1.2)	20.6 (1.5)	21.4 (2.3)	32.2 (3.8)	23.9 (0.7)
35–44	20.4 (1.9)	22.4 (1.6)	24.7 (1.3)	23.7 (1.1)	20.2 (1.4)	23.9 (2.0)	15.7 (2.5)	22.6 (0.6)
45–54	20.5 (1.6)	19.1 (1.5)	22.5 (1.1)	17.2 (0.8)	20.3 (1.4)	22.7 (1.8)	12.1 (3.0)	19.1 (0.5)
55–64	10.0 (0.9)	10.4 (0.9)	14.9 (1.0)	9.4 (0.6)	13.5 (0.9)	13.0 (1.3)	5.0 (1.0)	11.1 (0.4)
65	4.6 (0.8)	4.6 (0.9)	12.1 (1.2)	4.0 (0.4)	8.7 (1.1)	6.1 (1.2)	2.4 (0.9)	6.2 (0.4)
Sex								
Female	59.6 (2.3)	51.6 (1.9)	45.2 (1.2)	52.0 (1.0)	47.6 (1.6)	52.9 (2.2)	52.2 (3.8)	50.9 (0.7)
Male	40.4 (2.3)	48.5 (1.9)	54.8 (1.2)	48.0 (1.0)	52.4 (1.6)	47.1 (2.2)	47.8 (3.8)	49.1 (0.7)
Nativity								
Foreign born	83.8 (2.2)	93.6 (1.1)	92.6 (1.1)	76.3 (1.1)	48.2 (1.8)	94.2 (1.0)	42.9 (3.9)	76.5 (0.8)
US born	16.2 (2.2)	6.4 (1.1)	7.4 (1.1)	23.7 (1.1)	51.8 (1.8)	5.8 (1.0)	57.1 (3.9)	23.5 (0.8)
Years lived in the U.S.								
<10	24.0 (2.2)	37.0 (2.3)	48.5 (1.9)	24.2 (1.3)	6.7 (1.0)	40.6 (2.5)	13.0 (2.7)	27.1 (0.9)
10–19	35.3 (2.0)	29.3 (1.7)	26.0 (1.4)	30.4 (1.2)	11.4 (1.3)	33.7 (2.0)	19.5 (3.0)	26.9 (0.7)
20	40.8 (2.2)	33.7 (2.1)	25.5 (2.0)	45.4 (1.3)	81.9 (1.7)	25.7 (2.2)	67.5 (3.6)	46.0 (1.0)
Language preference								
English	25.0 (2.8)	11.8 (1.6)	7.4 (0.9)	22.2 (1.1)	59.5 (2.0)	10.2 (1.6)	53.4 (4.3)	25.4 (0.9)
Spanish	75.0 (2.8)	88.2 (1.6)	92.6 (0.9)	77.8 (1.1)	40.5 (2.0)	89.8 (1.6)	46.6 (4.3)	74.6 (0.9)
Educational attainment								
< High school	33.9 (1.8)	36.2 (1.9)	18.3 (1.1)	35.3 (1.3)	31.5 (1.7)	20.9 (2.0)	18.0 (3.4)	30.3 (0.8)
High school	24.2 (2.1)	26.1 (1.5)	30.2 (1.7)	30.8 (1.0)	29.8 (1.4)	27.1 (1.9)	21.3 (3.5)	29.0 (0.6)
> High school	41.9 (2.0)	37.7 (1.9)	51.5 (1.7)	34.0 (1.6)	38.7 (1.9)	52.0 (2.2)	60.8 (4.0)	40.8 (0.9)
Household income								
<\$15,000	41.3 (2.4)	37.3 (1.9)	36.2 (1.6)	25.4 (1.2)	33.2 (1.8)	30.0 (2.3)	22.1 (2.9)	30.9 (0.8)
\$15,000–<\$30,000	30.4 (1.7)	35.1 (1.9)	34.4 (1.5)	34.0 (1.4)	29.5 (1.6)	34.5 (2.0)	25.7 (3.4)	32.8 (0.7)

Characteristic	Dominican (n=1,128)	Central American (n=1,336)	Cuban (n=1,601)	Mexican (n=5,482)	Puerto Rican (n=1,935)	South American (n=874)	Mixed/other (n=374)	Total (n=12,730)
\$30,000	28.4 (2.1)	27.7 (2.1)	29.4 (1.8)	40.6 (1.8)	37.3 (2.0)	35.6 (2.3)	52.3 (4.2)	36.3 (1.1)
Subjective social status								
Low (rungs 0–3)	39.9 (2.2)	32.3 (1.6)	34.7 (1.4)	25.7 (1.2)	29.4 (1.5)	22.7 (1.8)	22.9 (3.0)	29.4 (0.8)
Moderate (rungs 4–6)	52.9 (2.2)	58.6 (1.8)	58.8 (1.4)	61.0 (1.0)	56.7 (1.8)	61.9 (2.2)	60.8 (3.8)	59.1 (0.7)
High (rungs 7–10)	7.2 (1.2)	9.0 (1.2)	6.5 (0.7)	13.2 (1.0)	13.9 (1.5)	15.4 (2.1)	16.3 (2.9)	11.5 (0.6)
Marital status								
Single	47.5 (2.2)	37.7 (1.8)	26.6 (1.5)	28.2 (1.1)	48.0 (1.8)	30.6 (2.4)	50.9 (4.1)	34.5 (0.7)
Married/partner	38.0 (2.1)	48.9 (1.9)	54.0 (1.7)	60.4 (1.3)	34.2 (1.7)	51.6 (2.3)	32.5 (3.7)	50.7 (0.9)
Separated/divorced/	14.5 (1.3)	13.5 (1.1)	19.5 (1.2)	11.5 (0.7)	17.8 (1.4)	17.9 (1.9)	16.7 (3.2)	14.8 (0.5)
Sex-specific waist:hip ratio ^(a)								
Not at risk	38.1 (2.3)	30.4 (1.7)	29.2 (1.3)	20.4 (0.9)	30.3 (1.7)	30.1 (2.2)	35.9 (3.5)	27.0 (0.6)
At risk	61.9 (2.3)	69.6 (1.7)	70.8 (1.3)	79.6 (0.9)	69.7 (1.7)	69.9 (2.2)	64.1 (3.5)	73.0 (0.6)
Body mass index								
Underweight/normal	20.9 (1.6)	24.4 (1.6)	24.2 (1.4)	21.8 (0.9)	21.1 (1.5)	27.2 (2.3)	28.3 (3.3)	22.8 (0.6)
Overweight	37.9 (2.3)	37.7 (1.8)	37.9 (1.5)	39.1 (1.2)	33.1 (1.6)	42.2 (2.3)	28.7 (3.3)	37.5 (0.7)
Obese	41.2 (2.4)	37.8 (1.6)	37.9 (1.7)	39.1 (1.4)	45.8 (1.7)	30.6 (2.2)	43.0 (3.6)	39.8 (0.8)
Cigarette smoking status								
Never	77.2 (1.9)	73.0 (1.7)	56.5 (1.7)	63.8 (1.2)	51.5 (1.8)	65.9 (2.3)	57.2 (4.0)	62.5 (0.7)
Former	10.9 (1.2)	13.8 (1.1)	18.5 (1.2)	18.2 (0.9)	15.3 (1.1)	22.2 (1.8)	16.8 (2.8)	16.9 (0.5)
Current	11.9 (1.8)	13.2 (1.2)	25.0 (1.4)	18.0 (1.0)	33.3 (1.7)	12.0 (1.5)	26.0 (3.7)	20.6 (0.6)
Diabetes status								
Non-diabetic	54.9 (2.6)	51.7 (2.0)	49.4 (1.6)	50.3 (1.2)	48.7 (1.7)	56.1 (2.4)	56.0 (3.9)	51.0 (0.7)
Pre-diabetic	30.9 (2.0)	35.7 (1.6)	37.2 (1.5)	35.6 (1.1)	35.1 (1.7)	34.6 (2.1)	35.6 (3.8)	35.3 (0.6)
Diabetic	14.2 (1.3)	12.6 (1.2)	13.5 (1.1)	14.2 (0.7)	16.2 (1.2)	9.3 (1.2)	8.4 (2.9)	13.8 (0.5)
Time since last dental visit								
1 year	64.9 (2.1)	42.7 (2.0)	47.8 (1.5)	45.0 (1.3)	54.2 (1.9)	53.2 (2.4)	53.1 (3.6)	49.4 (0.8)
>1 year, 5 years	27.2 (2.0)	36.4 (1.6)	32.9 (1.3)	39.8 (1.2)	32.0 (1.7)	32.6 (2.2)	30.9 (3.4)	35.2 (0.7)
>5 years/not ever visited	7.9 (1.0)	20.9 (1.6)	19.3 (1.3)	15.2 (0.8)	13.9 (1.2)	14.2 (1.7)	16.0 (2.7)	15.4 (0.6)

^(a) Waist-hip ratio is dichotomized at thresholds of 85 for females and 90 for males based on guidelines from a WHO expert consultation

Table 2

Relationship of exposures to periodontal health and to mild, moderate and severe periodontitis (row percent, 95% confidence limits), Hispanic Community Health Study/Study of Latinos (N=12,730), 2008–2011

Characteristic	Periodontal health (95% CL)	Mild periodontitis (a) (95% CL)	Moderate periodontitis (b) (95% CL)	Severe periodontitis (c) (95% CL)	P-value
All subjects	51.5 (50.0, 53.1)	10.0 (9.2, 10.8)	30.4 (29.1, 31.7)	8.1 (7.5, 8.7)	
Hispanic/Latino group					
Dominican	68.2 (64.0, 72.2)	7.0 (4.9, 10.1)	18.1 (15.3, 21.3)	6.6 (5.1, 8.6)	<0.001
Central American	46.9 (43.4, 50.4)	10.7 (8.7, 13.2)	35.2 (32.0, 38.6)	7.2 (5.9, 8.8)	
Cuban	42.4 (39.4, 45.5)	5.5 (4.2, 7.1)	41.7 (38.3, 45.1)	10.5 (9.0, 12.2)	
Mexican	49.2 (46.7, 51.7)	13.2 (11.8, 14.7)	30.5 (28.6, 32.5)	7.0 (6.3, 7.9)	
Puerto Rican	55.0 (51.4, 58.6)	9.1 (7.5, 11.0)	24.9 (22.2, 27.9)	11.0 (9.2, 13.1)	
South American	53.9 (49.1, 58.7)	7.8 (5.8, 10.3)	30.1 (26.1, 34.3)	8.3 (6.2, 10.9)	
Mixed/other	66.5 (59.5, 72.8)	8.0 (5.0, 12.7)	21.8 (16.4, 28.4)	3.7 (2.2, 6.1)	
Age (years)					
18–24	77.4 (74.1, 80.4)	10.6 (8.7, 12.9)	11.9 (9.8, 14.5)	0.1 (0.0, 0.3)	<0.001
25–34	63.1 (60.0, 66.0)	12.6 (10.9, 14.6)	22.6 (20.0, 25.3)	1.8 (1.2, 2.6)	
35–44	48.6 (45.7, 51.5)	10.8 (9.3, 12.6)	33.3 (30.7, 36.1)	7.3 (6.1, 8.7)	
45–54	35.5 (33.2, 37.9)	8.7 (7.5, 10.1)	40.5 (38.2, 42.8)	15.4 (13.7, 17.3)	
55–64	32.4 (29.6, 35.3)	7.1 (5.7, 8.9)	42.2 (39.2, 45.2)	18.3 (16.3, 20.5)	
65	30.5 (25.6, 35.9)	4.1 (2.8, 5.9)	48.2 (42.8, 53.6)	17.3 (13.9, 21.2)	
Sex					
Female	57.4 (55.5, 59.4)	9.9 (8.9, 11.1)	26.5 (24.9, 28.2)	6.1 (5.5, 6.9)	<0.001
Male	45.4 (43.4, 47.5)	10.0 (8.9, 11.3)	34.4 (32.5, 36.3)	10.2 (9.2, 11.2)	
Nativity					
Foreign born	47.3 (45.8, 48.9)	9.3 (8.5, 10.3)	33.9 (32.5, 35.3)	9.5 (8.8, 10.2)	<0.001
United States born	65.2 (62.2, 68.2)	12.0 (10.3, 14.0)	19.0 (16.9, 21.3)	3.8 (2.9, 4.9)	
Years lived in the U.S.					
<10	51.1 (48.5, 53.7)	9.7 (8.3, 11.2)	32.7 (30.4, 35.2)	6.5 (5.6, 7.6)	<0.001
10 years–<20	55.1 (52.1, 58.0)	8.6 (7.3, 10.0)	28.6 (26.2, 31.1)	7.7 (6.7, 8.9)	
20	49.7 (47.7, 51.7)	11.0 (9.8, 12.2)	30.0 (28.3, 31.8)	9.3 (8.4, 10.3)	
Language preference					

Characteristic	Periodontal health (95% CL)	Mild periodontitis (a) (95% CL)	Moderate periodontitis (b) (95% CL)	Severe periodontitis (c) (95% CL)	P-value
English	66.5 (63.7, 69.1)	10.6 (9.0, 12.4)	18.7 (16.8, 20.9)	4.3 (3.4, 5.4)	<0.001
Spanish	46.5 (44.8, 48.1)	9.8 (8.8, 10.8)	34.3 (32.9, 35.8)	9.4 (8.7, 10.2)	
Educational attainment					
< High school	43.0 (40.4, 45.7)	9.9 (8.7, 11.4)	35.4 (33.2, 37.7)	11.6 (10.5, 12.9)	<0.001
High school	54.2 (51.6, 56.8)	10.4 (9.1, 11.8)	29.2 (26.9, 31.5)	6.2 (5.4, 7.2)	
> High school	55.9 (53.8, 58.1)	9.7 (8.4, 11.1)	27.5 (25.7, 29.4)	6.9 (6.0, 7.9)	
Household income					
<\$15,000	49.1 (46.5, 51.6)	9.1 (7.9, 10.5)	32.4 (30.2, 34.6)	9.4 (8.4, 10.5)	<0.001
\$15,000–<\$30,000	49.5 (47.2, 51.9)	10.5 (9.0, 12.1)	31.6 (29.6, 33.6)	8.4 (7.4, 9.5)	
\$30,000	55.5 (53.1, 57.9)	10.4 (9.2, 11.9)	27.5 (25.4, 29.6)	6.6 (5.6, 7.7)	
Subjective social status					
Low (rungs 0–3)	48.1 (45.8, 50.3)	10.7 (9.2, 12.4)	32.5 (30.3, 34.7)	8.8 (7.8, 9.9)	<0.001
Moderate (rungs 4–6)	51.9 (50.0, 53.9)	9.6 (8.6, 10.6)	30.5 (28.8, 32.2)	8.0 (7.2, 8.9)	
High (rungs 7–10)	58.4 (54.5, 62.3)	10.1 (8.1, 12.5)	24.5 (21.4, 27.8)	7.0 (5.5, 8.9)	
Marital status					
Single	63.6 (61.2, 66.0)	10.6 (9.2, 12.1)	21.0 (19.0, 23.0)	4.8 (4.0, 5.8)	<0.001
Married/partner	46.4 (44.4, 48.4)	10.0 (9.0, 11.2)	34.7 (33.0, 36.4)	8.9 (8.1, 9.8)	
Separated/divorced/widowed	41.0 (38.0, 44.1)	8.3 (6.9, 9.9)	37.5 (34.5, 40.7)	13.2 (11.3, 15.4)	
Sex-specific waist:hip ratio (d)					
Not at risk	63.1 (60.7, 65.4)	10.2 (8.6, 11.9)	22.1 (20.1, 24.3)	4.6 (3.7, 5.8)	<0.001
At risk	47.3 (45.4, 49.1)	9.9 (9.0, 10.9)	33.4 (31.9, 35.0)	9.4 (8.7, 10.2)	
Body mass index					
Underweight/normal	58.6 (56.0, 61.2)	11.1 (9.5, 13.0)	24.5 (22.2, 26.8)	5.8 (4.7, 7.2)	<0.001
Overweight	51.0 (48.7, 53.4)	8.5 (7.5, 9.7)	31.8 (29.7, 34.0)	8.7 (7.7, 9.7)	
Obese	48.0 (45.7, 50.3)	10.7 (9.4, 12.1)	32.4 (30.4, 34.5)	8.9 (8.0, 10.0)	
Cigarette smoking status					
Never smoked	55.9 (54.2, 57.5)	10.3 (9.3, 11.4)	27.4 (25.9, 28.9)	6.4 (5.8, 7.2)	<0.001
Former smoker	38.2 (35.3, 41.1)	9.5 (7.8, 11.5)	40.9 (37.9, 44.0)	11.5 (10.0, 13.2)	
Current smoker	49.4 (45.9, 52.9)	9.3 (7.6, 11.3)	30.9 (28.0, 33.9)	10.5 (9.1, 12.0)	
Diabetes status					
Non-diabetic	61.1 (59.0, 63.0)	9.9 (8.8, 11.0)	24.5 (22.8, 26.4)	4.6 (3.9, 5.3)	<0.001

Characteristic	Periodontal health (95% CL)	Mild periodontitis (a) (95% CL)	Moderate periodontitis (b) (95% CL)	Severe periodontitis (c) (95% CL)	P-value
Pre-diabetic	43.9 (41.5, 46.4)	10.8 (9.4, 12.4)	35.1 (33.0, 37.2)	10.2 (9.1, 11.4)	
Diabetic	35.8 (32.9, 38.7)	8.2 (6.7, 9.9)	40.1 (37.2, 43.1)	16.0 (14.3, 17.9)	
Time since last dental visit					
1 year	55.4 (53.5, 57.3)	8.7 (7.6, 9.9)	28.4 (26.8, 30.1)	7.5 (6.7, 8.4)	<0.001
>1 year, 5 years	50.5 (48.1, 52.9)	11.7 (10.3, 13.2)	29.9 (27.9, 32.1)	7.9 (7.0, 8.9)	
>5 years or not ever visited	41.4 (38.4, 44.6)	10.2 (8.6, 12.1)	37.8 (34.5, 41.2)	10.6 (8.9, 12.5)	

(a) Mild periodontitis 2 interproximal sites with 3mm CA loss and 2 interproximal sites with 4 mm pocket depth (not on same tooth) or 1 site with 5 mm PD

(b) Moderate periodontitis >2 interproximal sites with CA loss >4 mm (not on same tooth); OR >2 interproximal sites with PD >5 mm (not on same tooth)

(c) Severe periodontitis >2 interproximal sites with CA loss >6 mm (not on same tooth) and > 1 interproximal site with PD >5 mm

(d) The waist-hip ratio risk category is 85 for females and 90 for males based on guidelines from a WHO expert consultation

Table 3

Prevalence estimate (standard error) of periodontal status case definitions according to age-group in Hispanic Community Health Study/Study of Latinos (N= 12,730), 2008–2011

	<u>Periodontal health</u>	<u>Mild periodontitis</u>	<u>Moderate periodontitis</u>	<u>Severe periodontitis</u>
All study participants	51.5 (0.8)	10.0 (0.4)	30.4 (0.7)	8.1 (0.3)
Dominican				
18–24	88.7 (0.0)	6.4 (0.0)	4.9 (0.0)	--
25–34	80.4 (0.0)	9.4 (0.0)	9.1 (0.0)	1.1 (0.0)
35–44	69.8 (0.0)	8.5 (0.0)	17.4 (0.0)	4.3 (0.0)
45–54	50.9 (0.0)	5.6 (0.0)	31.4 (0.0)	12.0 (0.0)
55–64	42.9 (0.0)	4.5 (0.0)	31.4 (0.0)	21.3 (0.0)
65	38.1 (0.1)	3.7 (0.0)	38.5 (0.1)	19.8 (0.1)
Total	68.2 (2.1)	7.0 (1.3)	18.1 (1.5)	6.6 (0.9)
Central American				
18–24	68.5 (0.1)	16.7 (0.0)	14.8 (0.0)	--
25–34	56.8 (0.0)	12.4 (0.0)	28.2 (0.0)	2.6 (0.0)
35–44	43.1 (0.0)	12.2 (0.0)	38.6 (0.0)	6.1 (0.0)
45–54	35.5 (0.0)	4.3 (0.0)	46.8 (0.0)	13.4 (0.0)
55–64	32.7 (0.0)	5.6 (0.0)	47.0 (0.0)	14.7 (0.0)
65	15.2 (0.1)	13.3 (0.1)	50.5 (0.1)	21.0 (0.1)
Total	46.9 (1.8)	10.7 (1.1)	35.2 (1.7)	7.2 (0.7)
Cuban				
18–24	78.3 (0.0)	7.5 (0.0)	14.2 (0.0)	--
25–34	59.8 (0.0)	10.0 (0.0)	26.7 (0.0)	3.5 (0.0)
35–44	41.4 (0.0)	8.0 (0.0)	41.5 (0.0)	9.0 (0.0)
45–54	32.1 (0.0)	3.2 (0.0)	47.5 (0.0)	17.2 (0.0)
55–64	26.5 (0.0)	2.1 (0.0)	55.7 (0.0)	15.8 (0.0)
65	30.7 (0.0)	1.0 (0.0)	56.2 (0.0)	12.1 (0.0)
Total	42.4 (1.6)	5.5 (0.7)	41.7 (1.7)	10.5 (0.8)
Mexican				
18–24	71.8 (0.0)	14.1 (0.0)	13.9 (0.0)	0.1 (0.0)
25–34	59.6 (0.0)	14.2 (0.0)	25.0 (0.0)	1.3 (0.0)
35–44	46.1 (0.0)	12.9 (0.0)	34.2 (0.0)	6.9 (0.0)
45–54	29.4 (0.0)	13.1 (0.0)	43.6 (0.0)	13.9 (0.0)

	<u>Periodontal health</u>	<u>Mild periodontitis</u>	<u>Moderate periodontitis</u>	<u>Severe periodontitis</u>
55-64	31.3 (0.0)	12.1 (0.0)	38.6 (0.0)	18.0 (0.0)
65	18.3 (0.0)	7.3 (0.0)	50.0 (0.1)	24.5 (0.0)
Total	49.2 (1.3)	13.2 (0.7)	30.5 (1.0)	7.0 (0.4)
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Puerto Rican	85.9 (0.0)	6.7 (0.0)	7.4 (0.0)	--
18-24	64.6 (0.0)	14.4 (0.0)	19.1 (0.0)	1.8 (0.0)
25-34	52.1 (0.0)	8.7 (0.0)	29.9 (0.0)	9.3 (0.0)
35-44	37.8 (0.0)	10.5 (0.0)	29.8 (0.0)	22.0 (0.0)
45-54	36.8 (0.0)	6.5 (0.0)	35.8 (0.0)	20.9 (0.0)
55-64	48.1 (0.1)	2.5 (0.0)	32.8 (0.1)	16.5 (0.0)
65	55.0 (1.8)	9.1 (0.9)	24.9 (1.5)	11.0 (1.0)
Total	82.6 (0.1)	4.2 (0.0)	13.2 (0.0)	--
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South American	66.9 (0.1)	7.8 (0.0)	23.1 (0.0)	2.1 (0.0)
18-24	51.4 (0.0)	12.9 (0.0)	27.7 (0.0)	8.1 (0.0)
25-34	45.5 (0.0)	6.7 (0.0)	37.2 (0.0)	10.7 (0.0)
35-44	35.3 (0.0)	6.1 (0.0)	39.2 (0.0)	19.4 (0.0)
45-54	28.9 (0.1)	2.7 (0.0)	53.4 (0.1)	15.0 (0.1)
55-64	53.9 (2.4)	7.8 (1.1)	30.1 (2.1)	8.3 (1.2)
Total	79.4 (0.1)	6.6 (0.0)	13.9 (0.0)	--
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Mixed/Other	72.6 (0.1)	10.7 (0.0)	15.1 (0.0)	1.6 (0.0)
18-24	60.9 (0.1)	7.0 (0.0)	29.3 (0.1)	2.8 (0.0)
25-34	49.6 (0.1)	5.8 (0.0)	32.3 (0.1)	12.4 (0.1)
35-44	22.6 (0.1)	5.9 (0.0)	46.0 (0.1)	25.5 (0.1)
45-54	19.7 (0.1)	13.0 (0.1)	67.3 (0.2)	--
55-64	51.5 (0.8)	10.0 (0.4)	30.4 (0.7)	8.1 (0.3)
Total				

Table 4

Prevalence ratios (PR) and 95% confidence limits (CL) for associations between exposures and the combined categories of moderate or severe periodontitis, Hispanic Community Health Study/Study of Latinos (N= 12,730), 2008–2011

	Model 1 (a)		Model 2 (b)		Model 3 (c)		Model 4 (d)	
	PR (95% CL)	P-value	PR (95% CL)	P-value	PR (95% CL)	P-value	PR (95% CL)	P-value
Hispanic/Latino group [ref: Dominican]								
Central American	1.66 (1.45, 1.91)	<0.001	1.62 (1.41, 1.86)	<0.001	1.55 (1.35, 1.78)	<0.001	1.55 (1.35, 1.78)	0.000
Cuban	1.65 (1.44, 1.90)	<0.001	1.60 (1.39, 1.84)	<0.001	1.56 (1.35, 1.80)	<0.001	1.53 (1.32, 1.76)	0.000
Mexican	1.53 (1.34, 1.75)	<0.001	1.55 (1.36, 1.77)	<0.001	1.46 (1.28, 1.67)	<0.001	1.43 (1.25, 1.64)	0.000
Puerto Rican	1.27 (1.08, 1.48)	0.003	1.46 (1.25, 1.71)	<0.001	1.41 (1.20, 1.65)	<0.001	1.37 (1.17, 1.61)	0.000
South American	1.40 (1.19, 1.65)	<0.001	1.35 (1.15, 1.59)	<0.001	1.34 (1.14, 1.58)	<0.001	1.34 (1.13, 1.58)	0.001
Mixed/other	1.21 (0.93, 1.59)	0.160	1.35 (1.02, 1.77)	0.036	1.33 (1.01, 1.76)	0.044	1.29 (0.98, 1.70)	0.071
Male sex [ref: female]	1.41 (1.32, 1.50)	<0.001	1.42 (1.33, 1.51)	<0.001	1.38 (1.30, 1.47)	<0.001	1.31 (1.22, 1.41)	0.000
Age in decades	1.37 (1.34, 1.40)	<0.001	1.35 (1.31, 1.38)	<0.001	1.33 (1.30, 1.37)	<0.001	1.31 (1.27, 1.35)	0.000
U.S. born nativity status [ref: foreign-born]			0.94 (0.82, 1.07)	0.356	0.97 (0.84, 1.11)	0.619	0.96 (0.84, 1.09)	0.516
Years lived in the U.S. [ref: <10 years]								
10–19 years			0.98 (0.90, 1.07)	0.644	0.97 (0.89, 1.06)	0.518	0.97 (0.89, 1.05)	0.415
20 years			0.94 (0.87, 1.01)	0.108	0.93 (0.86, 1.00)	0.052	0.92 (0.85, 0.99)	0.024
Spanish preferred language [ref: English]			1.34 (1.18, 1.54)	<0.001	1.27 (1.11, 1.46)	0.001	1.28 (1.12, 1.47)	0.000
Marital status [ref: single]								
Married or living with partner					1.13 (1.04, 1.23)	0.003	1.12 (1.04, 1.22)	0.005
Separated/divorced/widowed					1.14 (1.04, 1.26)	0.008	1.14 (1.03, 1.26)	0.010
Educational attainment [ref: < high school]								
High school					0.93 (0.86, 1.00)	0.062	0.94 (0.87, 1.01)	0.079
> High school					0.86 (0.80, 0.92)	0.000	0.87 (0.81, 0.94)	0.000
Time since last dental visit [ref: 1 year]								
> 1 year, 5 years					1.07 (1.00, 1.15)	0.061	1.05 (0.98, 1.13)	0.146
> 5 years or not ever visited					1.29 (1.19, 1.39)	<0.001	1.26 (1.16, 1.36)	0.000
Cigarette smoking status [ref: never smoked]								
Former smoker							1.13 (1.05, 1.21)	0.001
Current smoker							1.18 (1.09, 1.27)	0.000

	Model 1 (a)		Model 2 (b)		Model 3 (c)		Model 4 (d)	
	PR (95% CL)	P-value	PR (95% CL)	P-value	PR (95% CL)	P-value	PR (95% CL)	P-value
Diabetes [ref: non-diabetic]								
Pre-diabetes							1.06 (0.97, 1.14)	0.195
Diabetes							1.06 (0.97, 1.15)	0.213
Body mass index [ref: underweight/normal]								
Overweight							1.06 (0.97, 1.15)	0.198
Obese							1.12 (1.02, 1.23)	0.018
Waist-hip ratio							1.55 (0.94, 2.54)	0.084
Constant	0.06 (0.05, 0.07)	<0.001	0.05 (0.04, 0.06)	<0.001	0.05 (0.04, 0.07)	<0.001	0.03 (0.02, 0.05)	<0.001

(a) Model 1 includes Hispanic/Latino groups and adjusts for sex and age in decades;

(b) Model 2 additionally adjusts for nativity status, years lived in the United States and preferred language;

(c) Model 3 additionally adjusts for other socio-demographic factors of marital status, educational attainment and dental utilization;

(d) Model 4 additionally adjusts for putative risk factors for diabetes of smoking, diabetes and body composition