Oral Health among Residents of Publicly Supported Housing in Boston

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ABSTRACT *Tooth loss in adults diminishes quality of daily life, affecting eating, speaking, appearance, and social interactions. Tooth loss is linked to severe periodontitis and caries; and to risk of stroke, cardiovascular disease, rheumatoid arthritis, and dementia. At the national (USA) level, poverty and African-American race have been linked to lower utilization of dental services, suggesting that the 7.5 million residents of publicly supported housing may be at risk of tooth loss and poor overall oral health. We assessed whether residence in publicly supported housing in Boston was associated with four oral health-related indicators. Compared to residents of nonpublicly supported housing, after adjusting for covariates residents of both public housing developments (PHDs) and rental assistance units (RAUs) had significantly lower odds of having had a dental cleaning in the past year (PHD, OR=0.64 (95 % CI, 0.44–0.93); RAU, OR=0.67 (95 % CI, 0.45–0.99))—despite parity in having had a past year dental visit. Further, residents of RAUs had double the odds of having had six or more teeth removed (OR=2.20 (95 % CI, 1.39–3.50)). Associations of race/ethnicity and housing type with dental insurance were interrelated. Unadjusted results document a deficit in oral health-related indicators among public housing residents, taken as a group, giving a clear picture of an oral health care gap and identifying a defined real-world population that could benefit from services. Existing public housing infrastructure could provide both a venue and a foundation for interventions to reduce oral health disparities on a broad scale.*

KEYWORDS *Oral health, Tooth loss, Public housing, Behavioral Risk Factor Surveillance System*

INTRODUCTION

In 2009, about 7.5 million people in the USA were living in publicly supported housing—2.3 million in public housing developments (PHDs) and 5.2 million in privately owned rental assistance units (RAUs), using a voucher that covers all or part of the rent.¹ Eligibility for publicly supported housing is limited to low-income families and individuals. Most households were headed by a woman (PHDs, 75 %; RAUs, 82 %), often with at least one child (36 and 48 %). Among heads of household aged 62 or older,

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disability of either the head of household or spouse was common (PHDs, 42 %; RAUs, 56 %), and even in younger households this proportion was about one third. Many residents stay in publicly supported housing for long periods—in 2009, for example, residents of public housing developments had moved in, on average, 8 years and 9 months previously; in rental assistance units, 6 years and 2 months previously. The majority of 2009 residents were either black (PHDs, 44 %; RAUs, 45 %) or Hispanic (22 %; 17 %). In the census tracts in which publicly supported housing units were located, minority residents made up about half of the population (PHDs, 54 %; RAUs, 47 %), and a substantial share of the population lived in poverty (28 and 18 %).¹

Oral health is an important aspect of overall health, both physical and social, and among adults, tooth loss is a useful indicator of poor oral health. Both severe periodontitis and severe caries are risk factors for tooth loss among adults, mostly by extraction. Tooth loss has been linked to increased risk of a range of chronic diseases including prevalent stroke,² cardiovascular disease,³ rheumatoid arthritis,⁴ dementia,⁵ and poor cognitive function in old age.⁶ Tooth loss, including edentulism (the loss of all teeth) can also affect the quality of daily life more directly: for example, with or without dentures, individuals with tooth loss may experience difficulty in chewing, changes in speech sounds, and self-consciousness about appearance.^{7,8} Rehabilitative dental treatment for welfare recipients has been linked to greater success in finding employment, as well as improved quality of life.⁹

Disparities in health outcomes, including oral health outcomes, across economic and racial/ethnic subgroups of the general US population are well documented, and these patterns are pertinent to public housing residents in light of the demographic makeup of this group. At the national level, both poverty and African-American race have been linked to lower utilization of dental services.¹⁰ Indeed, the 2010 National Health Interview Survey found that 26.7 % of respondents with incomes below the federal poverty level, and 21.4 % of the “near-poor,” had last seen a doctor more than 5 years previously, compared to only 8.6 % of those with higher incomes.¹¹ In Boston, research has shown that black and Hispanic residents bear a disproportionate burden of poor general health outcomes, as well as challenges in accessing health care, compared to white residents.¹² Residents of publicly supported housing have also been found to have poorer general health outcomes than other Boston residents.¹³

The current research builds on this earlier work in Boston, asking whether there is any association between type of housing (public housing development, rental assistance unit, and nonpublicly supported housing) and key indicators of access to oral healthcare services, utilization of such services, or oral health status. Specifically, we examined differences across types of housing in dental insurance coverage, as a marker of access to oral health services; in two measures of utilization of oral health services (visited dentist in past year, teeth cleaned in past year); and in tooth loss (having had six or more permanent teeth removed (including third molars lost to dental decay or periodontal disease)), an oral health outcome. For the sake of brevity, we refer to all these measures simply as oral health indicators.

We assessed further whether the associations persist in analyses controlling for demographic characteristics and insurance status, indicating that these differences are associated with the public housing venue itself, separate from the demographic profile of its residents. However, unadjusted results are also of genuine interest as simple descriptive data on real-world patterns associated with housing venue.

METHODS

The Boston Housing Authority (BHA) and Boston Public Health Commission (BPHC) are two of four partners in the Partners in Health and Housing Prevention Research Center (PHH-PRC), along with the Boston University School of Public Health and the Community Committee for Health Promotion, representing public housing residents. Since 2001, the PHH-PRC has added a single question to the biennial Boston Behavioral Risk Factor Surveillance System (BBRFSS), to identify residents of publicly supported housing. This analysis compared indicators of oral healthcare access, oral healthcare utilization, and oral health across three groups: residents of conventional PHDs of the BHA, residents living in RAUs, and other residents of Boston.

The Boston BRFSS

Data are from a modified version of the Behavioral Risk Factor Surveillance System (BRFSS) survey administered in Boston. The BRFSS is an annual random-digit-dial household telephone survey of health-related behaviors and conditions among adults (18 years and older) in the non-institutionalized civilian US population. It is undertaken by state health departments in collaboration with the US Centers for Disease Control and Prevention (CDC); the methodology used in each survey year is detailed by CDC.¹⁴ The BPHC administered the Boston BRFSS biennially in odd years from 1999 through 2005, then in even years from 2006 through 2010, with a sample size ranging from 1,500 to 3,300 respondents per year. Like the BRFSS, the Boston survey methodology uses stratified random sampling with the probability of selection related to the number of adults and telephone lines in the household. One adult from each eligible household contacted is randomly selected for interview. The data were poststratified to city of Boston age and gender parameters, and subsequently scaled to produce equal weighting across years. In 2010, a 10 % cell phone-only sample was included. The survey is administered in English and Spanish.

Measures

All Boston BRFSS respondents are asked: “Are you (1) a public housing resident living in a building owned by the Boston Housing Authority, (2) part of a household that receives rental assistance such as Section 8 or any other rental assistance program, or (3) neither of the above?” Other demographic items in the survey gather information on respondents’ age, gender, race/ethnicity, educational attainment, place of birth (USA and non-USA), health status (excellent/good health vs. fair/poor health), and health insurance status (health insurance/no health insurance).

The oral health indicators were: dental insurance coverage, based on the question “Do you have any kind of insurance coverage that pays for some or all of your routine dental care, including dental insurance, prepaid plans such as HMOs, or government plans such as Medicaid?”; two indicators of utilization of oral health services (visited dentist in past year, based on the question “How long has it been since you last visited a dentist or a dental clinic for any reason?”, and teeth cleaned in the past year, based on the question “How long has it been since you had your teeth cleaned by a dentist or dental hygienist?”); and a marker of poor oral health (six or more permanent teeth removed, based on the question “How many of your permanent teeth have been removed because of tooth decay or gum disease?”).

Analytic Methods

Analyses were done using SAS version 9.2. For all procedures, we utilized a design-based approach that accounted for the disproportionate probability of selection among survey respondents and subsequent poststratification to Boston's adult population. Logistic regression was used to generate unadjusted and adjusted odds ratios of the four binary oral health outcome variables with public housing status (PHD, RAU, neither) as well as covariates. Since the same questions were not asked each survey year, data for multiple years were combined as available for each model (see tables).

Univariate and stratified analyses of age, gender, race/ethnicity, year, US birth, educational attainment, general health self-assessment (excellent, good, fair, or poor), and health insurance status were conducted to identify potential confounders and effect modifiers of the association between housing status and oral health outcome variables. Proportions were tested using the chi-square test. A two-tailed p value of 0.05 was judged to be statistically significant. Unadjusted odds ratios and prevalences were generated using logistic regression. Adjusted prevalences and confidence intervals were calculated from multivariable logistic regression models using least squares means weighted back to observed study population characteristics.

For each outcome variable, models were built using the forward stepwise approach starting with a fixed model that included year and housing status. At each step, one potential covariate from a priori list of possible predictors (age, gender, race/ethnicity, education, US birth, general health self-assessment, and either health or dental insurance coverage) was added sequentially at each step based on having the strongest statistical significance among the remaining potential covariates. Public housing status and year were kept as main effects regardless of statistical significance. Given the dual vulnerability of Boston's black and Hispanic residents living in subsidized housing, we assessed a public housing–race/ethnicity interaction based on a priori considerations in all four models, forcing race/ethnicity when not included among the main effects.

After significant predictors and interactions were identified, the remaining variables were assessed as potential confounders. A variable was considered a confounder and kept in the model if including it in the model resulted in a greater than 20 % change in the odds ratio of housing status variables.

RESULTS

We first describe the study population. We then present unadjusted odds ratios, which provide a simple comparison of the three housing settings, and then present results on key predictors of the oral health indicators.

Study Population

Table 1 compares population characteristics for residents of PHDs, RAUs, and nonpublicly supported housing in Boston; figures for the city as a whole appear in the first column as context. As shown, age distribution did not differ by housing type. The gender, race/ethnicity, place of birth, highest level of education, and general health status of respondents were significantly associated with housing type. In addition, having dental insurance, having visited a dentist in the past year, having had teeth cleaned in the past year, and having had six or more teeth removed were associated with housing status.

TABLE 1 Population characteristics and oral health outcomes of Boston residents, as a group and by housing type (*n*=11,869)

Population characteristics	Boston % (95 % CI)	Public housing development % (95 % CI)	Rental assistance unit % (95 % CI)	Nonpublicly supported housing % (95 % CI)
Housing type				
Public housing development (PHD)	6.6 (5.9–7.2)			
Rental assistance unit (RAU)	7.2 (6.5–7.9)			
Nonpublicly supported housing	86.2 (85.3–87.1)			
Age				
18–39	55.0 (53.6–56.3)	53.5 (48.6–58.5)	53.6 (48.8–58.4)	54.9 (53.4–56.3)
40–64	32.4 (31.3–33.5)	31.8 (27.7–36.0)	34.1 (29.9–38.3)	32.9 (31.7–34.2)
65–74	7.5 (6.8–8.2)	9.5 (7.1–11.9)	7.2 (5.2–9.2)	7.2 (6.3–8.0)
75+	5.2 (4.7–5.6)	5.1 (3.8–6.4)	5.1 (3.2–7.0)	5.0 (4.6–5.5)
Gender*				
Male	47.5 (46.1–48.8)	39.5 (34.2–44.8)	30.3 (25.6–35.1)	49.8 (48.3–51.3)
Female	52.5 (51.2–53.9)	60.5 (55.2–65.8)	69.7 (64.9–74.4)	50.2 (48.7–51.7)
Race/ethnicity*				
Black non-Hispanic	20.1 (19.0–21.2)	32.8 (27.9–37.6)	41.9 (36.9–46.8)	17.1 (16.0–18.2)
Hispanic	14.8 (13.8–15.9)	38.3 (33.4–43.3)	28.4 (23.9–32.9)	11.5 (10.4–12.6)
White non-Hispanic	57.9 (56.6–59.3)	21.9 (17.8–25.9)	20.9 (17.4–24.4)	64.5 (63.0–65.9)
Other	7.2 (6.5–7.9)	7.1 (4.5–9.7)	8.8 (6.1–11.6)	6.9 (6.1–7.7)
Place of birth*				
US birth	78.7 (77.4–80.0)	61.3 (56.1–66.5)	76.5 (72.4–80.6)	80.9 (79.6–82.3)
Non-US birth	21.3 (20.0–22.6)	38.7 (33.5–43.9)	23.5 (19.4–27.6)	19.1 (17.7–20.4)
Highest level of education*				
<HS	9.2 (8.4–10.0)	31.7 (27.0–36.3)	21.4 (17.6–25.2)	6.2 (5.4–7.0)
HS	21.6 (20.4–22.8)	39.9 (35.0–44.9)	39.9 (35.0–44.8)	18.0 (16.8–19.3)
Any college	69.2 (67.9–70.5)	28.4 (23.6–33.2)	38.7 (33.9–43.5)	75.8 (74.4–77.2)
General health status*				
Excellent/V. good/ good health	87.0 (86.2–87.9)	67.8 (63.4–72.2)	70.1 (65.8–74.4)	90.0 (89.1–90.8)
Fair/poor health	13.0 (12.1–13.8)	32.2 (27.8–36.6)	29.9 (25.6–34.2)	10.0 (9.2–10.9)
Health insurance coverage				
Health insurance	93.9 (93.1–94.6)	91.8 (88.6–94.9)	93.8 (91.6–96.1)	94.2 (93.3–95.0)
No health insurance	6.1 (5.4–6.9)	8.2 (5.1–11.4)	6.2 (3.9–8.4)	5.8 (5.0–6.7)
Oral health outcomes				
Has dental insurance*	66.0 (64.5–67.6)	60.8 (54.6–67.0)	62.2 (56.8–67.6)	67.2 (65.4–68.9)
Visited dentist in past year*	71.9 (70.5–73.4)	64.0 (58.3–69.7)	63.8 (58.2–69.3)	73.5 (71.9–75.1)
Teeth cleaned in past year*	71.5 (69.4–73.5)	58.1 (50.5–65.7)	60.1 (51.9–68.3)	73.5 (71.2–75.7)
Six or more teeth removed*	12.7 (11.4–14.0)	20.3 (15.2–25.4)	24.3 (17.6–30.9)	10.8 (9.4–12.2)

Source: BBRFSS data for 2001, 2003, 2005, 2008, 2010 combined

*p<0.05, global chi-square

TABLE 2 Unadjusted odds ratios for four oral health outcomes, by population subgroup

Population characteristic	Has dental insurance OR (95 % CI)	Visited dentist in past year OR (95 % CI)	Teeth cleaned in past year OR (95 % CI)	Six or more teeth removed OR (95 % CI)
2001	(reference)	(reference)	(reference)	(reference)
2003	0.92 (0.74–1.14)	1.01 (0.81–1.26)		
2005	0.86 (0.70–1.05)	0.94 (0.77–1.16)		
2008	1.30 (1.04–1.62)	0.98 (0.79–1.23)		
2010			1.09 (0.90–1.34)	0.76 (0.60–0.95)
Public housing development (PHD)	0.76 (0.58–0.99)	0.64 (0.49–0.83)	0.50 (0.36–0.70)	2.11 (1.50–2.99)
Rental assistance unit (RAU)	0.80 (0.63–1.03)	0.63 (0.49–0.82)	0.54 (0.38–0.78)	2.66 (1.81–3.93)
Nonpublicly supported housing	(reference)	(reference)	(reference)	(reference)
18–39	(reference)	(reference)	(reference)	(reference)
40–64	0.96 (0.83–1.12)	1.12 (0.96–1.30)	1.22 (0.98–1.52)	11.46 (7.16–18.35)
65–74	0.30 (0.22–0.40)	0.72 (0.56–0.94)	0.74 (0.50–1.11)	43.63 (24.39–78.05)
75+	0.20 (0.15–0.25)	0.56 (0.44–0.71)	0.46 (0.32–0.66)	68.51 (39.98–117.39)
Male	0.96 (0.83–1.10)	0.84 (0.73–0.97)	0.64 (0.53–0.79)	0.86 (0.67–1.10)
Female	(reference)	(reference)	(reference)	(reference)
Black	1.30 (1.07–1.58)	0.73 (0.61–0.88)	0.62 (0.49–0.80)	1.35 (1.03–1.77)
Hispanic	0.84 (0.68–1.04)	0.68 (0.55–0.86)	0.67 (0.51–0.89)	0.79 (0.54–1.14)
White	(reference)	(reference)	(reference)	(reference)
Other	1.06 (0.80–1.42)	0.97 (0.74–1.29)	1.00 (0.64–1.56)	0.33 (0.19–0.55)
<HS	0.45 (0.36–0.57)	0.44 (0.35–0.56)	0.38 (0.28–0.51)	5.99 (4.27–8.41)
HS	0.67 (0.57–0.80)	0.59 (0.49–0.70)	0.51 (0.40–0.66)	3.43 (2.57–4.57)
Any college	(reference)	(reference)	(reference)	(reference)
US birth	1.40 (1.17–1.69)	1.19 (0.98–1.44)	1.03 (0.80–1.34)	1.38 (1.00–1.90)
Non-US birth	(reference)	(reference)	(reference)	(reference)
Excellent/Good Health	1.71 (1.42–2.04)	2.24 (1.87–2.68)	2.20 (1.70–2.84)	0.17 (0.13–0.23)
Fair/poor health	(reference)	(reference)	(reference)	(reference)
Health insurance	19.55 (12.20–31.34)	1.65 (1.22–2.24)	3.90 (2.55–5.94)	0.92 (0.42–2.03)
No health insurance	(reference)	(reference)	(reference)	(reference)

Comparison of Oral Health Indicators across Housing Venues

Unadjusted odds ratios for the four key oral health indicators simply delineate oral health-related differences between residents of publicly supported housing and other Boston residents (Table 2). Compared to residents of nonpublicly supported housing, residents of PHDs had somewhat lower odds of having dental insurance. Residents in both publicly supported housing venues had lower odds of having had a dental visit in the past year, and had about half the odds of having had their teeth cleaned in the past year. Finally, compared to other residents of Boston, residents of both public housing venues had more than twice the odds of having had six or more adult teeth removed.

Predictors of Key Oral Health Indicators

Tables 3, 4, and 5 present adjusted prevalences and adjusted odds ratios for predictors of the four key health indicators.

Dental insurance After adjusting for covariates, neither residence in a PHD nor residence in a RAU was initially associated with dental insurance status (data not shown).

TABLE 3 Point estimates and adjusted odds ratios for having dental insurance, by demographic characteristic (n=7,336)

Variables	Adjusted prevalence estimate (95 % CI)	Adjusted OR (95 % CI)
2001	68.5 (63.3–73.3)	(reference)
2003	66.1 (62.7–69.4)	0.90 (0.68–1.19)
2005	65.0 (61.9–68.0)	0.86 (0.66–1.12)
2008	71.3 (68.0–74.4)	1.15 (0.87–1.52)
Age 18–39	72.6 (70.0–75.2)	(reference)
Age 40–64	70.7 (68.4–72.9)	0.91 (0.77–1.08)
Age 65–74	37.9 (30.6–45.9)	0.23 (0.16–0.33)
Age 75+	29.1 (24.2–34.6)	0.16 (0.12–0.21)
<High school education	56.5 (48.8–64.0)	0.58 (0.42–0.81)
High school graduate	67.4 (62.6–71.9)	0.92 (0.73–1.17)
Any college	69.1 (67.0–71.2)	(reference)
US birth	69.2 (67.0–71.2)	1.37 (1.01–1.85)
Non-US birth	62.1 (55.8–68.1)	(reference)
Health insurance	71.8 (70.0–73.5)	20.86 (12.49–34.84)
No health insurance	10.9 (6.9–16.8)	(reference)
PHD×Black non-Hispanic	70.2 (54.8–82.0)	1.21 (0.62–2.37)
PHD×Hispanic	76.2 (66.1–84.0)	1.64 (0.96–2.80)
PHD×White non-Hispanic	53.4 (38.4–67.7)	0.59 (0.32–1.09)
PHD×Other	73.2 (53.5–86.6)	1.40 (0.58–3.37)
RAU×Black non-Hispanic	67.5 (57.2–76.3)	1.07 (0.67–1.69)
RAU×Hispanic	75.0 (62.9–84.1)	1.54 (0.84–2.80)
RAU×White non-Hispanic	44.3 (33.2–56.0)	0.41 (0.25–0.66)
RAU×Other	73.0 (41.9–91.0)	1.39 (0.37–5.24)
Non-PSU×Black non-Hispanic	78.0 (73.3–82.1)	1.82 (1.37–2.43)
Non-PSU×Hispanic	66.1 (58.6–72.9)	1.00 (0.70–1.44)
Non-PSU×White non-Hispanic	66.1 (63.3–68.8)	(reference)
Non-PSU×other	65.5 (55.5–74.4)	0.98 (0.62–1.53)

The final model, presented in Table 3, included an interaction between housing status and racial/ethnic group. Older adults had considerably lower odds of having dental insurance than did the youngest adults (age, 65–74; OR=0.23 (95 % CI, 0.16–0.33); age, 75+; OR=0.16 (95 % CI, 0.12–0.21)). Adults with less than a high school education had lower odds of having dental insurance than those with at least some college (OR=0.58 (95 % CI, 0.42–0.81)). Further, Boston residents who were born in the USA had nearly 40 % greater odds of having dental insurance than residents born elsewhere (OR=1.37 (95 % CI, 1.01–1.85)). By far the most powerful predictor of having dental insurance was having health insurance (OR=20.86 (95 % CI, 12.49–34.84)).

Though public housing status was not initially associated with having dental insurance, there was a significant interaction between housing status and racial/ethnic group (global interaction term, $p < 0.001$). Compared to white residents in nonpublicly supported housing, white RAU residents had *lower* odds of having dental insurance (white RAU: OR=0.41 (95 % CI, 0.25–0.66)), black residents of nonpublicly supported housing had *higher* odds of having dental insurance (OR=1.82 (95 % CI, 1.37–2.43)), and Hispanic PHD residents had borderline significantly higher odds (OR=1.64 (95 % CI, 0.96–2.80)).

Dental Services After adjusting for covariates, there was no association between living in publicly supported housing and having had a dental visit in the past year, but residents of both PHDs and RAUs had significantly lower odds of having had a dental cleaning in the past year than nonpublic housing residents (PHD, OR=0.64 (95 % CI, 0.44–0.93); RAU, OR=0.67 (95 % CI, 0.45–0.99); Table 4).

Adults in young middle age (age, 40–64) had significantly higher odds than younger adults (age, 18–39) of having had a dental visit in the past year (OR=1.27 (95 % CI, 1.07–1.51)) and of having had their teeth cleaned in the past year (OR=1.35 (95 % CI, 1.06–1.73)). However, the odds that adults in the oldest age bracket (age, 75+) had had their teeth cleaned was only about half the odds for 18- to 39-year-olds (OR=0.53 (95 % CI, 0.35–0.81)). Men had significantly lower odds than women of having had a dental visit (OR=0.74 (95 % CI, 0.63–0.87)) or having had their teeth cleaned in the past year (OR=0.60 (95 % CI, 0.48–0.75)). The odds of having had a dental visit in the past year was lower for black residents than for white residents (OR=0.70 (95 % CI, 0.56–0.88)). Those with no college education had lower odds than those with at least some college education of having used dental services in the past year (visited dentist—less than high school education, OR=0.66 (95 % CI, 0.49–0.89); high school graduate, OR=0.68 (95 % CI, 0.55–0.83)) (teeth cleaned—less than high school education, OR=0.59 (95 % CI, 0.41–0.84); high school graduate, OR=0.57 (95 % CI, 0.43–0.75)).

The odds that respondents with excellent or good self-reported health had made use of dental services in the past year were about 70–80 % greater than the odds for those with fair or poor health (dental visit, OR=1.84 (95 % CI, 1.49–2.26); teeth cleaned, OR=1.69 (95 % CI, 1.25–2.28)). Not surprisingly, having insurance had a strong, positive association with use of dental services—adults with dental insurance had more than twice the odds of having had a dental visit in the past year (OR=2.17 (95 % CI, 1.82–2.58)), and adults with health insurance had more than twice the odds of having had their teeth cleaned in the past year (OR=2.69 (95 % CI, 1.56–4.65)).

Six or More Teeth Removed After adjusting for covariates, the odds of having had six or more teeth removed were greater for residents of RAUs than for residents of nonpublicly supported housing (RAU, OR=2.20 (95 % CI, 1.39–3.50); Table 5). There was no significant difference for residents of PHDs.

TABLE 4 Point estimates and adjusted odds ratios for two indicators of recent use of dental services, by demographic characteristic (n=7,298)

Variable	Adjusted prevalence (95 % CI)	Adjusted OR (95 % CI)
Visited dentist in past year		
2001	73.8 (69.8–77.5)	(reference)
2003	73.8 (70.6–76.7)	1.00 (0.77–1.28)
2005	73.5 (70.8–76.1)	0.99 (0.78–1.25)
2008	72.8 (69.6–75.7)	0.95 (0.74–1.22)
Public housing development (PHD)	72.2 (65.5–78.0)	0.93 (0.67–1.29)
Rental assistance unit (RAU)	71.3 (65.0–76.8)	0.88 (0.65–1.20)
Nonpublicly supported housing	73.7 (72.0–75.4)	(reference)
18–39	71.8 (69.4–74.2)	(reference)
40–64	76.4 (74.1–78.5)	1.27 (1.07–1.51)
65–74	73.3 (68.2–77.9)	1.08 (0.81–1.43)
75+	72.4 (67.2–77.1)	1.03 (0.78–1.36)
Male	70.2 (67.6–72.7)	0.74 (0.63–0.87)
Female	76.2 (74.3–78.0)	(reference)
Black non-Hispanic	67.7 (63.2–71.9)	0.70 (0.56–0.88)
Hispanic	73.1 (68.1–77.5)	0.91 (0.69–1.19)
White non-Hispanic	74.9 (72.9–76.9)	(reference)
Other	74.0 (67.7–79.5)	0.95 (0.69–1.33)
< High school education	67.1 (60.8–72.9)	0.66 (0.49–0.89)
High school graduate	67.8 (63.9–71.4)	0.68 (0.55–0.83)
Any college	75.7 (73.8–77.5)	(reference)
Excellent/good health	74.9 (73.3–76.5)	1.84 (1.49–2.26)
Fair/poor health	62.0 (57.4–66.3)	(reference)
Has dental insurance	78.2 (76.4–79.9)	2.17 (1.82–2.58)
No dental insurance	62.3 (59.1–65.4)	(reference)
Teeth Cleaned in Past Year n=4130		
2001	72.1 (68.0–75.9)	(reference)
2010	73.2 (70.8–75.5)	1.06 (0.84–1.33)
Public housing development (PHD)	64.3 (55.7–72.1)	0.64 (0.44–0.93)
Rental assistance unit (RAU)	65.4 (56.6–73.2)	0.67 (0.45–0.99)
Nonpublicly supported housing	73.9 (71.4–76.1)	(reference)
18–39	71.3 (67.8–74.6)	(reference)
40–64	77.1 (73.9–80.0)	1.35 (1.06–1.73)
65–74	68.7 (59.5–76.5)	0.88 (0.57–1.36)
75+	57.1 (47.7–66.0)	0.53 (0.35–0.81)
Male	67.0 (63.3–70.5)	0.60 (0.48–0.75)
Female	77.4 (74.6–80.0)	(reference)
<High school graduate	64.8 (56.9–71.9)	0.59 (0.41–0.84)
High school graduate	64.1 (58.5–69.3)	0.57 (0.43–0.75)
Any college	75.8 (73.2–78.2)	(reference)
Excellent/good health	74.0 (71.6–76.2)	1.69 (1.25–2.28)
Fair/poor health	62.7 (56.0–68.9)	(reference)
Has health insurance	73.8 (71.5–76.0)	2.69 (1.56–4.65)
No health insurance	51.1 (38.2–64.0)	(reference)

Age was a statistically significant ($p<0.001$) and very powerful predictor of tooth removal: compared to young adults (age, 18–39), the odds of having had six or more teeth removed were almost tenfold greater for those in the 40–64 age bracket (OR=9.75

TABLE 5 Point estimates and adjusted odds ratios for having had six or more teeth removed, by demographic characteristic, $n=4,099$

Variables	Adjusted prevalence (95 % CI)	Adjusted OR (95 % CI)
2001	6.6 (4.7–9.2)	(reference)
2010	4.3 (3.3–5.6)	0.64 (0.45–0.90)
Public housing development (PHD)	6.6 (4.0–10.9)	1.39 (0.82–2.35)
Rental assistance unit (RAU)	10.1 (6.6–15.4)	2.20 (1.39–3.50)
Nonpublicly supported housing	4.9 (3.7–6.4)	(reference)
18–39	1.7 (1.0–2.7)	(reference)
40–64	14.2 (11.6–17.3)	9.75 (5.74–16.54)
65–74	33.8 (23.0–46.5)	30.01 (14.27–63.11)
75+	42.0 (33.9–50.5)	42.65 (23.36–77.86)
Black non-Hispanic	6.2 (4.4–8.5)	1.04 (0.72–1.52)
Hispanic	3.1 (2.0–4.8)	0.51 (0.32–0.82)
White non-Hispanic	5.9 (4.3–8.1)	(reference)
Other	3.1 (1.7–5.8)	0.51 (0.26–1.02)
<High school education	11.3 (7.5–16.7)	2.97 (1.89–4.66)
High school graduate	8.7 (5.8–12.7)	2.22 (1.40–3.52)
Any college	4.1 (3.1–5.5)	(reference)
Excellent/good health	4.6 (3.6–6.0)	0.34 (0.25–0.48)
Fair/poor health	12.5 (9.0–17.1)	(reference)

(95 % CI, 5.74–16.54)), were 30-fold greater for those aged 65–74 (OR=30.01 (95 % CI, 14.27–63.11)), and were almost 43-fold greater for those 75 or older (OR=42.65 (95 % CI, 23.36–77.86)). Compared to white residents, Hispanic residents had lower odds of having had six or more teeth removed (OR=0.51 (95 % CI, 0.32–0.82)). Compared to those with at least some college education, those with no college education had more than twice the odds of having had six or more teeth removed (less than high school, OR=2.97 (95 % CI, 1.89–4.66)); high school graduate, OR=2.22 (95 % CI, 1.40–3.52). Respondents with self-reported excellent or good health also had lower odds of having had six or more teeth removed compared with those with fair or poor health (OR=0.34 (95 % CI, 0.25–0.48)).

DISCUSSION

Due to initial eligibility requirements for public housing, its residents are presumed to have relatively low incomes overall, and statistics show that they come disproportionately from racial/ethnic minority groups—characteristics that suggest public housing residents may have difficulty accessing oral health services and may bear a disproportionate burden of negative oral health indicators.

In fact, there was little difference across housing type in the prevalence of individuals with health insurance: in Massachusetts, medical (but not dental) insurance coverage is mandatory, and this may be the key reason for the observed equity in health insurance. In all three groups, the percentage of individuals who had seen a dentist in the past year was higher than the Healthy People 2020 target of 49 %.¹⁵ This may be attributable to Boston's sizable dental safety net infrastructure, which includes 3 dental schools and 18 community health center dental clinics. Yet, despite parity in having had a dental visit within the past year, after adjusting for

relevant covariates, both PHD and RAU residents have approximately 35 % lower odds of having had their teeth cleaned in the past year—that is, there is a deficit in at least one type of utilization of dental care.

While the mandate for all Massachusetts residents to have health insurance does not require residents to have dental insurance, in non-enrolled Medicaid-eligible populations this new mandate may have increased the number of low-income individuals with dental insurance. Before the mandate, Medicaid-eligible individuals were free to choose to have no medical insurance. These individuals now are required to have medical insurance and in many cases when they enroll in Medicaid, they automatically receive dental insurance through the Medicaid program.

Our analysis also suggests that the effects of housing status and race/ethnicity are intertwined: for reasons not yet understood, compared to white residents of nonpublicly supported housing, white residents of RAUs had significantly lower odds, and black residents of nonpublicly supported housing had significantly higher odds, of having dental insurance; the odds for Hispanic residents of PHDs are modestly elevated, a result that only approaches statistical significance. Hispanics not living in subsidized housing may lack documentation of their immigration status, and this may contribute to the lower odds of having dental insurance in this group.

Prior research shows that having dental insurance is a strong predictor of access to dental services and of good oral health,¹⁶ and it has been well documented that individuals from low-income and racial/ethnic minority groups have lower odds of having dental insurance.¹⁶ Thus it is not surprising that the deficit in dental insurance for PHD residents in the unadjusted analysis was largely explained by sociodemographic differences between the groups. Results in Table 3 should be interpreted cautiously, however, as there was no measure of the type or quality of dental insurance coverage, which may affect not only dental care utilization, but also the treatment options available to individuals with limited discretionary income.

Given their low-income status, public housing residents are more likely to qualify for Medicaid than other city residents. But Medicaid benefits shift over time: in Massachusetts in 2002–2006 and again since 2010, adult dental Medicaid benefits did not include simple restorative procedures. In the 2010 benefit cut, services such as annual dental examinations and cleanings remained covered benefits, an improvement in coverage compared to the benefit reduction in 2002.¹⁷

As noted above, in unadjusted analyses, public housing residents had significantly lower odds of having been to the dentist in the past year for any reason and also lower odds of having had their teeth cleaned in the past year. In adjusted analyses, the relationship between housing status and having a dental visit within the last year became nonsignificant, but both PHD and RAU residents still had lower odds than residents of nonpublicly supported housing of having had their teeth cleaned in the last year.

It is unclear why public housing status in and of itself would have a negative effect on accessing routine dental care, although one possible explanation is found in research indicating that a higher neighborhood deprivation index is positively associated with using dental care only for symptomatic problems.¹⁸ It may be that regular dental care simply takes a back seat to other problems in public housing residents' lives. Further, the significant wait times for non-emergency dental appointments at community health centers in Boston, coupled with the lack of private dental practices accepting Medicaid, may have created access barriers that are more difficult for public housing residents to overcome than for low-income individuals not living in public housing.

Future research might explore the knowledge, attitudes, and beliefs of, as well as the barriers uniquely experienced by, public housing residents that may contribute to this

disparity. Analyses of the only direct measure of oral health status assessed by the Boston BRFSS showed that RAU residents had twice the odds, compared to residents of nonpublicly supported housing, of having had six or more teeth removed. Just as the neighborhood deprivation index affects access to regular care, it has also been shown that neighborhood characteristics are linked to severity of dental decay.¹⁹ The lack of regular care is likely to be a contributing factor to poor oral health in public housing residents, as is the aforementioned lack of comprehensive dental insurance coverage for low-income adults in Massachusetts. Unfortunately, individuals with Massachusetts Medicaid who have no means to pay for simple fillings are forced to choose between having no treatment and the extraction of restorable teeth.

This study has several limitations inherent to any BRFSS analysis. Before 2010, the Boston BRFSS was a landline telephone survey that did not include a cell-only household subsample, and during the data years 2001 through 2008 the proportion of households with landlines declined. It is not known if the prevalence of landlines is distributed similarly across demographic population groups and housing type. At least one study found cell phone-only households disproportionately younger and Latino (compared to white non-Latino and black non-Latino).²⁰ In addition, all BBRFSS data are self-reported and are therefore subject to reporting biases such as over-reporting of socially acceptable behaviors, underreporting of socially unacceptable behaviors, and inaccurate recall. Given that the dataset contains a limited number of variables, the analysis could not adjust for all known confounders, and unmeasured confounders may have played a role in our findings. In addition, stepwise analyses, even the modified manual procedures used here, have limitations including small standard errors, narrow confidence intervals, and low *p* values. Most significantly, the study data are limited to one city and since this is the first report of its kind, comparisons to other locations are not possible and the results cannot be assumed to be generalizable beyond Boston. Similar data could be obtained if states added a single question to the BRFSS, asking about public housing status.

Adjusted analyses of BRFSS data show that, compared to those not living in subsidized housing, public housing residents are more lacking in the basic dental service of teeth cleaning, and those living in RAUs are also more prone to substantial tooth loss. Taking a broader view, results of unadjusted analyses—which document, for *both* PHD and RAU residents, significant deficits for both a dental visit and a dental cleaning in the past year, along with significantly higher odds of substantial tooth loss—delineate a real-world oral health gap and identify a defined population that could benefit from services. Further, existing public housing infrastructure (such as a housing authority or other overall management structure, community rooms, individual property managers, and tenant task forces) could provide both a venue and a foundation for developing and implementing interventions to reach large numbers of individuals burdened with poor oral health or risk factors for poor oral health. Public housing is an untapped resource that could be utilized to reduce oral health disparities across the country.

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REFERENCES

1. US Department of Housing and Urban Development. Picture of Subsidized Households for 2009 [dataset]. <http://www.huduser.org/portal/picture/picture2009.html>. Accessed October 25, 2012.
2. Elter J, Offenbacher S, Toole J, Beck J. Relationship of periodontal disease and edentulism to stroke/TIA. *J Dent Res*. 2003; 82: 998–1001.
3. Lowe G, Woodward M, Rumley A, Morrison C, Tunstall-Pedoe H, Stephen K. Total tooth loss and prevalent cardiovascular disease in men and women. Possible roles of citrus fruit consumption, vitamin C, and inflammatory and thrombotic variables. *J Clin Epidemiol*. 2003; 56: 694–700.
4. dePablo P, Dietrich T, McAlindon T. Association of periodontal disease and tooth loss with rheumatoid arthritis in the US population. *J Rheumatol*. 2008; 35: 70–6.
5. Stein PS, Desrosiers M, Donegan SJ, Yepes J, Kryscio R. Tooth loss, dementia and neuropathology in the Nun study. *JADA*. 2007; 138: 1314–22.
6. Kaye EK, Valencia A, Baba N, Spiro A III, Dietrich T, Garcia R. Tooth loss and periodontal disease predict poor cognitive function in older men. *J Am Geriatr Soc*. 2010; 58: 713–718.
7. Saintrain MV, de Souza EH. Impact of tooth loss on the quality of life. *Gerodontology*. 2012; 29(2): e632.
8. Roumanas ED. The social solution—denture esthetics, phonetics, and function. *J Prosthodont*. 2009; 18(2): 112.
9. Hyde S, Satariano WA, Weintraub JA. Welfare dental intervention improves employment and quality of life. *J Dent Res*. 2006; 85(1): 79–84.
10. Kiyak HA, Reichmuth M. Barriers to and enablers of older adults' use of dental services. *J Dent Educ*. 2005; 69: 975–986.
11. Schiller JS, Lucas JW, Ward BW, Peregoy JA. Summary health statistics for U.S. adults: National Health Interview Survey, 2010. *Vital Health Stat*. 2012;10(252).
12. Boston Public Health Commission Research and Evaluation Office. *Health of Boston 2011*. Boston, MA; 2011.
13. Digenis-Bury E, Brooks D, Chen L, Ostrem M, Horsburgh R. Use of a population-based survey to describe the health of Boston public housing residents. *Am J Public Health*. 2008; 98: 85–91.
14. US Centers for Disease Control and Prevention, Survey Data and Documentation. Available from: http://www.cdc.gov/brfss/data_documentation.htm. Accessed July 21, 2013.
15. US Centers for Disease Control and Prevention, Healthy People 2010 Summary of Objectives, Oral Health Objective 7 (OH-7). Available from: <http://healthypeople.gov/2020/topicsobjectives2020/pdfs/OralHealth.pdf>. Accessed July 21, 2013.
16. National Institute of Dental and Craniofacial Research. *Oral health in America: a report of the surgeon general—executive summary*. Rockville, MD: 2000.
17. Pryor C, Monopoli M. *Eliminating adult dental coverage in Medicaid: an analysis of the Massachusetts experience*. Washington, DC: The Kaiser Commission on Medicaid and the Uninsured, The Kaiser Family Foundation; 2005.
18. Lang I, Gibbs S, Steel N, Melzer D. Neighbourhood deprivation and dental service use: a cross-sectional analysis of older people in England. *J Pub Health (Oxf)*. 2008; 30: 472–478.
19. Tellez M, Sohn W, Burt BA, Ismail AI. Assessment of the relationship between neighborhood characteristics and dental caries severity among low-income African-Americans: a multilevel approach. *J Pub Health Dentistry*. 2006; 66: 30.
20. Blumberg SJ, Luke JV. *Wireless substitution: early release of estimates from the National Health Interview Survey, January–June 2009*. National Center for Health Statistics, Division of Health Interview Statistics; 2009.