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Prevalence and mean number of teeth with amalgam and nonamalgam restorations, United States, 2015 through 2018

Eugenio D. Beltrán-Aguilar, DMD, MPH, MS, DrPH, DABDPH [epidemiologist],
DB Consulting, Atlanta, GA

Gina Thornton-Evans, DDS, MPH, DABDPH [dental officer],
Division of Oral Health, Centers for Disease Control and Prevention, Atlanta, GA.

Liang Wei, MS, MPH [statistician],
DB Consulting, Atlanta, GA.

Jorge Bernal, DDS, MPH [dental public health resident]
Division of Oral Health, Centers for Disease Control and Prevention, Atlanta, GA

Abstract

Background.—Amalgam has been used for more than 150 years as a safe and reliable restorative material. The authors described the occurrence of amalgam and nonamalgam restorations in the United States in primary and permanent teeth across age groups and according to sociodemographic characteristics.

Methods.—The authors used clinical examination data from the National Health and Nutrition Examination Survey 2015–2018 for participants 2 years and older (n = 17,040). The authors estimated the prevalence and mean number of amalgam and nonamalgam restorations in primary and permanent teeth according to age groups (2–5 years, 6–11 years, 12–15 years, 16–19 years, 20–39 years, 40–59 years, 60–79 years, and ≥ 80 years), race and ethnicity, federal poverty guideline, education, and pregnancy status.

Results.—The prevalence of amalgam restorations ranged from 4% through 69%. Overall, amalgam restorations were more prevalent in children and adolescents from racial and ethnic minority groups and families at higher poverty levels and with lower education. The mean number of teeth with nonamalgam restorations was higher than those with amalgam restorations in primary teeth of children aged 6 through 11 years, permanent teeth of those 12 through 15 years and 20–39 years, and women aged 20 through 49 years, regardless of pregnancy status. The mean number of amalgam restorations was higher than that for nonamalgam restorations in older age groups.

Conclusions.—Nonamalgam restorations was the most common in the primary teeth of children older than 5 years and in the permanent teeth of adults younger than 40 years. Amalgam

Address correspondence to Dr. Beltrán-Aguilar, DB Consulting, 4770 Buford Hwy, MS 107-8, Atlanta, GA 30341, edb4@cdc.gov or e.beltran@mac.com.
when the work described in this article was conducted. He now is a sealant and education coordinator, Oral Health Program, Georgia Department of Public Health, Atlanta, GA.

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restorations were more common in older adults. Amalgam and nonamalgam restorations were equally common in children younger than 5 years.

Practical Implications.—The study findings suggest a shift from amalgam to alternative restorative materials in the United States.

Keywords

Dental restorations; dental amalgam; composites

Surveillance data from the United States indicated that 5% through 17% of children aged 2 through 19 years, 26% of adults aged 20 through 64 years, and 16% of adults 65 years and older had untreated caries.[1] Direct restoration refers to materials applied to reestablish the tooth's anatomy (hence the term restoration) and fabricated inside the mouth.[2] The most common direct restorative materials used in posterior teeth are amalgam and composite resins.[2]

Amalgam is a malleable mixture of silver, tin, copper, and elemental mercury.[3] Amalgam has been used worldwide for more than 150 years to restore posterior teeth. Composite resins were designed to restore anterior teeth and, later, improvements in their composition extended their use as a restorative material in posterior teeth.[4] Composite resins require careful clinical handling to avoid moisture contamination.[5,6] In 2 systematic reviews, researchers reported that composite resin restorations were more likely to fail or to have a higher rate of secondary caries than amalgam restorations in posterior teeth.[2,7] In another systematic review, researchers reported a higher risk of failure in Class I and II restorations in the permanent dentition of people with high caries risk and those with a higher number of restored teeth.[8]

Other direct restorative materials include glass ionomer cements, which chemically combine fluoroaluminosilicate and polyacrylic acid.[9] Glass ionomers have been modified by means of incorporating resin material and labeled as resin-modified glass ionomer cement. In a 1995 study, researchers reported that resin-modified glass ionomer cements are more resilient to moisture contamination than non-modified glass ionomers.[10] In a retrospective, practice-based study, researchers reported 97% survival rates after 3 years in Class II restorations with resin-modified glass ionomer types of cement.[11] Both composite resins and glass ionomer cements rely on chemical bonding (adherence) and not only on the physical characteristics of the clinical preparation.[2,3,9] Both materials reduced the amount of dental tissue removed during placement compared with amalgam.

The selection of restorative material depends on multiple clinical factors and material properties, professional and patient choices, esthetics, reimbursement, and geographical areas in the United States.[12,13]

The US Food and Drug Administration (FDA) classifies amalgam as a Class II medical device and monitors its safety.[14–16] In a 2019 FDA systematic review,[17] researchers concluded that ". . . there is not sufficient evidence of a relationship between clinically detectable adverse health outcomes and dental amalgam mercury exposure." This conclusion

applies to the general population receiving restorations and dental care professionals delivering the restorations. This conclusion agreed with the 2015 European Commission on Emerging and Newly Identified Health Risks report.[18] The 2019 FDA systematic review emphasized the need to monitor potential adverse effects among high-risk people.[17] Therefore, in 2020[19] the FDA recommended avoiding amalgam restorations in

> . . . groups that may be at a greater risk for potential harmful health effects includ[ing]: Pregnant women and their developing fetuses; Women who are planning to become pregnant; Nursing women and their newborns and infants; Children, especially those younger than six years of age; People with pre-existing neurological disease such as multiple sclerosis, Alzheimer's disease or Parkinson's disease; People with impaired kidney function; and People with known heightened sensitivity (allergy) to mercury or other components of dental amalgam.

However, the "FDA does not recommend anyone remove or replace existing amalgam fillings in good condition unless it is considered medically necessary by a health care professional (for example, documented hypersensitivity to the amalgam material)."[16]

Professional organizations have emphasized the safety of amalgam restorations in their policies and recommendations.[20–22] In 2018, researchers in Canada published a comprehensive evaluation of amalgam and resin restorations, including efficacy, safety, cost, patient perspectives and experiences, implementation issues, and ethical considerations.[23] The authors concluded that amalgam was more efficacious than composite resin and costs less. In addition, according to the report, amalgam waste has a small relative contribution to environmental contamination within the Canadian context, assuming appropriate clinical and waste management.[23]

The United Nations Environmental Program has raised mercury environmental issues, leading to the Minamata Convention to phase down and phase out mercury products globally, including amalgam.[24,25]

In a 2007 survey of dentists conducted by the American Dental Association, 63% of dentists reported using amalgam restorations in their practices.[26] In addition, 65% of practitioners 40 years and older reported using amalgam restorations compared with 55% of those younger than 40 years.[26] Some researchers have reported changes in the use of restorative materials. For example, researchers from the University of Otago in New Zealand reported that although the annual rates of restorations placed in the dental school had not changed, the use of amalgam for direct restorations declined from 52% in 1998 to 7% in 2017.[27] In 2 reports, researchers from The Dental Practice-Based Research Network[12,13] provided additional information on the use of amalgam and resin-based materials in the United States. In 1 of these studies, researchers found no difference in the percentage of practitioners using amalgam or resin-based composite in molars and premolars (45%–50%).[12] In the second report, the research team found that the choice of restorative material depended on practitioner characteristics (years since graduation), practice (large, small, public health), patient (sex, race, age, insurance status), and location of the caries lesion.[13] However, The Dental Practice-Based Research Network researchers provided estimates only among people seeking care in selected practices in the United States.

In the 2015 National Health and Nutrition Examination Survey (NHANES) protocol, the dental examiners evaluated all tooth surfaces for amalgam or any other restorative material, including crowns. NHANES included this change in the 2015 through 2016, 2017 through 2018, and 2019 through March 2020 (prepandemic file) cycles. In a 2021 article using 2015 through 2016 data limited to permanent teeth in participants 15 years and older, researchers reported 51.5% as the "proportion of restored teeth restored with silver amalgam on ≥1 surface."[28]

Our aim was to describe the prevalence and mean number of teeth with amalgam and non-amalgam restorations in the United States in primary and permanent teeth across different age groups and sociodemographic characteristics.

METHODS

We used data from the oral health status and dentition component of NHANES 2015 through 2016 and 2017 through 2018. We did not use the 2017 through March 2020 (prepandemic file) data cycle, which overlaps with 2017 through 2018, because data collection stopped in March 2020 due to the COVID-19 pandemic, and these data cannot be added to previous years.[29] The NHANES protocols and procedures are described elsewhere.[30,31] Briefly, a probability sample of households are selected and members are interviewed at home. Then, a selection of household members are invited to participate in a dental examination at a mobile examination center. Trained and standardized dental examiners complete the clinical examinations. Two teams that visit approximately 15 sites per year collect the data. The interview, examination, and laboratory data provide annual estimates of the US noninstitutionalized population. Still, data are released in 2-year cycles to increase the sample size and improve the accuracy of the estimates. In our secondary data analysis, we used publicly available data sets from the National Center for Health Statistics, which do not include personal identifier information and did not require institutional review board approval. NHANES completed all institutional review board and consent or assent requirements before data collection (additional information is available at http://medbox.iiab.me/modules/en-cdc/www.cdc.gov/nchs/nhanes/irba98.htm). In addition, we applied all NHANES technical recommendations regarding minimum cell numbers to reduce the risk of disclosure.

We used SAS, Version 9.4 and SUDAAN, Release 11.0.3 to account for the survey's complex sampling design. A total of 17,040 participants 2 years and older completed the oral examination about the type of restorative material used (that is, amalgam vs nonamalgam). Twenty-eight variables (1 per tooth, excluding third molars) identified the surfaces with amalgam and nonamalgam restorations (variables were OHX##CSC, where ## is the tooth number, CSC is coronal surface condition, and OHX is the NHANES identifier for oral health examination). Nonamalgam restorations included composite resins, glass ionomers, resin-modified glass ionomers, temporary restorative materials, and porcelain, ceramic, gold, and other fabricated materials (inlays).[31] Amalgam took precedence in scoring when more than 1 type of restorative material was in a single tooth surface.[31] In addition, we included the variables in the data set that NHANES identified as secondary restoration (variables were OHX##RSC, where ## is the tooth number and RSC is secondary

restoration surface call). These are restorations located on tooth surfaces with an untreated caries lesion. Before 2015, the NHANES protocol did not include these restorations because untreated caries lesions had coding precedence over treated lesions on the same tooth surface.[30] Our estimates of the number of restorations were more accurate than estimates that excluded the secondary restoration variables.

A reference examiner trained the examiners. NHANES uses a quality-assurance protocol to evaluate the interexaminer reliability for each clinical outcome using the reference examiner as the standard. These data have not yet been published.

We estimated the prevalence and mean number of teeth with amalgam or nonamalgam restorations. The estimates are not mutually exclusive because a participant can have both types of restorations. Our estimates for the mean number of restorations used 2 different denominators, all participants, and was restricted to those with 1 or more amalgam or nonamalgam restorations, which is consistent with a previous study.[28] We excluded teeth with crowns from all calculations. Our results include SEs calculated in SUDAAN following sampling parameters. Lastly, we obtained the population ratio of the mean number of teeth with amalgam to nonamalgam restorations among those with 1 or more restorations (except crowns). Ratios greater than 1 indicate a higher mean number of teeth with amalgam restorations. We used χ^2 or t tests to compare sociodemographic groups' prevalence estimates and mean numbers.

We used age groups representing NHANES sampling domains. We grouped participants aged 2 through 5 years and 6 through 11 years to analyze restorations in the primary dentition. We grouped children and adolescents aged 6 through 11 years, 12 through 15 years, and 16 through 19 years, and adults aged 20 through 39 years, 40 through 59 years, 60 through 79 years, and 80 years and older for analysis in the permanent dentition. We stratified the estimates according to sex, race and ethnicity, federal poverty guideline, and education (parents' education for children and adolescents) using variables provided in the NHANES data set. We reported separate estimates for Mexican American and other Hispanic participants. In addition, we obtained similar estimates for women aged 20 through 44 years according to pregnancy status using the corresponding NHANES recode variable (that is, pregnant, not pregnant, or undetermined). However, we did not stratify these estimates according to sociodemographic characteristics because of the low number of pregnant participants.

RESULTS

Primary teeth: children aged 2 through 11 years

The prevalence of amalgam restorations in primary teeth among children aged 2 through 11 years was 9.4% (Table 1) and increased according to age group from 5.1% through 12.3%. Mexican American participants (19.4%), other Hispanic participants (11.9%), Asian American participants (14.1%), children from families below 100% of the federal poverty guideline (12.6%), and children whose parents had less than a high school education (17.7%) had a higher prevalence of amalgam restorations than their sociodemographic counterparts.

The mean number of teeth with amalgam restorations among participants with restorations (Table 1) was higher in the age group 2 through 5 years ($\bar{x}$ = 1.6), and the mean number of teeth with nonamalgam restorations was higher in the age group 6 through 11 years ($\bar{x}$ = 1.7). Mexican American participants ($\bar{x}$ = 1.7), other Hispanic participants ($\bar{x}$ = 1.5), Asian American participants ($\bar{x}$ = 1.9), children from families below 100% of the federal poverty guideline ($\bar{x}$ = 1.4), and parents with less than a high school education ($\bar{x}$ = 1.6) had higher mean numbers of teeth with amalgam restorations than their sociodemographic counterparts (Table 1). However, the differences were not statistically significant. The same groups had a higher ratio of amalgam to nonamalgam restorations than their sociodemographic counterparts (Table 1).

Permanent teeth: children and adolescents aged 6 through 19 years

The prevalence of amalgam restorations in permanent teeth increased from 4.1% among those aged 6 through 11 years to 15.3% among those aged 12 through 15 years and 22.8% among those aged 16 through 19 years (Table 2). Mexican American children (19.8%), children from families below 100% of the federal poverty guideline (18.9%), and children with parents who had less than a high school education (20.5%) had the highest prevalence of amalgam restorations compared with their sociodemographic counterparts.

The mean number of teeth with amalgam restorations among participants with restorations increased according to age group from 0.8 to 1.5 (Table 2). The mean number of teeth with nonamalgam restorations increased from 1.2 to 3.2 (Table 2). Non-Hispanic White participants ($\bar{x}$ = 1.0), those from families above 200% of the federal poverty guideline ($\bar{x}$ = 0.9), and parents with more than a high school education ($\bar{x}$ = 0.8) had lower mean numbers of teeth with amalgam restorations than their sociodemographic counterparts (Table 2). However, these differences were not statistically significant. The ratio of the mean number of teeth with amalgam to nonamalgam restorations was less than 1 in all age groups and sociodemographic groups (Table 2).

Permanent teeth: adults 20 years and older

The prevalence of amalgam restorations in permanent teeth among adults was 56.5% (Table 3). The prevalence increased in the 2 younger age groups (41.7% and 68.6% among participants aged 20 through 39 years and 40 through 59 years, respectively) and then decreased in the 2 older age groups (61.9% and 51.1% among participants aged 60 through 79 years and 80 years and older, respectively). Non-Hispanic White participants (60.3%), adults from families above 200% of the federal poverty guideline (61.2%), and those with greater than a high school education (59.6%) had a higher prevalence of amalgam restorations than their sociodemographic counterparts.

The mean number of teeth with amalgam restorations among participants with restorations (Table 3) increased from 2.5 to 3.7 in the 2 younger age groups, then remained at 3.1 in the older age groups (Table 3). The mean number of teeth with nonamalgam restorations decreased from 3.1 in the age group 20 through 39 years to 2.1 in the age group 80 years and older (Table 3). The ratio of mean number of teeth with amalgam to nonamalgam

restorations was greater than 1 in all age groups except in the youngest age group (20–39 years) and among Asian American participants.

The prevalence of amalgam restorations was higher among women who were not pregnant than pregnant women (47.3% and 39.8%, respectively) (Table 4). However, the mean number of teeth with amalgam to nonamalgam restorations ratios (0.7 and 0.8) reflects the same values in the overall sample in comparable age (0.8 among those aged 39 years) (Table 3).

DISCUSSION

Our data suggest age cohort differences in the prevalence and mean number of teeth with amalgam and nonamalgam restorations. Teeth with nonamalgam restorations were more common among younger age groups, except in the age group 2 through 5 years. In addition, children and adolescents from ethnic or racial minority groups, those living in lower income households, and parents with lower education levels had higher prevalence and mean number of teeth with amalgam restorations than other sociodemographic groups.

Among children aged 2 through 5 years, the mean number of teeth with amalgam and nonamalgam restorations was similar, a finding not observed in older children, adolescents, and young adults. We do not have information on the reasons why restorations were placed. However, it is possible that the easier clinical handling of amalgam compared with composite restorations may favor using amalgam in young children. High-viscosity glass ionomers share common properties with composite resins but are more resistant to moisture during placement and appear to be a viable alternative for restoring primary teeth.[32]

The prevalence and mean number of teeth with amalgam restorations were higher in adults 40 years and older. Like primary teeth, we do not know why materials were chosen or when the restorations were placed. Furthermore, changing amalgam includes more extensive restorations, probably followed by inlays and crowns. We do not know the cycle of rerestoration with composite resins. Despite these differences, our finding of higher prevalence and higher mean number of teeth with amalgam restorations in older cohorts can also reflect a trend in the selected material. If the trend toward less use of amalgam as a restorative material continues, the mean number of non-amalgam restorations should increase in older cohorts. In addition, missing teeth and restorations replaced with crowns might explain the lower amalgam prevalence in the 2 older age groups (60–79 years and ≥ 80 years). These hypotheses require additional study.

Our results regarding adults expanded on the findings of Estrich and colleagues.[28] Our estimates were not directly comparable with theirs because we included a larger sample size, described different age groups, and provided age-specific estimates. However, our trends of amalgam and nonamalgam restorations agreed.

The selection of restorative material depends on many factors, including material properties, professional training, personal choices, and cost and reimbursement.[12,13,26] By extension, as our data suggest, the time when the restoration was placed is also important for understanding trends. Results of a 2013 survey of 408 Australian general oral health care

practitioners (<3% of registered dentists) found that 30% do not use amalgam.[33] Dentists who graduated before the 1960s, those in nonprivate settings, and those in rural areas reported higher use of amalgam than their counterparts. In the same study, clinical factors, such as moisture control and esthetics, were influential in deciding which material to use.[34] Results from a 2007 American Dental Association survey of dental practices showed that 64% of responders used amalgam.[26] Still, this percentage is likely to decrease as newer graduating dentists trained in using alternative materials enter clinical practice.

The teaching of restorative materials is not uniform either. Results of a 2009 through 2010 survey of dental schools in the United States and Canada showed that all 49 participating schools taught composite resins for Class I and II restorations on posterior teeth.[35] In the same study, resin-based restorations accounted for 49% of posterior restorations at academic institutions.[35] In a 2011 preliminary study of US dental schools, researchers reported comparable curriculum time in teaching amalgam and alternative material restorations.[36] In addition, results of a 2011 survey of predoctoral pediatric dentistry programs researchers reported that for primary teeth 74% of 44 dental schools used amalgam, 93% used composite, and 61% used glass ionomers.[37] Use of glass ionomers was associated with programs with off-site academic clinics.[37] The authors suggested that a positive attitude toward minimally invasive dentistry favors nonamalgam materials. Results of a survey of dental schools in Australia, New Zealand, Fiji, and Papua New Guinea showed that they taught composite restorations for occlusal and occlusal-proximal cavities in permanent molars and premolars, with slightly more teaching time dedicated to composites (39%) than to amalgams (29%).[38]

Regarding the environmental impact of amalgams in the United States, since the 1980s, dental care professional groups and the US Environmental Protection Agency have recommended and regulated the use of encapsulated amalgam (single dose) and amalgam separators to reduce amalgam waste released into the wastewater systems.[39,40] Amalgam separators are included in the Minamata Convention as interventions to reduce environmental mercury from dental practice.[41]

The main limitation of our study was the lack of separate information on material type among nonamalgam restorations. The increase in nonamalgam restorations could be attributed to inlays and crowns, not just composite resins or glass ionomers. In addition, the age and history of the restorations (primary, secondary) are unknown. Despite these differences, NHANES data provide a baseline to monitor the patterns of restorative materials placed in the United States.

CONCLUSIONS

We found that nonamalgam restorations were the most common restorative material found in the primary teeth of children older than 5 years and in the permanent teeth of adults younger than 40 years. Amalgam restorations were more common in older adults. Amalgam and nonamalgam restorations were equally common in children younger than 5 years. The age-related findings suggest a shift from amalgam over time, as alternative restorative

materials have been introduced and improved. It also may reflect changes in treatment toward minimally invasive approaches.

Acknowledgments

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

ABBREVIATION KEY

CSC	Coronal surface condition
FDA	US Food and Drug Administration
NHANES	National Health and Nutrition Examination Survey
OHX	Oral health examination
RSC	Second restoration surface condition

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Table 1.

Prevalence and mean number of teeth with amalgam and nonamalgam restorations in primary teeth among children aged 2–11 y: National Health and Nutrition Examination Survey, 2015–2018.

VARIABLE	PARTICIPANTS, NO.	PREVALENCE OF AMALGAM RESTORATIONS*	TEETH WITH AMALGAM RESTORATIONS†	TEETH WITH NONAMALGAM RESTORATIONS‡	TEETH WITH AMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS§	TEETH WITH NONAMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS¶	RATIO OF TH MEAN NO. OF AMALGAM T NONAMALGA RESTORATION
		% (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	
Total	3,895	9.4 (1.1)	0.3 (0.04)	0.4 (0.04)	1.2 (0.14)	1.7 (0.15)	0.7
Age (Y)							
2–5	1,584	5.1 (1.2)	0.3 (0.04)	0.2 (0.03)	1.6 (0.27)	1.5 (0.24)	1.1
6–11	2,311	12.3 (1.3)	0.3 (0.04)	0.5 (0.06)	1.1 (0.12)	1.7 (0.15)	0.6
Sex							
Male [Reference]	1,942	10.3 (1.1)	0.3 (0.03)	0.4 (0.04)	1.2 (0.12)	1.6 (0.14)	0.8
Female	1,953	8.5 (1.3)	0.3 (0.04)	0.4 (0.05)	1.2 (0.18)	1.7 (0.19)	0.7
Race and Ethnicity							
Non-Hispanic White [Reference]	1,154	6.1 (1.0)	0.2 (0.03)	0.3 (0.05)	0.8 (0.16)	1.9 (0.18)	0.4
Non-Hispanic Black	897	6.8 (1.4)	0.1 (0.03)	0.2 (0.06)	0.9 (0.15)	1.5 (0.19)	0.6
Mexican American	744	19.4 (3.9)#	0.6 (0.12)#	0.5 (0.10)	1.7 (0.26)	1.4 (0.27)	1.2
Other Hispanic	417	11.9 (2.4)#	0.4 (0.07)#	0.3 (0.08)	1.5 (0.26)	1.4 (0.27)	1.1
Asian American	339	14.1 (2.0)#	0.4 (0.08)#	0.3 (0.10)	1.9 (0.29)	1.4 (0.36)	1.4
Federal Poverty Guideline							
< 100%	1,096	12.6 (2.5)#	0.4 (0.08)#	0.3 (0.07)	1.4 (0.26)	1.4 (0.22)	1.0
100%–200%	1,009	11.6 (1.4)#	0.3 (0.04)#	0.3 (0.05)	1.3 (0.14)	1.4 (0.18)	0.9
> 200% [Reference]	1,418	6.1 (0.9)	0.2 (0.03)	0.4 (0.05)	1.0 (0.15)	2.0 (0.18)	0.5
Education (Parent)							
< High school	669	17.7 (3.3)#	0.5 (0.12)#	0.5 (0.10)	1.6 (0.32)	1.4 (0.29)	1.1
High school graduate	1,305	9.9 (1.7)	0.3 (0.05)	0.4 (0.05)	1.2 (0.19)	1.6 (0.19)	0.8
> High school [Reference]	1,826	6.9 (0.8)	0.2 (0.03)	0.3 (0.05)	1.0 (0.13)	1.8 (0.15)	0.6

* Defined as participants having ≥ 1 tooth restored with amalgam.

[†]Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Surveyvariables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

[‡]Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Surveyvariables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

[§]Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

[¶]Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

[#]Statistically significant difference from the Reference group using *t* test at $P < .05$.

Table 2.

Prevalence and mean number of teeth with amalgam and nonamalgam restorations in permanent teeth among adolescents aged 6–19 y: National Health and Nutrition Examination Survey, 2015–2018.

VARIABLE	PARTICIPANTS, NO.	PREVALENCE OF AMALGAM RESTORATIONS*	TEETH WITH AMALGAM RESTORATIONS†	TEETH WITH NONAMALGAM RESTORATIONS‡	TEETH WITH AMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS§	TEETH WITH NONAMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS¶	RATIO OF TH MEAN NO. OF AMALGAM T NONAMALGA RESTORATION
		% (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	
Total	4,717	12.6 (1.0)	0.4 (0.05)	0.8 (0.06)	1.3 (0.13)	2.6 (0.13)	0.5
Age (Y)							
6–11	2,311	4.1 (0.7)	0.1 (0.01)	0.1 (0.02)	0.8 (0.11)	1.2 (0.13)	0.7
12–15	1,254	15.3 (1.8)	0.4 (0.06)	0.9 (0.09)	1.1 (0.14)	2.3 (0.18)	0.5
16–19	1,152	22.8 (1.7)	0.8 (0.12)	1.8 (0.12)	1.5 (0.19)	3.2 (0.16)	0.5
Sex							
Male [Reference]	2,366	12.7 (1.2)	0.4 (0.06)	0.7 (0.07)	1.4 (0.19)	2.5 (0.19)	0.6
Female	2,351	12.6 (1.2)	0.4 (0.05)	0.9 (0.07)	1.1 (0.13)	2.7 (0.15)	0.4
Race and Ethnicity							
Non-Hispanic White [Reference]	1,336	9.5 (0.9)	0.3 (0.05)	0.8 (0.08)	1.0 (0.18)	2.7 (0.21)	0.4
Non-Hispanic Black	1,067	13.5 (2.3)	0.4 (0.09)	0.9 (0.13)	1.3 (0.25)	2.8 (0.24)	0.5
Mexican American	959	19.8 (2.9)#	0.7 (0.12)#	0.9 (0.15)	1.7 (0.28)	2.9 (0.25)	0.6
Other Hispanic	507	17.0 (2.4)#	0.4 (0.06)	0.9 (0.13)	1.3 (0.19)	2.6 (0.28)	0.5
Asian American	469	13.0 (2.3)	0.4 (0.08)	0.7 (0.11)	1.2 (0.27)	2.3 (0.31)	0.5
Federal Poverty Guideline							
< 100%	1,207	18.9 (2.1)#	0.6 (0.09)#	0.9 (0.11)	1.6 (0.20)	2.5 (0.25)	0.6
100%–200%	1,283	15.7 (1.8)#	0.5 (0.08)#	0.8 (0.09)	1.5 (0.23)	2.4 (0.24)	0.6
> 200% [Reference]	1,758	8.1 (0.9)	0.2 (0.04)	0.8 (0.07)	0.9 (0.11)	2.8 (0.17)	0.3
Education (Parent)							
< High school	908	20.5 (2.1)#	0.7 (0.11)#	1.0 (0.15)#	1.8 (0.26)	2.5 (0.25)	0.7
High school graduate	1,639	16.3 (1.5)#	0.5 (0.08)#	0.9 (0.10)	1.5 (0.24)	2.4 (0.24)	0.6
> High school [Reference]	2,061	7.7 (1.1)	0.2 (0.04)	0.7 (0.07)	0.8 (0.13)	2.8 (0.17)	0.3

[*] Defined as participants having ≥ 1 tooth restored with amalgam.

[†] Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

[‡] Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

[§] Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

[¶] Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

[#] Statistically significant difference from the Reference group. using *t* test at $P < .05$.

Table 3.

Prevalence and mean number of teeth with amalgam and nonamalgam restorations in permanent teeth among adults ≥ 20 y: National Health and Nutrition Examination Survey, 2015–2018.

VARIABLE	PARTICIPANTS, NO.	PREVALENCE OF AMALGAM RESTORATIONS*	TEETH WITH AMALGAM RESTORATIONS†	TEETH WITH NONAMALGAM RESTORATIONS‡	TEETH WITH AMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS§	TEETH WITH NONAMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS¶	RATIO OF TH MEAN NO. OF AMALGAM T NONAMALGA RESTORATION
		% (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	
Total	10,739	56.5 (0.9)	2.3 (0.08)	2.0 (0.07)	3.1 (0.09)	2.6 (0.08)	1.2
Age (Y)							
20–39	3,453	41.7 (1.5)	1.7 (0.10)	2.1 (0.11)	2.5 (0.12)	3.1 (0.14)	0.8
40–59	3,459	68.6 (1.2)	3.0 (0.11)	2.0 (0.09)	3.7 (0.12)	2.5 (0.10)	1.5
60–79	3,102	61.9 (1.5)	2.4 (0.10)	1.8 (0.08)	3.1 (0.14)	2.3 (0.07)	1.3
≥ 80	725	51.1 (2.5)	1.9 (0.17)	1.3 (0.13)	3.1 (0.21)	2.1 (0.17)	1.5
Sex							
Male [Reference]	5,165	55.8 (1.1)	2.3 (0.09)	1.7 (0.08)	3.2 (0.11)	2.4 (0.09)	1.3
Female	5,574	57.1 (1.2)	2.3 (0.08)	2.2 (0.08)#	3.1 (0.10)	2.9 (0.09)	1.1
Race and Ethnicity							
Non-Hispanic White [Reference]	3,598	60.3 (1.2)	2.5 (0.11)	2.2 (0.08)	3.2 (0.13)	2.8 (0.09)	1.1
Non-Hispanic Black	2,401	49.7 (1.4)#	1.9 (0.09)#	1.4 (0.09)#	2.9 (0.11)	2.1 (0.12)	1.4
Mexican American	1,649	49.6 (1.7)#	2.2 (0.14)	1.4 (0.09)#	3.4 (0.17)	2.2 (0.12)	1.5
Other Hispanic	1,219	56.6 (2.2)	2.4 (0.13)	2.1 (0.16)	3.2 (0.12)	2.7 (0.18)	1.2
Asian American	1,408	40.2 (1.8)#	1.4 (0.09)#	1.7 (0.10)#	2.2 (0.12)	2.7 (0.13)	0.8
Federal Poverty Guideline							
< 100%	1,943	45.6 (1.8)#	1.9 (0.10)#	1.4 (0.08)#	3.0 (0.13)	2.2 (0.09)	1.4
100%–200%	2,646	52.1 (2.0)#	2.2 (0.10)#	1.6 (0.06)#	3.2 (0.11)	2.3 (0.07)	1.4
> 200% [Reference]	4,888	61.2 (1.0)	2.5 (0.09)	2.3 (0.90)	3.2 (0.11)	2.8 (0.10)	1.1
Education							
< High school	2,350	43.8 (1.5)#	1.7 (0.10)#	1.0 (0.08)#	3.1 (0.09)	1.9 (0.11)	1.6
High school graduate	2,437	55.0 (1.7)#	2.3 (0.13)	1.7 (0.09)#	3.3 (0.14)	2.4 (0.12)	1.4

VARIABLE	PARTICIPANTS, NO.	PREVALENCE OF AMALGAM RESTORATIONS*	TEETH WITH AMALGAM RESTORATIONS†	TEETH WITH NONAMALGAM RESTORATIONS‡	TEETH WITH AMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS§	TEETH WITH NONAMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS¶	RATIO OF TH MEAN NO. OF AMALGAM T NONAMALGA RESTORATION
		% (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	
> High school [Reference]	5,937	59.6 (1.0)	2.5 (0.99)	2.3 (0.08)	3.1 (0.11)	2.8 (0.09)	1.1

*Defined as participants having ≥ 1 tooth restored with amalgam.

†Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

‡Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

§Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

¶Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

#Statistically significant difference from the Reference group using *t* test at $P < .05$.

Table 4.

Prevalence and mean number of teeth with amalgam and nonamalgam restorations in permanent teeth among women aged 20–44 y, according to pregnancy status: National Health and Nutrition Examination Survey, 2015–2018.

VARIABLE	PARTICIPANTS, NO.	PREVALENCE OF AMALGAM RESTORATIONS*	TEETH WITH AMALGAM RESTORATIONS†	TEETH WITH NONAMALGAM RESTORATIONS‡	TEETH WITH AMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS§	TEETH WITH NONAMALGAM RESTORATIONS AMONG PARTICIPANTS WITH ≥ 1 RESTORATIONS¶	RATIO OF T MEAN NO. AMALGAM NONAMALG RESTORATI
		% (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	Mean No. (SE)	
Women Aged 20–44 Y	2,297	46.6 (1.7)	2.0 (0.11)	2.5 (0.13)	2.7 (0.14)	3.5 (0.15)	0.8
Pregnant (Self-Reported)	125	39.8 (4.0)	1.7 (0.31)	2.3 (0.45)	2.5 (0.40)	3.4 (0.60)	0.7
Not Pregnant [Reference]	2,091	47.3 (1.8)	2.0 (0.11)	2.6 (0.13)	2.7 (0.13)	3.5 (0.14)	0.8
Undetermined	81	34.6 (6.9)	1.4 (0.35)	2.0 (0.56)	2.2 (0.54)	3.3 (0.74)	0.7

*Defined as participants having ≥ 1 tooth restored with amalgam.

†Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

‡Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included all participants.

§Included participants with codes 0, 1, 2, 3, and 4 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.

¶Included participants with codes 5, 6, 7, 8, and 9 for National Health and Nutrition Examination Survey variables OHX##CSC and OHX##RSC, where OHX is oral health examination, ## is the tooth identification number, CSC is coronal surface condition, and RSC is second restoration surface condition. Third molars were excluded. The denominator included participants with ≥ 1 amalgam or nonamalgam restorations.