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Dental treatment affordability and oral outcomes among U.S. adults: NHANES 2015–2018

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Abstract

Background Despite the increase in dental care utilization in the U.S., access to dental care is limited by many barriers, particularly financial ones. The aim of this study was to assess the relationship between the affordability of dental treatment and oral health outcomes.

Methods This cross-sectional study utilized 2015–2018 National Health and Nutrition Examination Survey data (NHANES). The key outcomes measured included the number of decayed teeth, missed teeth due to caries, and filled teeth (DMFT), the number of untreated teeth with dental decay and missing teeth, the presence of root caries, and the affordability of dental care as the main predictor. Descriptive analyses, negative binomial analyses for count outcomes, and logistic regression for binary outcomes were conducted. The analyses were adjusted for the NHANES sampling weights.

Results The study included 11,566 participants, 14.17% of whom reported being unable to afford dental treatment. Among those who could not afford dental treatment, the mean ratio was 3.27 (95% CI: 2.72–3.95; $p < 0.01$) for untreated dental decay, along with a higher DMFT (mean ratio 1.24; 95% CI: 1.18–1.31; $p < 0.01$) compared with those who could afford treatment. The odds of having root caries were significantly greater (odds ratio 4.46; 95% CI: 3.53–5.64; $p < 0.01$) among those unable to afford dental care than among those who could afford treatment.

Conclusion Individuals who cannot afford dental care experienced significantly higher ratios of untreated dental decay and other oral health outcomes. The findings highlight the necessity for targeted interventions to address financial barriers and improve access to dental services.

Keywords Affordability, Cost, Oral health, DMFT.

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Introduction

Oral health is a multifaceted concept that involves the essential functions necessary for communication, expression, and nutrition [1] The perception of oral health is shaped by both personal and societal values and is fundamental to an individual's quality of life [1]. Furthermore, dental caries serves as a key indicator of oral health status, characterized as the localized chemical breakdown of tooth enamel due to metabolic activities in dental plaque [2]. Approximately 91% of adults aged 20–64 in the United States have experienced dental caries [3]. The primary barrier to accessing dental care is cost, which remains a challenge even for individuals with dental coverage [4]. Additional obstacles include anxiety related to dental procedures and issues with appointment scheduling or locations [5]. Many social determinants—including socioeconomic status, education, race/ethnicity, and access to healthcare—shape oral health inequalities. These structural elements influence people's capacity to participate in preventive behaviors, access dental care, and manage oral diseases [6]. Obeidat et al. showed that U.S. adults' poorer oral health results were significantly linked to housing insecurity [7]. Tellez et al. summarized recent worldwide data showing that social determinants regularly affect caries prevalence, tooth loss, and access to care [8]. A meta-analysis study indicated that those with low socioeconomic status have a much greater risk of dental caries [9].

A study utilizing data from the 2014 National Health Interview Survey (NHIS), which included 112,053 interviews representing the civilian noninstitutionalized population of the U.S. The findings indicated that nonelderly adults were more likely to face financial barriers to dental care than other age groups were, with 12.8% of nonelderly adults reporting that cost prevented them from receiving necessary dental care, compared with 7.2% of seniors and 4.3% of children [4]. A 2023 study focused on adult Medicaid beneficiaries and dentists, with a total of 2,467 beneficiaries participating. Notably, 51% of respondents reported not visiting a dentist in the past year, and among those, 39% cited affordability as the reason for not seeking dental care [10]. Furthermore, data from the National Health and Nutrition Examination Survey (NHANES) (2015–2018) were analyzed to assess the relationship between the number of teeth with untreated caries and the affordability of dental care among 9,440 U.S. adults. The results revealed that those unable to afford dental care had a mean of 1.46 teeth with untreated caries, whereas those who could afford it had a mean of 0.36 [11]. Additionally, a study analyzed data from the 2011–2014 NHANES, which included 9,673 adult participants. The study revealed that the prevalence of untreated caries among U.S. adults during this period was 25.0%. The odds of having untreated caries were 2.4 times greater for adults living below 100% of the Federal Poverty Level (FPL) than for those living at or above 400% FPL [12]. Badr and Sabbah examined this association and reported that untreated root caries affected 42.5% of individuals unable to afford dental care, in contrast to only 14% of those with access to such services [13]. Vujicic et al. reported on financial barriers to various types of care in 2019 and reported that 19% of individuals faced barriers to dental care [14].

Previous studies have examined the prevalence of untreated dental caries among U.S. adults who cannot afford treatment [11, 12]. This cross-sectional study aims to assess the relationships between affordability and multiple oral health outcomes, such as missing teeth, the number of decayed teeth, teeth missed due to caries, filled teeth (DMFTs), and root caries.

Materials and methods

Study design

This cross-sectional study utilized data from two distinct cycles of the NHANES conducted between 2015 and 2018: the first cycle (2015–2016) and the second cycle (2017–2018). Each cycle comprises its own participants, providing a nationally representative sample of the U.S. population. NHANES is administered by the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC) [15]. Comprehensive data on the health and nutritional status of noninstitutionalized U.S. adults were collected through a combination of interviews and clinical examinations. The survey employs a complex, multistage sampling design, enabling the results to be generalized to the entire U.S. adult population. Dental examiners, who were calibrated and trained, conducted the oral health examinations in a designated area of the mobile examination center. However, x-rays were not included in these assessments. All adults above the age of 18 who had undergone a dental clinical examination were included in the study.

Outcome

Count outcomes:

1 The number of teeth with untreated dental decay.
2 The number of missing teeth due to caries.
3 DMFT. To measure DMFT, count the number of teeth that are decayed, missing due to caries, or filled, and sum these values to obtain the DMFT score. The mean DMFT is then calculated by dividing the total DMFT scores by the number of individuals in the population.
4 The number of decayed, missed due to caries, and filled surfaces (DMFS). To measure DMFS, count the decayed, missing due to caries, and filled surfaces for each tooth, then sum these counts to get the DMFS

score. The mean DMFS is calculated by dividing the total DMFS scores by the total number of individuals in the population.

Binary outcomes:

1 Presence of any root caries.
2 Presence of any root caries restoration.

Main predictor

The main predictor of the study was the affordability of dental care. The NHANES question included was "What were the reasons that you (or she/he) could not get the dental care needed?" Responses were coded as 0 for those who could afford care and 1 for those who answered, "Could not afford the cost."

Sociodemographic variables

In this study, we included several variables. First, gender was categorized into two groups: male and female. Second, the participants were divided into three age groups: 19–45 years, 46–64 years, and 65 years and above. Third, race/ethnicity categories were classified as Mexican American and other Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and other. Fourth, educational attainment was assessed by classifying participants into three levels: less than high school, high school graduate, and more than high school. Finally, family income was based on FPL and was stratified into four categories: less than 100% FPL, 100–199% FPL, 200–399% FPL, and 400% and above FPL.

Statistical analysis

The study utilized STATA software 18.0 (Stata Corp, College Station, TX, USA) to conduct the statistical analyses. The collection of NHANES data was based on a complex survey design. All results were weighted to account for clustering and stratification, ensuring unbiased estimates and reliable variance, except for the count of the total population. Analyses were conducted on the combined data from two NHANES cycles, and the weights were adjusted by dividing them by the total number of cycles. Multiple imputation was used to impute values for missing covariates. Descriptive analyses were used to examine the distributions of age, race/ethnicity, education, and family income among adults who could and could not afford dental treatment, with chi-square tests used to assess the significance of differences. Negative binomial analyses were used to assess the associations between count outcomes and the affordability of dental treatment. Logistic regression models were used to assess the associations between the ability to afford dental treatment and the presence of root caries or root caries restorations. A statistical significance threshold of $p < 0.05$ was used.

Results

The total sample size is 11,566 participants. The majority (51.81%) were female, 46.68% were 19–45 years old, 62.83% were non-Hispanic White for race/ethnicity, 63.13% had some college education or above, and 28.29% had a 200%–399% FPL income. A total of 14.17% of the total individuals were unable to afford dental treatment. Additionally, 15.42% of the total population were edentulous. In terms of gender, 15.55% of women and 12.66% of men could not afford dental treatment. Among the age groups, 16.82% of those between the ages of 19 and 45 years lacked the ability to afford dental treatment; compared with those between the ages of 46 and 64 years, 7.55% of those aged 65 and above did. For race/ethnicity, 21.03% of non-Hispanic Black individuals could not afford dental treatment, 20.12% of Mexican American and other Hispanic groups, and 11.92% of non-Hispanic White individuals could not afford dental treatment. With respect to educational level, 10.80% of those with some college education or above could not afford dental treatment, whereas 26.05% of those with less than a high school education could not afford dental treatment. In terms of family income categories, 3.51% of those earning 400% + FPL and 31.03% of those earning less than 100% FPL could not afford dental treatment. All sociodemographic variables were significantly associated with receiving dental treatment, with a p value of less than 0.01 for all categories (Table 1).

Individuals who cannot afford dental treatment are associated with a significantly greater number of teeth with untreated caries than those who can afford treatment (mean ratio = 3.27; 95% CI: 2.72–3.95; $p < 0.01$). The mean ratio for missing teeth resulting from caries is 1.39 (95% CI: 1.20–1.63; $p < 0.01$), meaning that those who cannot afford dental treatment are associated with a significantly greater number of missed teeth than those who can afford treatment. The mean ratio for filled teeth was 0.87 (95% CI: 0.81–0.95; $p < 0.01$), indicating that those who cannot afford dental treatment have a lower likelihood of having filled teeth than those who can afford treatment (Table 2).

With respect to the DMFT measure, the mean ratio is 1.24 (95% CI: 1.18–1.31; $p < 0.01$), showing that those who cannot afford dental treatment are associated with a significantly higher DMFT score than those who can afford it. Similarly, for the DMFS measure, the mean ratio is 1.39 (95% CI: 1.32–1.48; $p < 0.01$), indicating that those who cannot afford dental treatment also have a significantly higher DMFS score than individuals who can afford treatment (Table 3).

Table 1 Sociodemographic variables by the affordability of dental treatment among U.S. Adults, NHNAES 2015–2018

Variable	Total[1]	Total (%)[2]	Afford (%)[3]	Couldn't afford (%)[3]	*P* value**
Gender	11,566	240,115,894	85.83	14.17	< 0.01
Male	5,592	108,241,757 (48.19)	87.34	12.66	
Female	5,974	116,372,804 (51.81)	84.45	15.55	
Age (years)					< 0.01
19–45	4,983	112,086,099 (46.68)	83.18	16.82	
46–64	3,705	79,766,500 (33.22)	85.43	14.57	
65 and above	2,878	48,239,283 (20.09)	92.45	07.55	
Race/Ethnicity					< 0.01
Mexican American and other Hispanic	3,117	37,794,242 (15.74)	79.88	20.12	
Non-Hispanic White	3,871	150,864,816 (62.83)	88.08	11.92	
Non-Hispanic Black	2,547	27,397,224 (11.41)	78.97	21.03	
Non-Hispanic Asian	1,532	13,998,757 (05.83)	94.04	05.96	
Others	499	10,060,856 (04.19)	79.12	20.88	
Educational level					< 0.01
Less than high school	2,481	30,575,083 (12.93)	73.95	26.05	
High school graduate	2,561	56,610,014 (23.94)	82.38	17.62	
Some college and above	6,228	149,281,126 (63.13)	89.20	10.80	
Family income categories based on FPL *					< 0.01
< 100% FPL	2,118	30,036,609 (13.82)	68.97	31.03	
100% – 199% FPL	2,796	44,815,838 (20.62)	75.95	24.05	
200% – 399% FPL	2,719	61,485,939 (28.29)	86.86	13.14	
400% + FPL	2,465	81,024,949 (37.28)	96.49	03.51	

* Federal Poverty Level

** *p*-Value Statistically significant at p value < 0.05

[1] Unweighted sample counts

[2] Weighted counts and percentages to account for complex survey design

[3] Weighted percentages to account for complex survey design

Individuals who cannot afford dental treatment are significantly more likely to have root caries than those who can afford treatment; the odds ratio for the presence of any root caries is 4.46 (95% CI: 3.53–5.64; $p < 0.01$). On the other hand, the odds ratio for the presence of any root caries restoration was 1.45 (95% CI: 0.97–2.18; $p = 0.07$), indicating that persons who could not afford dental treatment are more likely to have root caries restoration than those who could afford treatment; however, this association was not statistically significant. (Table 4).

Table 2 Association of untreated dental decay, missed teeth due to caries, and filled teeth with affordability of dental treatment among U.S. Adults, NHANES 2015–2018

Model	Reference group	Mean Ratio*	95% CI	*P* value**
Model 1 (Outcome: Untreated dental decay)				
Couldn't afford dental treatment	Could afford dental treatment	3.27	(2.72–3.95)	< 0.01
Model 2 (Outcome: Missed teeth due to caries)				
Couldn't afford dental treatment	Could afford dental treatment	1.39	(1.20–1.63)	< 0.01
Model 3 (Outcome: Filled teeth)				
Couldn't afford dental treatment	Could afford dental treatment	0.87	(0.81–0.95)	< 0.01

*The model was adjusted for age, gender, race/ethnicity, educational level, and family income categories on the basis of federal poverty levels. All results included were imputed and weighted to account for complex survey design

** *p*-Value Statistically significant at *p* value < 0.05

Table 3 Association of DMFT and DMFS with the affordability of dental treatment among U.S. Adults, NHANES 2015–2018

Model	Reference group	Mean Ratio[2]	95% CI	*P* value**
Model 1 (Outcome: DMFT*)				
Couldn't afford dental treatment	Could afford dental treatment	1.24	(1.18–1.31)	< 0.01
Model 1 (Outcome: DMFS[1])				
Couldn't afford dental treatment	Could afford dental treatment	1.39	(1.32–1.48)	< 0.01

*Decayed, missed due to caries, and filled teeth

** *p*-Value Statistically significant at p value < 0.05

[1]Decayed, missed due to caries, and filled surfaces

[2]The model was adjusted for age, gender, race/ethnicity, educational level, and family income categories on the basis of federal poverty levels. All results included were imputed and weighted to account for complex survey design

Discussion

This study analyzed several oral health outcomes, providing a more holistic view of how the affordability of dental treatment influences each oral health outcome. Individuals who could not afford dental treatment presented a higher mean ratio of untreated dental decay. Previous studies have examined the associations between the affordability of dental treatment and specific oral outcomes [11, 12]. Gupta et al. assessed disparities in untreated caries among adults in the U.S. from 2011 to 2014 and reported that individuals facing financial barriers were more than double the odds of experiencing untreated caries than those who did not face financial

Table 4 Association of root caries and root caries restoration with affordability of dental treatment among U.S. Adults, NHANES 2015–2018

Model	Reference group	Odds ratio*	95% CI	*P* value**
Model 1 (Outcome: Presence of any root caries)				
Couldn't afford dental treatment	Could afford dental treatment	4.46	(3.53–5.64)	< 0.01
Model 2 (Outcome: Presence of any root caries restoration)				
Couldn't afford dental treatment	Could afford dental treatment	1.45	(0.97–2.18)	0.07

*The model was adjusted for age, gender, race/ethnicity, educational level, and family income categories on the basis of federal poverty levels. All results included were weighted to account for complex survey design

**p-Value Statistically significant at p value < 0.05

barriers [12]. In this study, it was found that the mean ratio for untreated dental decay was more than three times higher in individuals who could not afford dental treatment than in those who could. There are several explanations for why a greater percentage of untreated dental caries was observed; this may be because different populations are being examined in different years. Additionally, the variable for untreated dental caries was coded as a count variable, whereas Gupta et al. coded it as a binary variable [12].

In this study, the mean ratio of missed teeth due to caries was 1.39 for individuals who could not afford dental treatment compared with those who could. Griffin et al. assessed disparities in dental use and untreated caries prevalence and tooth retention by income via nationally representative surveys for the periods 1999–2004 and 2011–2016 [16]. They reported an increase in tooth retention for both high- and low-income individuals. However, only those with high incomes experienced improvements in dental care utilization. The authors emphasized the need for primary and secondary caries preventive services among older adults. Ju et al. assessed differences in dental visits in the United States concerning social inequality and inequity using data from NHANES 2015–2016, focusing on U.S. adults aged 30 and older [17]. They reported that individuals in the highest income group were nearly three times less likely to have not visited a dentist in the past 12 months than those in the lowest income group were. This study demonstrated an inverse relationship between the utilization of dental health services and the need for greater service use among higher-income individuals, whereas those with lower incomes had a greater need for dental care [17].

The study found that individuals unable to afford dental treatment have significantly higher DMFT and DMFS scores, with mean ratios of 1.24 and 1.39, respectively. While the DMFT index evaluates conditions at the tooth level, the DMFS index assesses the condition of individual tooth surfaces. This makes the DMFS a more precise indicator of caries severity and provides a comprehensive view of overall oral health [18]. In this study, the odds ratio for the presence of any root caries was 4.46 among those who could not afford dental treatment compared with those who could. Badr et al. assessed inequalities in untreated root caries and the affordability of dental services among older American adults via NHANES data. They reported that the inability to afford dental care remained a statistically significant predictor of untreated root caries [13]. Furthermore, the analysis of root caries restoration reported that the odds ratio for the presence of any root caries restoration was 1.45 for those who could not afford dental treatment compared with those who could.

Individuals unable to afford dental treatment may have limited access to preventive and restorative care due to high costs, resulting in untreated cavities. To address these disparities, targeted interventions are essential. One effective approach could be the implementation of subsidized dental care programs specifically designed for low-income populations, which would alleviate the financial burden and encourage individuals to seek necessary treatments. Additionally, educational campaigns that promote preventive care—such as regular dental checkups, proper oral hygiene practices, and early intervention—can empower individuals to take proactive steps in managing their oral health. Furthermore, enhancing access to dental services in underserved communities is important [19]. This could involve establishing mobile dental clinics, increasing the number of dental professionals in these areas, and integrating dental care into primary health services [20]. Additionally, access to dental care should also be made available to communities of older adults. This is suggested to be beneficial in terms of increasing the utilization of dental services and addressing oral health issues at earlier stages [21–23]. A study by Naavaal et al. examined data from the NHIS and reported that an increased prevalence of severe tooth loss, periodontitis, and untreated caries was associated with financial barriers, resulting in an estimated loss of 0.017 disability-adjusted life-years (DALYs) per person annually. The study recommended that making dental care more affordable could greatly improve the quality of life for older adults [24]. Ultimately, addressing these barriers not only improves individual health outcomes but also contributes to the overall health of communities, reducing the long-term economic and social costs associated with untreated dental issues [6]. Prioritizing equitable access to dental care is essential for fostering a healthier future for all.

One of the main strengths of this study was that we included several oral health outcomes, such as DMFT,

untreated dental decay, and root caries. This study has several limitations. NHANES data are collected at a single point in time, which prevents us from tracking changes or establishing causal relationships [25]. Another limitation of the study is the use of a self-reported binary question to measure the affordability of dental treatment, which may oversimplify the complexities involved. The model does not account for other important factors, such as dental insurance status, general health, smoking habits, sugar intake, and prior dental visits, all of which can influence perceptions of affordability and dental health outcomes. Failing to incorporate these variables may impact the validity of the findings. Additionally, the clinical exam did not include radiographs, which is another limitation. Future research could focus on conducting longitudinal studies to assess dental treatment affordability and oral health outcomes. Additionally, investigating disparities among diverse demographic groups will help identify other barriers. Finally, evaluating the impact of health policy changes on access to dental care might provide insights into improving health outcomes in underserved communities [6, 26].

Conclusion

The ratios of untreated dental decay and other oral health outcomes are significantly higher among individuals who cannot afford dental care. This might suggest a need for interventions that address financial barriers to accessing essential dental services. Future research could consider longitudinal studies to evaluate the affordability of dental treatments and their association on oral health outcomes.

Abbreviations

NHIS	National Health Interview Survey
NHANES	National Health and Nutrition Examination Survey
FPL	Federal Poverty Level
DMFT	Decayed, missed due to caries, and filled teeth
NCHS	National Center for Health Statistics
CDC	Centers for Disease Control and Prevention
DMFS	decayed, missed due to caries, and filled surfaces

Authors' contributions

S.A., A.A., D.A., H.A., M.A., and W.A. contributed to conceptualization, data curation, literature review, design, and writing of the original draft. M.A., H.A., and H.A.H. contributed to the formal analysis, writing of the original draft, and review and editing of the manuscript.

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Data availability

The datasets available in the National Health and Nutrition Examination Surveys repository at https://www.ncdc.gov/nchs/nhanes/continuousnhanes/default.aspxBeginYear=2017.

Declarations

Ethics approval and consent to participate

Informed consent was obtained from all participants by NHANES, and the study received approval from the National Center for Health Statistics Research Ethics Review Board. All procedures adhered to the relevant research guidelines and regulations. This study was exempt from additional ethical review.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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