Assessing Factors that Affect Dental Decay Using United States National Health and Nutrition Examination Survey Data

by

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Abstract

The purpose of this research was to study factors (i.e., last dental visit and age) that affect the oral health of United States (US) residents and determine whether, according to dental examinations, there were significant differences in dental decay. The study analyzed secondary data from the 2017–2018 National Health and Nutrition Examination Survey (NHANES) based on a sample of 9,254 residents aged 1–80 years old. A chi-squared test of independence was used to test associations between the variables of last dental visit and age. The results showed a significant association between dental decay and age but not between dental decay and the last dental visit. However, this paper recommends that future studies review other factors affecting oral health, such as oral health behaviors and high sugar intake, across all levels of the health system to provide optimal health benefits for the population and reduce oral health inequities.

Keywords: dental decay, dental caries, disparities, health education, oral health

Table of Contents

List of Tables

Introduction

Overview of the Literature

Oral health encompasses more than healthy teeth and is essential to people's general health and overall well-being. Untreated dental decay can lead to a range of diseases, including dental caries, periodontal (gum) disease, tooth loss, and oral cancer (World Health Organization [WHO], 2020). A lack of proper self-driven dental care regimens and effective oral health behaviors can lead to significant pain and discomfort and, ultimately, tooth loss, which can have debilitating effects on oral function and quality of life (Brien et al., 2016). Restricted access to preventive dental care, detrimental lifestyle behaviors, and socioeconomic and financial barriers have created at-risk populations whose oral health needs are not met (Center for Disease Control and Prevention [CDC], 2021a). The oral health and medical communities have now recognized the importance of oral hygiene and its connection to overall health for vulnerable populations, who typically face language, transportation, knowledge, awareness, and anxiety barriers (Institute of Medicine, 2011). A better understanding of the social determinants of health, high-risk behaviors, and culturally and linguistically appropriate caregiver and provider oral health literacy have led to more effective approaches to preventing and treating dental decay (Oral Health in America, 2022).

Dental decay is the most common chronic disease in childhood and is largely preventable and easily treatable. By 19 years of age, one in five children experience untreated dental decay, with children living in poverty twice as likely to have untreated dental decay (27%) than children in families whose incomes exceed 200% of the federal poverty level (FPL; 13%; Griffin, 2016). According to the *2000 Surgeon General's Report on Oral Health in America*, there have been changes in the prevalence of dental decay and oral disease. For example, the lifespan

examination of dental caries has generally been uneven across key demographic indicators. Although rates of dental decay have decreased in children, findings suggest that they are not consistent for all groups of children (Oral Health in America, 2022).

About half of all American children do not receive the recommended dental care because of social, economic, and geographical barriers. However, in the last two decades, approaches at the community and state levels have shown promising developments. Some states have strengthened their community water fluoridation systems, expanded state Medicaid dental coverage (Fisher-Owens et al., 2007), and implemented dental health programs and policies that serve as taxes on sugar-sweetened beverages (SSBs) to improve children's oral health outcomes (Aguiar et al., 2018; Kumar et al., 2010)

The *2011–2012 National Health and Nutrition Examination Survey* found that the prevalence of untreated dental decay in primary teeth was much higher in Hispanic and non-Hispanic Black children than in non-Hispanic White children. The study concluded that there are continuing disparities among some ethnic groups (Satcher, 2017). More than one in four adults (26%) have untreated dental decay, and nearly half (46%) of all adults over the age of 30 show signs of gum disease. There is an even greater need for treatment in some racial and ethnic groups. Twenty-two percent of non-Hispanic White adults had untreated dental decay, compared to 37% of Mexican-Americans and 40% of non-Hispanic Black people. Of adults with household incomes of at least twice the FPL, 18% had untreated dental decay, compared with 41% of adults with lower household incomes. Untreated dental decay is also highest among those aged 20–34 years (29%) and lowest among those aged 50–64 years (22%), which sets the stage for dental caries as a highly prevalent chronic disease throughout adulthood (CDC, 2021c).

People living in communities with fluoridated water systems have 25% fewer cavities than those without fluoridated community water systems. Fluoride is recognized as one of the most cost-effective measures for improving oral health. A nationwide economic analysis found that community water fluoridation systems can save an estimated average of $32 per person and nearly 6.5 billion dollars a year in net costs by preventing direct costs for tooth extractions and restorations and indirect costs for losses of productivity at work or school and follow-up treatment (O'Connell et al., 2016). Community water systems contained enough fluoridated water to protect more than 73% of the United States (US) population in 2018. The national goal is to provide 77% of Americans with the recommended amount of fluoridated water as a Healthy People 2030 Goal (CDC, 2021a).

Socioeconomic Status and Oral Health

Socioeconomic status (SES) factors, such as race, education level, income, and age, place oral health-care burdens on individuals, including a lack of nutrition, poor oral health habits, restricted access to dental care, and underutilization of healthcare services. For example, untreated dental caries is twice as likely to occur in children from low-income families, and 47% of low-income adults aged 20–64 years have untreated dental caries (Evans et al., 2011). Regarding at-risk populations, *Oral Health in America: A Report of the Surgeon General* found that almost half of Americans aged 30 years and older had gum disease, which was more prevalent among non-Hispanic Black adults, the poor, the uneducated, and smokers (Satcher, 2017). Additionally, at any age, periodontal disease affects more individuals living in poverty than people living above the poverty line (Eke et al., 2015; Quimby, 2019).

Some factors, such as economic and cultural barriers, have been shown to disadvantage some people who need dental care. Additional factors include inadequate insurance, the high cost

of dental care, and lack of access Medicaid providers, and differences arise when families have to decide whether to prioritize medical needs over necessities (US Department of Health and Human Services, 2000a). Many families choose not to seek preventive care or visit a primary care doctor or dental provider for routine care. For example, some cultural groups believe that primary teeth are unimportant, and tend to seek care when there is pain or emergency. Preventive care may be an unfamiliar concept, making visits to a doctor or dental provider less likely (Butani et al., 2008).

Disparities in Access to Oral Health Care

Many individuals and communities in the US face several barriers to utilizing oral health care, such as underserved populations, low-income, uninsured, and/or members of racial/ethnic minority, immigrant, or those living in rural areas. The need to improve the quality of oral health care for underserved populations has been recognized by public health professionals and public health organizations since oral diseases and other health conditions, such as obesity, diabetes, and kidney disease, are linked to common risk factors (Northridge et al., 2020). To narrow the gaps in access to oral health care, it is critical to integrate oral health and primary health care, and health-care teams can provide patient-centered care in both safety-net clinics and community settings (Northridge et al., 2020).

In many states, dental care coverage for adult beneficiaries is optional. Only 47 states and Washington, D.C. offer some dental benefits to Medicaid-enrolled adults, only 32 states cover services beyond emergency care, and only 16 states offer comprehensive dental coverage. Although increasing numbers of adults are gaining Medicaid coverage through the Affordable Care Act, inadequate overall access to oral health-care and dental services can lead to costly oral health-related emergency hospital visits, high rates of dental disease, and missed work time

(Center for Health Care Strategies, 2015). Policy efforts aimed at improving young children's oral health have included health promotion to encourage visits to a dentist by a child's first birthday or on the eruption of a first tooth, introduction of establishing the dental home (an ongoing relationship with a dentist), the expansion of the state-funded Children's Health Insurance Program (CHIP), and the implementation of interventions such as fluoride varnish applications in medical clinics (Dye et al., 2017).

The barriers faced by rural communities often lead to poor oral health outcomes. Many factors contribute to the oral health challenges of communities in rural America, including a lack of transportation, geographic isolation, higher rates of older adult and low-income residents, and a lack of dental providers. In 2017, 55.7% of adults aged 18–64 living outside a metropolitan statistical area (MSA) visited a dentist in the past year, compared to 65.2% of those living within an MSA, and African-Americans had high rates of tooth loss (28%) and low rates of dental visits (34%; Rural Health, 2015). Personal or public transportation is often not available or affordable for dental visits in rural communities, and the recruitment of dentists in rural areas is an ongoing challenge because most dental school graduates prefer to practice in densely populated urban areas. A shortage of dental providers also results in people having to travel further for care and finding it difficult to locate a dental provider that accepts Medicaid, which exacerbates the challenges and leads to lower rates of dental visits (Vujicic et al., 2016).

A study found that having an established source of health care or a nearby dental home was associated with a higher likelihood of dental visits for all adults. Overall, primary health-care access was associated with improved oral health outcomes; establishing a dental home where patients could visit the same provider on a regular basis translated into an increase in routine dental checkups and oral hygiene education (Caldwell et al., 2017).

Prevention

Healthy oral behaviors significantly enhance oral health. According to the American Dental Association (ADA), individuals can achieve good oral health and reduce dental decay by brushing their teeth twice a day with proper techniques, using pea-sized amounts of fluoride-containing toothpaste, flossing to clean between the teeth, eating a well-balanced diet, limiting the consumption of sugary snacks between meals, and visiting dentists regularly for dental checkups (Brien et al., 2016).

Children who practice proper oral hygiene habits are likely to brush their teeth more than twice a day, but children with irregular brushing habits are at twice the risk of developing dental caries. Brushing twice a day with fluoride-containing toothpaste may be the best prevention method for dental caries. To control the amount of toothpaste used and reduce the risk of fluorosis, parents and caregivers should help preschool-aged and younger children brush their teeth twice a day until they are able to spit and rinse on their own, beginning with the appearance of the first tooth (US Food and Drug Administration, 2020).

Another approach to promoting oral health in children focuses on using early education and childcare programs to provide preventive oral health care services, such as brushing children's teeth with fluoride toothpaste during the school day, providing dental screenings through school-based programs, and facilitating visits with local dentists. Integrating preventive oral health services into early education can greatly improve children's access to dental care (Burgette et al., 2018). Another important factor in oral health promotion is health literacy. It is known that parents and caregivers with low oral health literacy are likely to allow unhealthy oral health behaviors in their children, including nighttime baby bottle use, which can lead to baby bottle tooth decay through a lack of brushing or cleaning after feeding (Vann et al., 2010).

Studies have shown that parental or caregiver motivation and self-efficacy are associated with better child toothbrushing habits and techniques, proper oral hygiene, and healthier diets (Finlayson et al., 2007; Knowlden & Sharma, 2015).

Good oral health affects overall health because it contributes to the consumption of nutritious food, clear speech, social confidence, and, in the case of older adults, better cognitive and functional capacity and the reduced progression of diseases, such as atherosclerosis (Scannapieco & Cantos, 2016). A recent study found that parental diet was associated with children's caries. The consumption of sugary meals and unhealthy snacks proved to be a risk factor for increased rates of dental caries in children. Diet during the formative years affects children's risk for caries and the development of children's tastes and food preferences, which influence the risk of caries throughout their lives (Hooley et al., 2012). The American Academy of Pediatrics (AAP) recommends that concentrated juice should not be given to infants or toddlers due to its high sugar content and association with dental decay. The practice of allowing infants to use sippy cups or bottles filled with juice can lead to longer exposure of teeth to sugar, contributing to dental decay (Heyman & Abrams, 2017). Federally funded nutrition assistance programs implemented at the local, state, and national levels can help ensure that children and adolescents receive safe, fresh, healthy foods with low sugar and high nutrients to meet their growth and development needs. Children have access to nutrition assistance programs through the National School Lunch Program, the Supplemental Nutrition Assistance Program (SNAP), the Emergency Food Assistance Program (TEFAP), the Summer Food Service Program, and the Afterschool Snack Program (Roy & Stretch, 2018).

Health Education and Oral Health

Oral health literacy has attracted significant attention over the past two decades. Adults who have difficulty understanding basic medical-related tasks typically do not use preventive health care or know how much medication to take, thus increasing their dependence on emergency services. Research on oral health has shown that low health literacy affects understanding of Medicaid eligibility and benefit utilization, the frequency of dental visits, oral health and preventive care behaviors, and oral health knowledge. (Horowitz et al., 2013) Dental providers who use effective communication techniques contribute to self-care, professional care, and care for others. Although diverse strategies are needed to improve the oral health literacy of the public, communication among dental providers is important for distributing health information and improving patients' knowledge of disease processes and the necessary steps for self-care (Horowitz et al., 2012).

Many community-based oral health-care programs and organizations have focused on preventing oral disease in children and improving care for working adults. New methods of improving oral health equity among working and older adults reinforce oral hygiene behaviors through motivational interviewing and culturally appropriate messages on oral health, such as those created for tobacco prevention and cessation, cardiovascular disease, nutrition, workforce injury prevention, human papillomavirus vaccination, and diabetes education (Benzian & Williams, 2015). In many underserved communities, community health workers provide a bridge to link racial/ethnic minorities and immigrants to oral health resources. A lack of awareness and knowledge of local oral health resources in these populations disadvantages older adults, who often rely on the recommendations of others when seeking care (Kavathe et al., 2018).

Oral health education and screenings in schools have a long and successful history in some communities. In the past decade, schools across the US have implemented a School-Based

Oral Health Program whereby dental providers set up portable dental equipment in classrooms, multipurpose rooms, or assembly rooms, or work in mobile dental clinics that travel from school to school. Delivering oral health care and education in school settings has the potential to reach many at-risk students who need dental care. Schools are logical places in which to educate students and their families about the importance of oral health and to deliver oral health services aimed at preventing oral disease and connecting students to local dental providers or community-based oral health care services (Oral Health in America, 2022).

Purpose of the Study

The purpose of this study was to investigate factors that affect oral health (i.e., the last dental visit and age) among a sample of US residents from the 2017–2018 National Health and Nutrition Examination Survey (NHANES). To address disparities in oral health, there is a need to change perceptions and encourage the acceptance of oral health interventions as a component of general health practice to build an effective health infrastructure that meets the needs of individuals, communities, and the nation.

Research Questions and Hypotheses

The study focused on the following four research questions (RQs):

1. RQ1: Is there an association between dental decay and the last dental visit?

   H_1: Dental decay is associated with the last visit to the dentist.

2. RQ2: Is there an association between dental decay and age?

   H_1: Dental decay is associated with age.

Methodology

Study Design

The researcher conducted a cross-sectional study to explore factors that affect oral health (i.e., the last dental visit and age) among US residents. Secondary data was obtained from the 2017–2018 data set of the National Health and Nutrition Examination Survey (NHANES), which focuses on 9,254 residents aged 1–150 years regarding the health status, prevalence of disease, behavior risks, and environmental and genetic factors that may contribute to health conditions or disease. The participants represented the civilian non-institutionalized population living in the US. By identifying the needs of the population and the predisposing factors that cause oral disease, new policies can be formulated to promote and implement health education programs that will benefit individuals across the country (CDC, 2020). The data are accessible to the public through the Centers for Disease Control and Prevention NHANES website. This research project was exempt from the requirement for institutional review board approval because it used an anonymous secondary data set.

Procedures

The 2017–2018 NHANES data were collected through online health interviews followed by examinations conducted by a team of physicians and medical/health technicians. The NHANES interviews included demographic, socioeconomic, dietary, and health-related questions (CDC, 2017), and the medical categories were cardiovascular diseases, diabetes, environmental exposure, anemia, kidney diseases, infectious diseases, nutrition, obesity, oral health, reproductive history, and sexually transmitted diseases (CDC, 2017). The interviews were conducted in respondents' homes using a computer-assisted personal interview (CAPI) system.

The examinations consisted of dental measurements, including laboratory tests administered by trained medical personnel (CDC, 2017). The data were anonymized for public use.

Participants

The 2017–2018 NHANES covered a nationally representative sample of more than 5,000 participant's aged 1–150 years selected from more than 30 different locations across the US. A total of 9,254 participants aged 1–80 were selected for this study. who were grouped as either male or female and Mexican-American, other Hispanic, non-Hispanic white, non-Hispanic Black, non-Hispanic Asian, or other race (including multiracial). Oversampling of certain population subgroups was also conducted to increase the reliability and precision of the health status indicator estimates for these particular subgroups.

Independent Variables

The independent variables were last dental visit and age. The first variable was measured by the question OHQ030 – "When did you last visit a dentist?" The response was coded as 1 = "6 months or less," 2 = "More than 6 months, but not more than 1 year ago," 3 = "More than 1 year ago, but not more than 2 years ago," 4 = "More than 2 years ago, but not more than 3 years ago," 5 = "More than 3 years, but not more than 5 years ago," 6 = "More than 5 years ago," 7 = "Have never been," 77 = "Refused to answer," and 99. = "Don't Know."

The second independent variable was measured by the question RIDAGEYR –, "Age in years at screening?" The responses were coded as 1 = "1–17 years," 2 = "18–40 years," and 3 = "41–80 years."

Dependent Variable

The dependent variable was the examination presence of dental decay based on visual and tactile examinations conducted by licensed dentists (D.D.S/D.MD) using coronal caries

screening divided into eight rows corresponding to the four quadrants of the mouth: upper left, upper right, lower left, and lower right (CDC, 2018). The dependent variable was measured by the question, “Decayed Teeth?”, with the responses coded as 1 = “Yes” and 2 = “No.”

Data Analysis

Secondary data obtained from the 2017–2018 NHANES were uploaded to IBM® Statistical Package for the Social Sciences (SPSS®) version 27 software to answer the RQs using a chi-squared test of independence to determine the difference between the two categorical variables. A significance level of 0.05%, a marginal error of 5%, and a confidence interval (CI) of 95% were used for the data analysis. The sample size calculated for this study was 292. The independent variables were last dental visit and age, and the dependent variable was the presence of dental decay.

Results

Demographics

The total number of participants used for this study was 9,254, of which 50.8% were female and classified themselves as non-Hispanic White (34.0%) and non-Hispanic Black (22.9%). The average age was 37.7 years, and participants were categorized into three groups: children aged 1–17 years (36.7%), adults aged 18–40 years (22.2%), and older adults aged 41–80 years (41.1%; see Table 1).

Major Findings

A chi-squared test of independence was performed to examine the association between dental decay and the last dental visit. While the researcher hypothesized that there would be an association between examination-determined dental decay and the last dental visit, no significant association was found ($X^2(7) = 3.375$, $p = 8.48$). Since the p value was greater than 0.05, there was not enough evidence to suggest a significant association between examination-determined dental decay and the last dental visit (see Table 2).

A chi-squared test of independence was performed to examine the association between dental decay and age. The researcher hypothesized there would be an association between examination-determined dental decay and age, and a significant association was indeed found ($X^2(2) = 11.983$, $p = 0.002$). Since the p value was less than 0.05, there was clearly a significant association between examination-determined dental decay and age (see Table 3), and the highest prevalence was among older adults aged 41–80 years (41.1%).

Discussion

Summary of Major Findings

The results of this study were based on a detailed analysis of 2017–2018 NHANES data collected from 50 US states. The researcher used a chi-squared test of independence for the analysis, which included tables for the last dental visit and age, to determine whether there were any significant differences between the participants regarding dental decay, last dental visit, and age. There was no significant association between dental decay and those who visited a dentist within the last six months, therefore providing support for RQ1. The results showed that 45.0% of participants who had seen a dentist within the last six months had dental decay on one or more teeth, suggesting that regular dental visits can increase individuals' awareness of healthy oral behaviors and allow the early identification and communication of risk factors by dentists (Subramaniam & Reghuvaran, 2019). The results revealed a significant association between dental decay and age, answering RQ2, which supported previous findings that dental decay in children can be prevented if they visit a dentist by their first birthday or soon after the eruption of their first tooth (American Academy of Pediatrics [AAP], 2015). Studies have shown that older adults now retain more of their natural teeth, indicating increased detection of dental decay, but access to oral health care remains a challenge for many adults older than 65 years of age who seek restorative care (Dye et al., 2019).

Public Health Implications

The findings of this research have public health implications regarding the oral health of US residents. Local organizations and entities should promote and implement health programs to support oral health education and access to oral health resources. Public health strategies should

be developed to increase preventive dental visits and eliminate social disparities that prevent dental care utilization.

Despite increasing numbers of older adults in the US, their access to health care differs from that of younger adults. The association found among dental decay and age can suggest public policies should consider population demographics; aim to support the social, physical, and financial health of older adults; extend health care to include restorative care for older individuals who are possibly unable to work and accept employer-based dental coverage that is not included within Medicare (Oral Health in America, 2022). Nearly 70% of adults over the age of 65 suffer from periodontal disease and has been associated with chronic conditions affecting older adults including diabetes, heart disease and even Alzheimer's disease. Primary care physicians can help encourage older adults to seek treatment earlier and facilitate early intervention linking patients to dental providers (Varela et al., 2022).

The study results suggest that private and local organizations should include an oral health component in health promotion programs, media campaigns, and interventions to increase awareness of oral health and available dental resources among all age groups. Such health promotion programs would help individuals utilize the local dental resources available to them, communicate their concerns, and develop healthy behaviors. Studies that focused on increasing pediatric oral health knowledge and practice behaviors among both early head start (EHS) staff members and parents reflected positive outcomes. Ongoing research is needed to examine the effectiveness of oral health education and promotion activities as they relate to the oral health outcomes of children and caregivers enrolled EHS .The findings also suggest that regular preventive dental visits would benefit individuals across all age groups.

Study Limitations

One limitation of this study was recall bias. Recall bias is an error that occurs when participants do not remember previous events; therefore, their responses may be inaccurate or flawed. Participants may have over- or underreported their personal hygiene habits, and they may have given inaccurate responses due to a lack of oral health knowledge or health literacy regarding the topic. A second limitation was the underrepresentation of minority groups. In this study, the majority of participants (34.0%) identified as non-Hispanic White, implying the underrepresentation of other racial/ethnic groups. Future studies should obtain a larger pool of participants from diverse backgrounds, which would allow for a more comprehensive analysis and generalization of the findings. Researchers could also use weighted cases for future NHANES analyses. Finally, a Type 2 error occurred during the process of increasing the sample size after performing the power analysis.

Conclusion

Overall, the results of the study suggest further and advanced research regarding factors that affect the oral health of US residents. As previously stated, oral diseases are the most common chronic diseases throughout a person's lifespan. About 25% of young children, 50% of adolescents, and more than 90% of adults experience dental caries. Ten percent of young children and 26% of adults aged 20–64 years have experienced untreated dental caries (CDC, 2019). The study demonstrated no significant association between dental decay and the last dental visit, leading the researcher to conclude that individuals who had visited a dentist within the last six months had fewer signs of decay than those who had not visited a dentist in the last six months. Although no significant association was found, visiting the dentist twice a year can be promoted as a health-care tip to benefit individuals in learning the status of their oral health.

A significant association was found between dental decay and age. The ages were categorized as children aged 1–17 years, adults aged 18–40 years, and older adults aged 41–80 years. The researcher concluded that dental decay is particularly associated with the older adult age group; therefore, future research on the older adult age group may be helpful for better understanding all their risk factors and related needs. This might lead to better restorative care and less need for emergency dental visits due to the earlier identification of problems. The extension of dental Medicare benefits; programs to retain, reimburse, and attract dental providers to serve the older adult and rural populations; and the use of evidenced-based care to achieve better outcomes are key factors in effectively serving vulnerable populations (Oral Health in America, 2022). These initiatives have the potential to transform oral health care for all Americans.

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Appendix A: Demographics

Table 1

Demographic Frequencies

Variable	*N = 9,254*	%
Gender		
Male	4,557	49.2
Female	4,697	50.8
Age		
1–17	3,398	36.7
18–40	2,050	22.2
41—80	3,806	41.1
Race/Ethnicity		
Mexican-American	1,367	14.8
Other Hispanic	820	8.9
Non-Hispanic White	3,150	34.0
Non-Hispanic Black	2,115	22.9
Non-Hispanic Asian	1,168	12.6
Other Race (Including Multiracial)	634	6.9

Appendix B: Chi-Squared Tables

Table 2

Decayed Teeth and When Did You Last Visit a Dentist

Variable	6 months or less	More than 6 months	More than 1 year ago	More than 2 years ago	More than 3 years ago	More than 5 years ago	Never	Don't know
Decayed teeth								
Yes	851 (44.8%)	284 (14.9%)	215 (11.3%)	101 (5.3%)	87(4.6%)	228 (12.0%)	120 (6.3%)	6 (0.03%)
No	5 (0.3%)	1 (0.1%)	1 (0.1%)	1(0.1%)	1 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Chi-squared is 3.375, df = 7, p = 8.48

Table 3

Decayed Teeth and Age Group

Variable	Age 1–17	Age 18–40	Age 41–80
Decayed teeth			
Yes	646 (34.0%)	424 (22.3%)	822 (43.2%)
No	8 (0.4%)	0 (0.0%)	1 (0.1%)

Chi-squared is 11.983, df = 2, $p = 0.002$