Caries Process, Prevention, and Management: Epidemiology

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Conflict of Interest Disclosure Statement

- Dr. Noureldin reports no conflicts of interest associated with this course. She has no relevant financial relationships to disclose.

Caries Process, Prevention and Management consists of a series of ten continuing education courses that may be taken individually or as a complete series. This 2025 newly updated series was first developed in conjunction with the American Dental Education Association in 2008 and has now been comprehensively revised by authors who are members of the board of directors of the American Academy of Cariology (AAC) to reflect the current knowledge and best practices and quality depth of knowledge on the caries process, prevention, and management. Procter & Gamble is delighted to provide this resource enabling high quality educational experiences and an up-to-date understanding of both the science and its relevance to all clinicians in practice and we thank the authors for their contributions. Click *here* to learn more about the AAC.

Course Contents

Overview

The course introduces the DMF index (Decayed, Missing, and Filled teeth), a key measure in dental epidemiology. You will learn about the variations and limitations of the DMF index, as well as how to accurately calculate DMF scores to assess oral health outcomes.

Learning Objectives

Upon the completion of this course, the dental professional should be able to:

- Discuss the need for epidemiological studies.
- Apply the results of oral epidemiology studies to clinical practice.
- Be familiar with the prevalence, incidence, and trends of dental caries in the United States.
- Describe the value of the DMF index in measuring oral disease.
- Use the DMF index to measure the prevalence of dental caries.
- Understand the results of the NHANES surveys that are related to dental caries.
- Identify the factors that may or may not affect the DMF scores in adults.
- Calculate a DMFT, DMFS, dmft or dmfs index score from a patient tooth charting.

Glossary

incidence - The number of new cases of a disease or condition over a given time period. It is the rate at which new cases occur in a defined population group (e.g., the incidence rate of lung cancer is 2.5% per year in 25- to 29-year-old Hispanic males in the US). This term is frequently confused with and used interchangeably in error with the term prevalence which describes how common a disease is. In epidemiology of dental caries, it is important to note the denominator – people or individual teeth.

index - A standard numerical measure of a disease or condition. It extends from the proportion of individuals with a disease or condition to the number of millimeters of probing depth around a tooth. Common indices in dentistry are the DMF Index, which is a measure of caries, the O'Leary Plaque Index, which measures plaque/oral hygiene, and PSR (periodontal screening and report), which indicates treatment need for periodontal therapy.

mean - The arithmetical average, a measure of central tendency together with the measures of mode (the most commonly occured value) and median (the value in an order of numbers that is the midpoint – there are as many values above as below).

NHANES - National Health and Nutrition Examination Survey (NHANES) is a survey conducted by the US National Center for Health Statistics, part of the Centers for Disease Control & Prevention (commonly referred to as CDC), which investigates and publishes reports on the health and nutritional status of Americans. Currently, approximately 5000 people are examined each year.

prevalence - The proportion (%) of individuals exhibiting the disease or condition (e.g., dental caries, TB, lung cancer) in a defined population group (e.g., the prevalence of dental caries is 50% in children aged 6 to 11 years). This term is frequently confused with and used interchangeably in error with another term incidence which reports on the occurrence of new disease cases.

Introduction

Approximately 500 million dental visits occur annually in the United States, representing a significant healthcare expenditure. According to a 2023 report;[1] Within the context of overall

U.S. health spending, which reached $4.9 trillion in 2023 (a 7.5% increase from $4.56 trillion in 2022), dental care maintains its position as an essential healthcare service with distinct financing patterns. Dental services account for approximately 3-4% of total healthcare expenditures, with dental spending estimated to have increased by 5-6% from 2022 to 2023. The financing structure remains unique, with a higher proportion coming from out-of-pocket spending (40-45%) compared to other healthcare sectors, while private health insurance covers roughly 50% of dental expenses. This represents a slight shift from 2022, when out-of-pocket spending for dental services was closer to 42%. This financial structure highlights the ongoing challenges in dental care accessibility and affordability for many Americans, particularly as overall healthcare costs continue to outpace general inflation.[1]

Dental caries, commonly known as tooth decay, is an oral disease in which the acid generated by oral bacteria cause damage to hard tooth structure. Although preventable, it is one of the most common chronic, infectious diseases among American children and adults, and remains one of the most common diseases throughout the world. In spite of major improvements that have been made in the US dental health care system over the past few decades, particularly with regard to the percentages of cavities found in both children and adults, some population groups continue to experience caries at higher rates than others. This is particularly true for populations with lower income and lower education and also for some ethnic and racial groups.[2]

Clinical Significance Snapshots

What is the practical significance of the epidemiology of Dental Caries? As a dental practitioner why should this interest me?
Information that reports the amount of any disease in a population is of tremendous importance in planning, funding and delivery of health services so that enough healthcare professionals of the correct skill sets are trained, enough clinical centers are built, and that new and improved materials and clinical techniques are developed through adequately funded research programs. Access to care is a critical issue for oral health – many of the US population are currently unable to receive the dental care they need. Having knowledge of this need for care helps health planners create preventive programs to avoid disease in the first place (e.g., water fluoridation, availability of low sugar foods and beverages) and to ensure that enough dentists are produced to provide services, and that those services are adequately funded through private or public systems.

What is the value of a dental index to me in dental practice?
Recording of a patient's health status is important, not only to plan any treatment currently needed, but also to assess a patient's changes in disease status and their response to treatment over time. The dental chart of cavities and restorations is similar to an index, and while it is not quantified numerically, it does allow comparison over time. As early carious lesions are reversible and typically should be treated not by restorative means, but by preventive means such as fluoride agents and dietary modification, the methods of measurement and recording of the lesions is critically important. The DMF Index does not differentiate between early and late stage lesions, but new caries assessment indices having that capability, such as the ICDAS II (International Caries Diagnosis and Assessment System), are being introduced into dental school curricula.

Epidemiology: Oral Epidemiology in Clinical Practice

Studies in oral epidemiology provide insights into normal biological processes and oral diseases, identifying populations at risk or requiring special care. They also compare regional, environmental, social, and access-related differences in dental care. Additionally, oral epidemiology evaluates preventive

interventions for disease control and assesses the effectiveness and quality of oral health programs.[3]

To understand epidemiology, it is important to understand the definitions of the following terms:

Prevalence: This is the proportion of individuals with disease (cases) in a population at a specific point in time.[3]

Incidence: This is the number or proportion of individuals in a population who experience new disease during a specific time period.[3]

Trends: These are the changes or differences in the prevalence or incidence of disease with respect to time, location, or socioeconomics.[3]

Epidemiology: Measuring Oral Diseases

In oral epidemiology, there are a number of crucial terms that will help dentists to understand how oral disease data is measured and presented. These include:

Index: This is a standard method of rating a disease in which there is a graduated, numerical scale with values corresponding to specific criteria. Types of measurement scales for indices include:

nominal, which simply names conditions;

ordinal, which lists conditions in order of severity;

interval or ratio, which establishes a mathematical relationship;

irreversible, which measures cumulative conditions that cannot be reversed (such as enamel loss due to erosion);

reversible, which measures conditions that can be reversed (such as gingivitis).

An index is only valuable if the information it reports is:

- **Valid:** An index must be designed to measure the aspect of disease that it is intended to measure and correspond to clinical stages of the disease.[3,4]
- **Reliable:** An index should be reproducible and repeatable, and should provide consistent measurement at any given time under a variety of conditions.[3,4]
- **Clear, Simple, Objective:** An index should have clearly stated, unambiguous criteria with mutually exclusive categories, and should be simple enough for an examiner to memorize and score using the criteria.[3,4]
- **Quantifiable:** An index must present data that can be numerically analyzed and treated. Group status should be expressed by distribution, mean, median, or other statistical measures.[3,4]
- **Sensitive:** An index should identify small yet significant shifts in the condition studied.[3,4]
- **Acceptable:** The use of the index should not be unnecessarily painful, time-demanding, or demeaning to subjects.[3,4]

The important characteristics of a valid index, with reference to a disease such as dental caries

A valid index for measuring diseases like dental caries must accurately reflect the actual disease condition. The index should correspond to the true disease state, which can be verified using a "gold standard," such as histological findings. For example, if the index identifies enamel caries, histological observations should confirm that the caries is confined to the enamel layer.

In addition to accuracy, a valid index must be reliable or reproducible. This means that the same examiner, or different examiners, should be able to apply the index consistently and achieve the same results. Clear and well-defined criteria are essential to ensure users understand and correctly interpret the index codes.

In summary, the fundamental characteristics of a valid index are accuracy, reliability, and clear criteria; all of which are crucial for effectively assessing and monitoring dental caries.

Epidemiology: The DMF Index

The ***D***ecayed, ***M***issing, ***F***illed (DMF) **index** has been used for almost 80 years and is well established as the key measure of caries experience in dental epidemiology.[5] The DMF Index is applied to the permanent dentition and is expressed as the total number of teeth or surfaces that are decayed (D), missing (M), or filled (F) in an individual. When the index is applied to teeth specifically, it is called the DMFT index, and scores per individual can range from 0 to 28 or 32, depending on whether the third molars are included in the scoring. When the index is applied only to tooth surfaces (five per posterior tooth and four per anterior tooth), it is called the DMFS index, and scores per individual can range from 0 to 128 or 148, depending on whether the third molars are included in the scoring.[6]

When written in lowercase letters, the dmf index is a variation that is applied to the primary dentition. The caries experience for a child is expressed as the total number of teeth or surfaces that are decayed (d), missing (m), or filled (f). The dmft index expresses the number of affected teeth in the primary dentition, with scores ranging from 0 to 20 for children. The dmfs index expresses the number of affected surfaces in primary dentition (five per posterior tooth and four per anterior tooth), with a score range of 0 to 88 surfaces. Because of the difficulty in distinguishing between teeth extracted due to caries and those that have naturally exfoliated, missing teeth may be ignored according to some protocols. In this case, it is called the df index.[6]

Calculating DMFT: The teeth not counted are unerupted teeth, congenitally missing teeth or supernumerary teeth, teeth removed for reasons other than dental caries, and primary teeth retained in the permanent dentition. Counting the third molars is optional. When a carious lesion(s) or both carious lesion(s) and a restoration are present, the tooth is recorded as a D. When a tooth has been extracted due to caries, it is recorded as an M. When a permanent or temporary filling is present, or when a filling is defective but not decayed, this is counted as an F. Teeth restored for reasons other than caries are not counted as an F.[6]

Calculating DMFS: There are five surfaces on the posterior teeth: facial, lingual, mesial, distal, and occlusal. There are four surfaces on anterior teeth: facial, lingual, mesial, and distal. The list of teeth not counted is the same as for DMFT calculations, and listing D, M, and F is also done in a similar way: When a carious lesion or both a carious lesion and a restoration are present, the surface is listed as a D. When a tooth has been extracted due to caries, it is listed as an M. When a permanent filling is present, or when a filling is defective but not decayed, this surface is counted as an F. Surfaces restored for reasons other than caries are not counted as an F. The total count is 128 or 148 surfaces.[6]

Calculating dmft and dmfs: For dmft, the teeth not counted are unerupted and congenitally missing teeth, and supernumerary teeth. The rules for recording d, m, and f are the same as for DMFT. The total count is 20 teeth. For dmfs, the teeth not counted are the same as for dmft. As with DMFS, there are five surfaces on the posterior teeth and four surfaces on the anterior teeth. The total count is 88 surfaces.[6]

Limitations of DMF Index: While DMF indices can provide powerful data and perspectives on dental caries, they also have some limitations. For one, researchers have noted a significant amount of inter-observer bias and variability.[7] Other criticisms include that the values do not provide any indication as to the number of teeth at risk or data that is useful in estimating treatment needs; that the indices give equal weight to missing, untreated decay, or well-restored teeth; that the indices do not account for teeth lost for reasons other than decay (such as periodontal disease); and that they do not account for sealed teeth since sealants and other cosmetic restorations did not exist in the 1930s when this method was devised.[8,9]

Epidemiology: NHANES Surveys

The **NHANES**, or National Health and Nutrition Examination Survey, is a series of surveys conducted in the United States beginning in the 1960s to examine the oral and nutritional status of a large, representative population. A paper published in 2007 described the trends in oral health status based on data collected from people aged 2 years and over from 1988–1994

and 1999–2004.[10] Two more papers reported on the information from the 2005-2008[11] and 2011-2012[12] surveys. The information collected focused on caries, dental history, tooth retention, edentulism (tooth loss), periodontal status, and prosthodontic status. Conducted by the CDC's National Center for Health Statistics (NCHS), the data is released in two-year cycles for public use.

During the 2019–2020 cycle, data collection was disrupted in March 2020 due to the COVID-19 pandemic, making the incomplete cycle not nationally representative. To compensate, NCHS combined the 2019–2020 data with the 2017–2018 data and adjusted sampling parameters, such as primary sampling units and weights, to produce nationally representative data covering 2017 through March 2020 (pre-pandemic).[13] A detailed report from NCHS outlines the methodology used to create the combined dataset and provides analytical guidance for its use. The most recent NHANES survey[14] clearly indicates that oral health has improved for most Americans compared to the 2011–2012 survey period. What follows are some of the most significant findings of the last surveys (2017–2018 and 2019–2020).

Caries in Children and Adolescents in the United States

Prevalence and Severity of Tooth Decay in Primary Teeth in the United States[14]

About 11% of children aged 2-5 years had one or more primary teeth with untreated decay. Mexican American children had a higher **prevalence** of untreated tooth decay (18.5%) compared to non-Hispanic White children (8.1%). Also of note was the link between children's df scores and poverty. The highest d and f scores were in children living under the ***F***ederal ***P***overty ***L***ine (FPL). Children in high poverty groups (18.0%) also had a higher prevalence than those in low poverty groups (6.6%). Children aged 2-5 years with one or more decayed or filled primary teeth had, on average, 1.8 decayed teeth and 2.6 filled teeth. Nearly 18% of children aged 6-8 years had untreated decay in primary teeth, with higher prevalence in high and middle poverty groups (24.6% and 24.8%, respectively) compared to low poverty groups (11.6%). Mexican American children in this age group had the highest mean number of filled teeth (4.2).

Prevalence of Tooth Decay in Primary and Permanent Teeth in the United States[14]

Nearly 17% of children aged 6-9 years had untreated decay in primary or permanent teeth. Children in high (26.3%) and middle (23.4%) poverty groups were more than twice as likely to have untreated decay compared to those in low poverty groups (10%). About 50% of children aged 6-9 had one or more decayed, filled, or missing primary or permanent teeth. Mexican American children (70.3%) and those in high (59.9%) and middle (61.4%) poverty groups had higher prevalence compared to non-Hispanic White children (43.4%) and those in low poverty groups (40.5%).

Prevalence and Severity of Tooth Decay in Permanent Teeth[14]

Nearly 3% of children aged 6-11 years had untreated decay in permanent teeth. Those with one or more decayed, missing, or filled permanent teeth had, on average, 0.3 decayed teeth and 1.6 filled teeth. About 10% of adolescents aged 12-19 years had untreated decay in permanent teeth, with higher prevalence among older adolescents (16-19 years, 12.1%) compared to younger adolescents (12-15 years, 8.6%). Adolescents with one or more decayed, missing, or filled permanent teeth had, on average, 0.4 decayed teeth and 3.7 filled teeth. The **mean** number of filled teeth was higher among older adolescents (4.4) and Mexican American adolescents (4.3).

The report provides evidence of a link between children's decayed and filled (dft) scores and poverty. It shows that children living under the Federal Poverty Line (FPL) have the highest dft scores. Specifically, children aged 2-5 years in the high poverty group had a mean number of 2.2 decayed teeth and 2.6 filled teeth, while those in the low poverty group had a mean number of 1.6 decayed teeth and 2.1 filled teeth. Similarly, children aged 6-8 years in the high poverty group had a higher prevalence of untreated decay (24.6%) compared to those in the low poverty group (11.6%). These findings indicate a significant association between poverty and higher dft scores in children.

Caries in Adults in the United States

Prevalence of Untreated Tooth Decay in Adults in the United States[14]

Nearly 21% of adults aged 20-64 years had untreated decay in permanent teeth. The prevalence was lower in the 50-64 age group (17.3%) compared to younger age groups (21.8% for 20-34 years and 21.4% for 35-49 years). Higher prevalence was observed among males (22.8%), non-Hispanic Black adults (30.3%), those in high (39.6%) and middle (30.9%) poverty groups, those with a high school education (30.2%) or less (39.1%), and current smokers (41.4%).

One interesting finding related to DMFT and DMFS scores in adults was that there were no significant differences based on poverty levels, as was found in children. Also, it was found that non-Hispanic Black adults have the highest prevalence of untreated caries, and men are more affected than women. It is most likely because women seek dental care more frequently than men, and women experience earlier tooth eruption patterns.

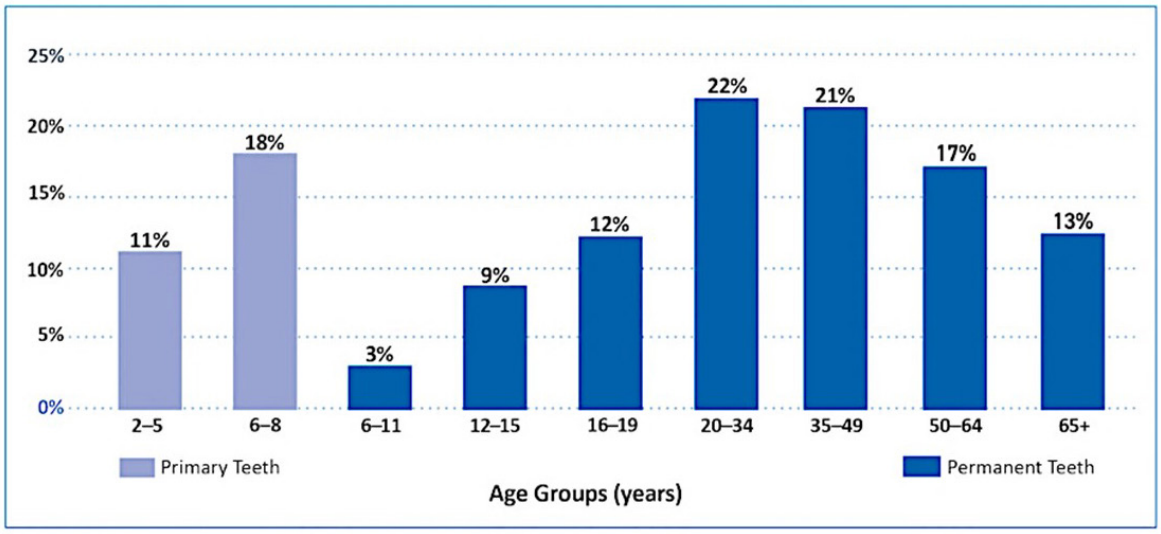
Prevalence of Untreated Tooth Decay in Older Adults[14]

Nearly 13% of adults aged 65 years or older had untreated decay in permanent teeth. The root caries prevalence was significantly higher among non-Hispanic Black adults (28.4%), Mexican American adults (24.0%), those in high (28.7%) and middle (19.4%) poverty groups, those with less than a high school education (20.0%), and current smokers (27.6%). This emphasizes the need for targeted interventions to address root caries in these high-risk populations.

Tooth Retention and Edentulism[14]

The mean number of permanent teeth decreased with age, from 27 teeth at 20-34 years to 23.3 at 50-64 years, 21.7 at 65-74 years, and 19.8 at 75 years or older. Among adults aged 65 years or older, the mean number of teeth was lower among non-Hispanic Black adults (16.2), those in high and middle poverty groups combined (17.6), those with less than a high school education (16.8), and current smokers (16.3). The prevalence of edentulism increased from 1.2% at 35-49 years to 5.9% at 50-64 years, 11.4% at 65-74 years, and 19.7% at 75 years or older. Edentulism was more prevalent among non-Hispanic Black adults (21.8%), those in high poverty groups (29.8%), those with less than a high school education (33.4%), and current smokers (29.4%).

Figure. Weighted Prevalence of Untreated Tooth Decay in Primary or Permanent Teeth, by Age, United States, National Health and Nutrition Examination Survey, 2017–March 2020



Note: All estimates are adjusted by age to the U.S. 2000 standard population.

Figure 1.
Adapted from ORAL HEALTH SURVEILLANCE REPORT Dental Caries, Tooth Retention, and Edentulism, United States 2017–March 2020

Comparison of the 2024 Oral Health Surveillance Report Findings with Previous Years

The 2024 Oral Health Surveillance Report findings show a comparison with previous years, highlighting trends in untreated decay among different age groups.[13-16] For children aged 2-5, the prevalence of untreated decay in primary teeth decreased slightly from 13% in 2011-2016 to 11% in 2024. Similarly, for children aged 6-11, untreated decay in permanent teeth decreased from 5% to 3%, and for adolescents aged 12-19, it decreased from 13% to 10%. Among adults aged 20-64, the prevalence of untreated decay decreased from 25% in 2011-2016 to 21% in 2024. For older adults aged 65 and older, untreated decay decreased from 15% to 13%.

Despite these improvements, the report highlights persistent disparities. Higher prevalence of untreated decay remains consistent among high poverty groups, and non-Hispanic Black and Mexican American individuals continue to have higher rates of untreated decay.[16] Additionally, current smokers still show higher rates of untreated decay and tooth loss. Overall, the 2024 report indicates a general improvement in oral health across various age groups compared to previous years, with notable decreases in untreated decay.[14,16] However, disparities based on socioeconomic status, race, ethnicity, and smoking habits persist.

In 2016, the Health Policy Institute of the American Dental Association (ADA) made available oral health fact sheets for every US state. These data can be accessed via the following ADA link: *http://www.ada.org/en/science-research/health-policy-institute/oral-health-care-system*, and may be of interest to both dental health professionals and their patients.

Conclusion

Dental caries is a serious public health issue and collecting data on its prevalence, **incidence**, and trends is an important field in oral epidemiology. The DMF index is a standard method for assessing dental caries experience in populations. While linear increases in caries with age in both children and adults indicate that caries affects individuals throughout life, longitudinal surveys indicate a decline in dental caries experience over the past two decades, yet dental caries remains a prevalent oral disease among the children and adults.

For dental professionals, understanding epidemiological data is crucial for implementing evidence-based interventions and guiding patients in caries prevention. Effectively communicating this data can enhance patient trust, compliance, and adherence to oral care recommendations, making prevention efforts more impactful.

Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/ce-courses/ce710/start-test*

1. What types of information do studies in oral epidemiology provide?

A. The data is used to identify populations at risk of oral disease.
B. The data compare regional similarities.
C. The data compare differences in dental care between populations.
D. All of the above.

2. What is the correct term for the proportion of individuals with a disease in a population at a specific point in time?

A. Incidence
B. Prevalence
C. Trend
D. Index

3. What is the correct term for the changes in prevalence or incidence of disease with respect to time, location, and socioeconomics?

A. Validity
B. Ordinal
C. Trend
D. Index
E. Herpes simplex infection

4. All of the followings are types of measurement scales for indices except:

A. Ordinal
B. Mean
C. Interval
D. Reversible

5. An index must be designed to measure the aspect of disease it is intended to measure, corresponding to the clinical stages of disease. This statement defines which of the following terms?

A. Quantifiability
B. Reliability
C. Objectivity
D. Validity

6. Which of the following is true about the DMF index?

A. It is expressed as the total number of teeth or surfaces that are decayed, missing, or filled.
B. It is expressed only as the total number of teeth that are decayed, missing, or filled.
C. It is applied to permanent and primary dentition.
D. It is a new measure of caries experience.

7. What is the score range of the DMFS index?

A. 0 to 20
B. 0 to 28 or 32
C. 0 to 128 or 148
D. 0 to 88

8. Which index calculates the number of surfaces that are decayed, missing, or filled in primary dentition?

A. DMFS
B. dmft
C. dmfs
D. DMFT

9. Which of the following are types of teeth not counted in calculating DMFT and DMFS?

A. Unerupted teeth
B. Congenitally missing teeth
C. Supernumerary teeth
D. All of the above

10. Which of the following is a limitation of DMF indices?

A. They do not account for sealed teeth.
B. They only count five surfaces on the posterior teeth.
C. They do not count unerupted teeth as missing.
D. They count a defective filling as an F.

11. What types of oral health data was collected with the NHANES surveys?

A. Dental history
B. Periodontal status
C. Caries
D. All of the above.

12. Which statistic accurately reflects the percentage of caries-free children in 2017-2020?

A. 21.8% of children aged 2 to 5 are caries-free.
B. 89% of children aged 2 to 5 are caries-free.
C. 28% of children aged 6 to 11 are caries-free.
D. 50.1% of children aged 12 to 15 are caries-free.

13. Which of the following statements about the findings of the NHANES survey with regards to dental caries in children is true?

A. Caries prevalence differs significantly based on gender.
B. There are no differences in caries prevalence based on race.
C. Untreated decay is highest in children living below the federal poverty line (FPL).
D. The prevalence of untreated decay rose significantly between 1998–2004 and 2017-2020.

14. Which of the following is an important gender difference in caries epidemiology?

A. Men are less likely to have caries on occlusal surfaces of teeth.
B. Men tend to have more caries on the facial surfaces of teeth.
C. Women and men have an equal prevalence of coronal and root caries.
D. Men have a higher prevalence of overall caries.

15. Which of the followings is a likely reason for women to have higher DMF scores?

A. Female hormones make them more susceptible to caries.
B. Women seek dental care more frequently than men.
C. Women tend to not take good enough care of their teeth.
D. Women experience later tooth eruption patterns.

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Additional Resources

- No Additional Resources Available

About the Author

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Dr. Noureldin BDS, MSD, MS, PhD, tenured Clinical Professor and Director of Cariology and Prevention in Department of Public Health Sciences School of Dentistry Texas A&M, specializes in three areas of dentistry, operative dentistry, preventive dentistry and cariology (caries management). She holds two master's degrees—one in Operative Dentistry from Cairo University (1998) and another in Biomaterials from Baylor College of Dentistry, Texas A&M University (2003). Additionally, she earned her PhD in Operative Dentistry in 2007 from Cairo University. This extensive education makes her an expert in the field of cariology.

Dr. Noureldin is a distinguished dentist, scholar, mentor, and educator, teaching at both the predoctoral and postdoctoral levels. Her research focuses on dental caries management and white spot lesion prevention and treatment, supported by industry contracts and intramural grants. She has published extensively in peer-reviewed journals. Dr. Noureldin serves on the Board of Directors for the American Academy of Cariology, is Vice President of Cariology Research Section of the International Association for Dental research (IADR) and is a member of the American Heart Association's Healthy Smiles, Healthy Hearts Scientific Advisory Group. She is also a national and international speaker. Her leadership and accomplishments have been recognized with the Distinguished Teaching Excellence Award (2016) and the Clinical Faculty Research Award (2019) from Texas A&M College of Dentistry.

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