

2020

# A smiling future: exploring the multidisciplinary associations with higher prevalence of tooth decay in minority children

---

<https://hdl.handle.net/2144/42155>

*"Downloaded from OpenBU. Boston University's institutional repository."*

BOSTON UNIVERSITY  
SCHOOL OF MEDICINE

Thesis

**A SMILING FUTURE: EXPLORING THE MULTIDISCIPLINARY  
ASSOCIATIONS WITH HIGHER PREVALENCE OF TOOTH DECAY IN  
MINORITY CHILDREN**

by

**JULIAN ROBERT NEHEMIAH JACKSON**

M.S., University of Alabama at Birmingham, 2019  
B.A., Howard University, 2014

Submitted in partial fulfillment of the  
requirements for the degree of  
Master of Science

2020

© 2020 by  
JULIAN ROBERT NEHEMIAH JACKSON  
All rights reserved

Approved by

First Reader

---

Theresa A. Davies, Ph.D.  
Director, M.S. in Oral Health Sciences Program  
Assistant Professor, Medical Sciences & Education

Second Reader

---

Maura A. Kelley, M.D.  
Assistant Professor, Medical Sciences & Education

## **DEDICATION**

I would like to dedicate this work to my niece, Lyric Hough, who is the newest edition to my family, and who this literature might impact the most.

## ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Theresa Davies, for providing me with guidance through my journey to pursue my dreams. Most of all, for allowing me the opportunity to participate in the Oral Health Science Program at Boston University.

I would like to also acknowledge Dr. Maura Kelley for agreeing to be my second reader. Dr. Kelley's has so much passion for her job but for her students. She made sure we all had the necessary components in order to succeed in her class, while also providing a challenge to prepare her students for any rigor of class.

I would like to acknowledge my former Principle Investigator Dr. Jeff Morris of University of Alabama at Birmingham for his continual guidance and support in my pursuit of my dreams, and for reigniting my love for science.

Lastly, I would like to acknowledge my family for without their prayers and support I would not be able to achieve the things that I have and will achieve in the future.

**A SMILING FUTURE: EXPLORING THE MULTIDISCIPLINARY  
ASSOCIATIONS WITH HIGHER PREVALENCE OF TOOTH DECAY IN  
MINORITY CHILDREN**

**JULIAN ROBERT NEHEMIAH JACKSON**

**ABSTRACT**

With over 20 million Americans living in food deserts, it is no wonder why the children who living in these areas are consuming more processed foods. Processed foods and lack of proportional diet can have an adverse effect on the oral health of children and adults leading to tooth decay. Early Childhood Caries (ECC) is the most chronic disease in children and it is especially chronic within children who come from disadvantage backgrounds. The objective of this study is to explore the multiple paradigms of tooth decay that exist within the minority population of children. The mechanism behind what leads to tooth decay will be evaluated in conjunction with other factors such as: disparities within minority children, insurance coverage, and agriculture to demonstrate the high prevalence of ECC within minority children.

What goes in a child's mouth can really determine the state of their oral healthcare, however more times than not children lack the responsibility and depend heavily upon their guardian to get their dental needs met. The development of ECC can lead to more severe problems if left untreated, and currently there is a high prevalence of untreated ECC in predominantly minority neighborhoods where families are typically

low income. Low-income means they are less likely to have a primary dentist leading to more untreated ECC, however it is also important to look at the federally funded programs. The government has been able to take strides in helping provided coverage for these at-risk children. ECC is chronic and can be detrimental to a child's healthcare.

What goes in the child's mouth is also important in that in low-income neighborhoods there are deserts full of no organic options. This can have an adverse effect on the child's help by their famine nutritional needs.

There is a need for new policy to be implemented in order to increase the rate at which children go to the dentist as well as gain access to avoidable options. Although there were limits within this study, there are many suggested improvements and directions for future research to address.

In conclusion, although the data reported here supports the conclusion that more evidence is needed that will lead to significant policy reform to eliminate the high prevalence of ECC especially within children coming from minority backgrounds. Positive progress is being made due to the constant support from both the government and community resources as well as dental practitioners who are focused on making a difference in the oral health and overall well-being of children.

## TABLE OF CONTENTS

DEDICATION.....	iv
ACKNOWLEDGMENTS .....	v
ABSTRACT.....	vi
TABLE OF CONTENTS.....	viii
LIST OF TABLES.....	x
LIST OF FIGURES .....	xi
LIST OF ABBREVIATIONS.....	xii
INTRODUCTION .....	1
I. Early Childhood Caries.....	1
II. Minority Differentiation.....	4
III. Coverage .....	7
IV. Agriculture Affluence.....	12
V. Current State of Literature .....	13
VI. Objective.....	15
PUBLISHED STUDIES.....	17
DISCUSSION.....	28
CONCLUSION.....	38
REFERENCES .....	40

CURRICULUM VITAE..... 44

## LIST OF TABLES

Table	Title	Page
1	Breakdown by Race and Ethnicity Oral Health Outcomes	9
2	Prevalence of Dental Caries in Primary Teeth Ages 2-5 Years Old	21
3	Prevalence of Dental Caries in Primary Teeth Ages 6-8 and 9-11 Years Old	22
4	Risk Assessments and Care Plans Promote ECC Prevention and Management	27
5	Utilization of Dental Services by Children In Medicaid in 2012	34
6	Utilization of Dental Services by Children In Enrolled in CHIP In 2012	36
7	Dental Caries Untreated in the United States from 1988-1994 to 2013-2016 for ages 5-19	37

## LIST OF FIGURES

<b>Figure</b>	<b>Title</b>	<b>Page</b>
<b>1</b>	Overview of the Development Process of Early Childhood Caries	3
<b>2</b>	Familial, Sociocultural, and Structural Aspects, Leading to Disparities in African American Children’s Oral Health Care	9
<b>3</b>	Percentage of Children with Untreated Caries by Ethnicity, Poverty Status Age Group and Dentition	11
<b>4</b>	Difference in Untreated Dental Caries Amongst Children from the Age 2-8 Years of Age	18
<b>5</b>	Untreated ECC Disproportionately Affects Children from Low-Income Minority Households	24
<b>6</b>	Student Perspective of Benefits Resulting from the Service-Learning Perspective	25
<b>7</b>	Etiological Factors in Dental Caries	29
<b>8</b>	Geographic Variation in the Percentage of Children Ages 1 to 20 Receiving Preventative Dental Services, FFY 2011	32
<b>9</b>	Geographic Variation in the Percentage of Children Ages 1 to 20 Receiving Dental Treatment Services, FFY 2011	33

## LIST OF ABBREVIATIONS

AAPD .....	American Academy of Pediatric Dentistry
CDC .....	Centers for Disease Control and Prevention
CHIP.....	Children’s Health Insurance Program
CMS .....	Centers for Medicare and Medicaid Services
ECC.....	Early Childhood Caries
EPSDT .....	Early and Periodic Screening, Diagnosis, and Treatment Program
NHANES .....	National Health and Nutrition Examination Survey

## INTRODUCTION

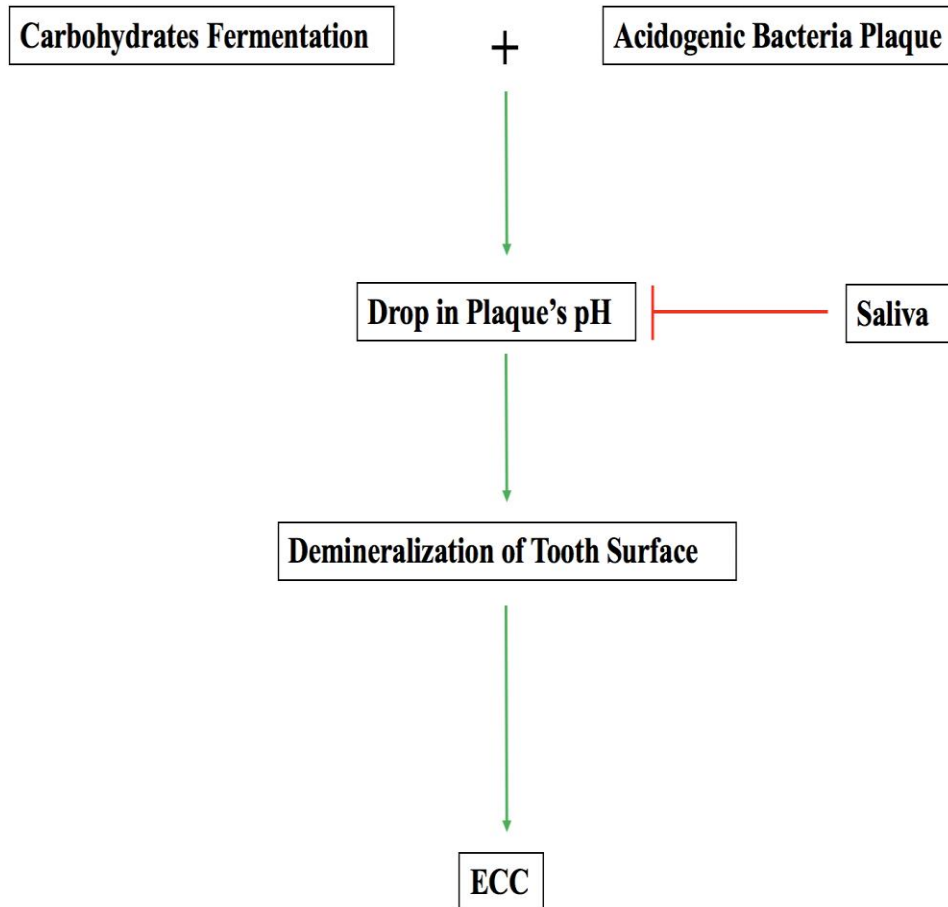
### I. Early Childhood Caries

For over 25 years, Early childhood Caries (ECC) prevalence has deemed greatest amongst the minority population, effecting their overall quality of dental health and access to preventative dental care (Henshaw and Singhal 2017). Caries are a form of biofilm that contain acid that can become harmful to one's teeth due to its ability to *demineralize*. Teeth are formed through a process of mineralization, hence demineralization being the breakdown of teeth, which can lead to periodontal disease which will be covered later **Figure 1**. The American Academy of Pediatric Dentistry defines ECC as having,

“the presence of 1 or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger(Council 2008).”

Developing ECC at a young age might predispose the child to higher risk of getting more tooth decay and lesions as they get older, overall effecting their secondary dentition (Nunn et al. 2009; Johnsen et al. 1987; Beil et al. 2014). Secondary dentition refers to the permanent teeth within our mouths, which are ultimately important as we must use them on a day to day basis. No matter the socioeconomic background, each child should not only be afforded the opportunity to have access dental care and use it, but also to evolve any previous cultural beliefs in order to provide a nascent lineage of family that partake in preventative ECC practices.

Tooth decay can become harmful to an individual oral health by leading to an infection. The etiological culprit of ECC is the acidogenic microorganism *Streptococcus mutans* (*S. mutans*) that attacks the primary dentition leading to further oral infection (Heng 2016; Vargas et al. 1998). The word “acido” means ill-natured and genic meaning producing, so *Streptococci* is a microorganism that causes acidity thereby igniting the process of demineralization (Seow 1998). These bacteria are often not by itself but instead accompanied by different nutritional elements that can help in demineralization. A child’s diet is also important due to carbohydrates acting as a catalyst and increasing the rate of demineralization on teeth through fermentation **Figure 1**. Fermentation is what causes the drop in pH in the plaque, ultimately leading to the breakdown of the teeth. *S. mutans* can be easily transmitted and has shown to more prevalent in children with low calcium in their diets (Heng 2016; Cagetti et al. 2020). It is also important to note that human saliva can act as a buffer to the acid that is produced, helping to remineralize the tooth surface. However, with a diet that has excess carbohydrates one is likely to develop ECC. A host’s diet is imperative to the beginning process of ECC development and will be covered in a later section.



**FIGURE 1. Overview of the Development Process of Early Childhood Caries.** The green arrows represent activation of the next step in carie development, while the red represents inhibition or remineralization of the tooth. Figure created by Julian Jackson, 2020

In children, caries development can happen on either their primary incisors or primary molars (Kaste et al. 1992). According to a study done by the National Center of Health Statistics, tooth decay is 20 times more prevalent than childhood obesity, making ECC the most common in disease in early childhood over asthma(Dye et al. 2007).

Primary dentition can be split into three classes of teeth while permanent dentition has four. Primary dentition consists of: Incisors, Canines and Molars; only permanent dentition has premolars. Incisors function in cutting, canines also assist in cutting through prehension, and molars function in chewing on the occlusal surfaces of the tooth (GS 2019).

## **II. Minority Differentiation**

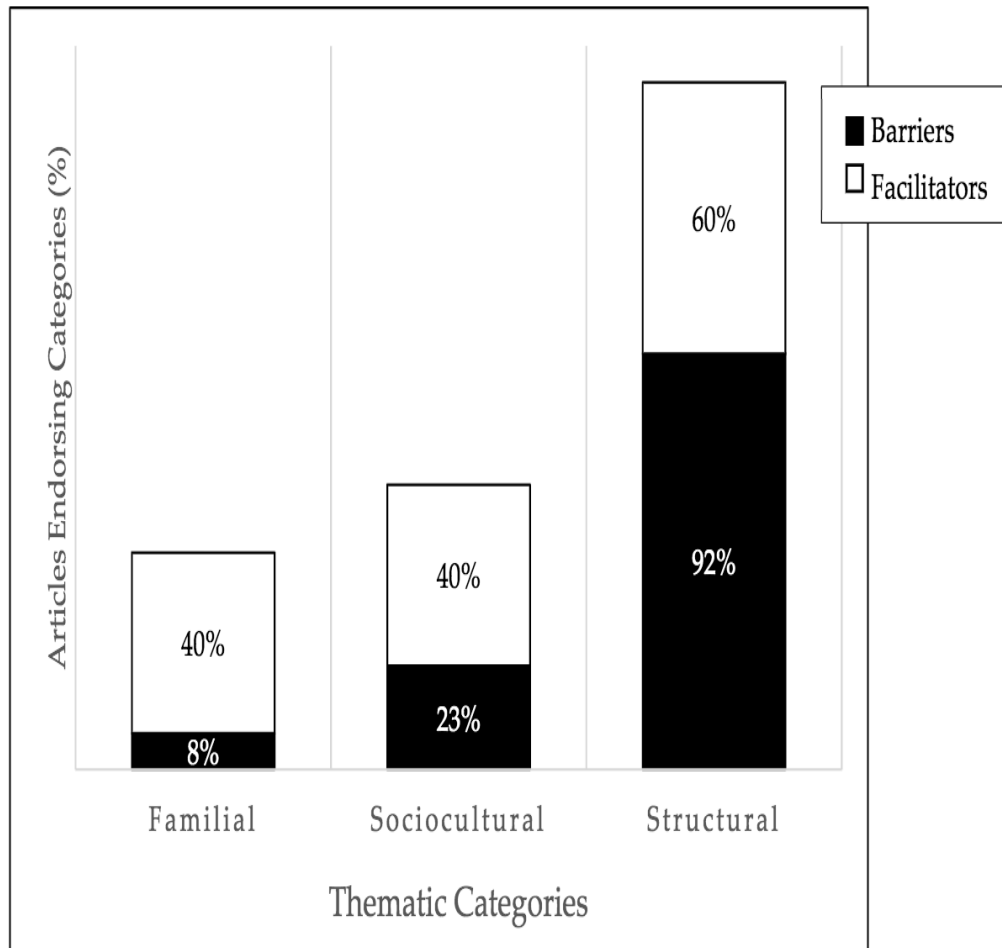
Children and their oral healthcare needs are imperative to address when talking about accessibility to care in that they usually do not determine whether they get care, but more so a decision that comes from their parent or guardian. As stated above, ECC is one of the most chronic disease in children, however this disease has become more prominent in children that come from low-income backgrounds, backgrounds that are compiled with minorities as the majority population (Vargas and Ronzio 2006; Heng 2016). Although there have been many preventative techniques in pediatric dentistry to prevent the development of ECC, there is still a gap within the minority children because the lack of education on preventative care, and lack of access to a primary dentist. Should a child be more prone to developing ECC just because of their socioeconomic background, or difference in culturally background?

Although there have been major progress in policy creation in the prevention of ECC in minorities, “underserved and vulnerable populations continue to suffer from the effects of poor oral health at disproportionate rates” says Surgeon General Vivek Murthy (2014-2017)(Como et al. 2019; Murthy 2016). The experience of going to the dentist can

differ person- to-person and can often be associated genetic factors that stem from their parents' experiences with the dentist (Smith et al. 2002; Beil et al. 2014). Health disparities disable people from being able to get the type of healthcare that they might need. However, this negative trend of attending the dentist is pre-disposing children to poor oral healthcare (Riedy et al. 2015; Beil et al. 2014). Children who identify as Mexican-American and African-American from the ages of 2 to 18 are more likely to have a higher prevalence of ECC according to the Third National Health and Nutrition Examination Survey (Vargas et al. 1998; Statistics National Center for Health 1994).

African-Americans are specifically affected by three factors: familial, sociocultural, and structural influences (Como et al. 2019). Growing up in an African American family and having a father who works, as a dentist, in a predominantly underserved area I have seen first-hand how these factors can affect the oral health of children. Most of the patients that are seen by my father are only coming when there is an emergency. Talking to the parents of children I have found that most cannot afford or do not have off days to take their children to the dentist. This was interesting to hear because it was not lack of insurance, but simply an absence of education and benefits to those families that have children with ECC. Sociocultural factors represent the people who share ideas, beliefs, communication with a certain group of people (McLeroy et al. 1988). I have seen firsthand how sociocultural beliefs and practices have negatively affected the perception and importance of having a primary dentist. For example, in some cultures they do not believe or have never had access to a primary dentist so therefore their children have the same expectation of not going to the dentist regularly leaving them at a

high risk for ECC. Structural factors dominate amongst the three factors in **Figure 2** (Como et al. 2019). These factors are the policies created by local, state, and federal offices that allocate the resources that are needed to provide oral healthcare in each area. Como et al. found that there are inconsistent preventative dental services in rural areas where there is a primarily African Americans. The location and the availability of dental healthcare have deemed to be inconsistent and it is the time now to really make even more policy. Policy creation is important at every level of government in order to not just provide service but to also educate and advertise affordable healthcare programs that would be beneficial to minority families.



**Figure 2. Familial, Sociocultural, and Structural aspects, leading to disparities in African American children’s oral health care.** Adapted from Como et al. 2019.

### III. Coverage

Affordable healthcare has, for years, helped many children in their health and maintenance of their help (Henshaw and Singhal 2017; Anon 2013). However, in low-income areas there is a small percentage of minorities attending the dentist (Nunn et al. 2009; Beil et al. 2014). The debate of private and public insurance, however public

insurance is more often than not, the sole provider of healthcare in low-income families (Nunn et al. 2009). Access to healthcare is also popular topic for our political leaders and this is because they are interested in providing an ethical service to people no matter their background. As stated above, minorities dominate the proportion of children with ECC and also children with untreated caries (Nunn et al. 2009; Beil et al. 2014; Vargas et al. 1998). Historically and still today minorities represent the largest percentage of children that have poor oral health status, no preventative dental visits, and delayed or unmet dental care needs **Table 1** (Fisher-Owens et al. 2013). Coverage of these minority children will be reviewed in this section. The two major programs that help provide insurance to cover dental procedures are Medicaid and the Children's Health Insurance Program (CHIP). Both programs, for years, have centered their agenda around closing the gap in children whose parents cannot afford dental care therefore increasing access to proper dental care.

**Table 1. Breakdown by Race and Ethnicity Oral Health Outcomes.** Groups include Hispanic, Non-Hispanic (NH), NH Black, NH Multiracial and NH White. Table from Fisher-Owens et al. 2013.

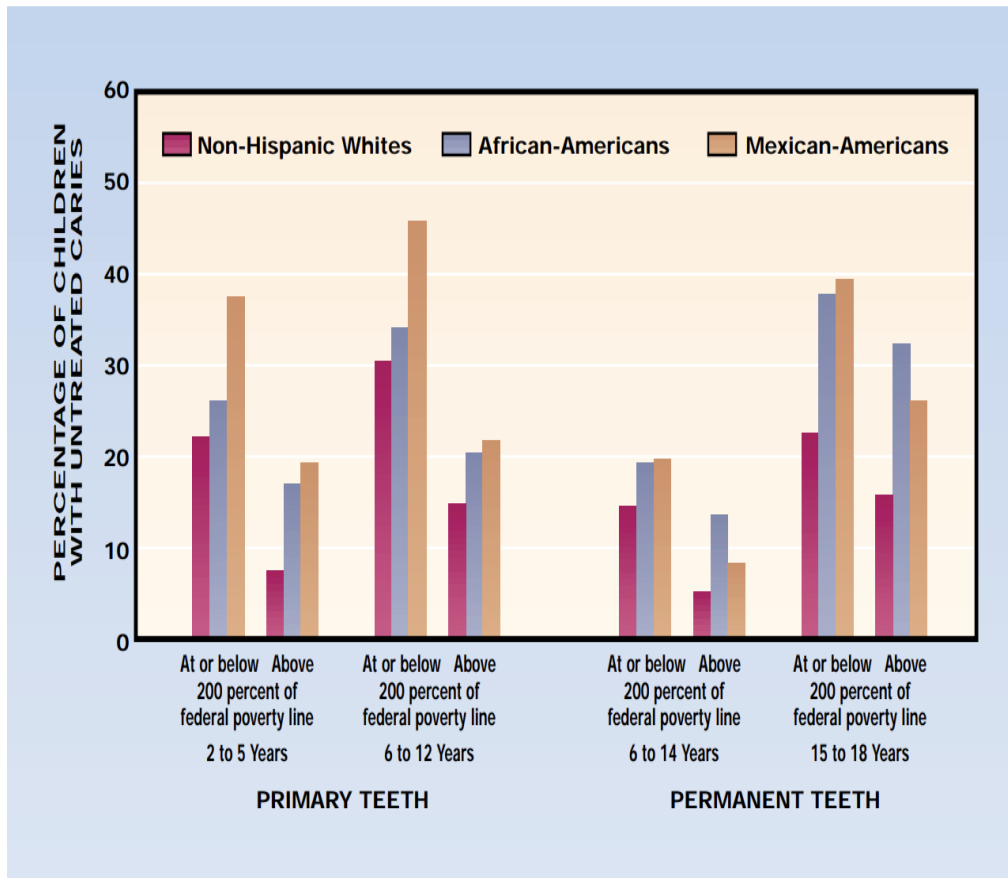
Race/Ethnicity	Fair or Poor Oral Health Status N=80,566 (n, % [CIs])	No Preventive Dental Visits in Past Year N=80,343 (n, % [CIs])	Delayed Care or Unmet Dental Care Need in Past Year N= 80,532 (n, % [CIs])
<b>Overall</b>	4,822 8.8 [8.1–9.4]	11,652 17.4 [16.7–18.1]	2,041 3.1 [2.8–3.4]
<b>Hispanic</b>	1,505 20.4* [18.1–22.7]	2,153 24.3* [22.0–26.6]	326 3.5 [2.6–4.4]
<b>NH Black</b>	664 9.8* [8.5–11.2]	1,308 18.4* [16.7–20.1]	238 3.4 [2.5–4.3]
<b>NH Multiracial</b>	181 5.3 [3.8–6.8]	573 16.9 [13.6–20.2])	148 4.4 [2.9–5.9]
<b>NH Other</b>	287 10.2* [7.1–13.3]	607 18.1 [15.2–21.0]	107 2.0 [1.4–2.6]
<b>NH White</b>	2,185 4.6 [4.2–5.2]	7,011 14.7 [14.0–15.4]	1,222 2.8 [2.4–3.2]

CI: confidence interval; NH: Non-Hispanic

\*p ≤ 0.05 vs NH White

To ensure that each child is covered, the Early and Periodic Screening, Diagnosis, and Treatment (EPSDT) program mandates that every child under the age of 21 receive dental care (Health National Institutes of 2000). For the children that need restorative dentistry but their families cannot afford to pay the thousands of dollars it takes to perform restorative dentistry, need these programs i.e. Medicaid in every rural areas (Griffin et al. 2000; Ramos-Gomez et al. 1996). Programs like the EPSDT are imperative in the conversation of access to dental care because the program does not allow for the

flexibility for a dentist to choose whether they will provide treatment to those enrolled in the program. Ultimately, this is keystone in reducing the prevalence of ECC in minority children that often come from low-income families. However, there is still a low percentage of minority children attending the dentist. This means that these children will need to receive more restorative dentistry care which is the opposite of “their more affluent counterparts (Vargas et al. 1998).” **Figure 3** shows that children from minority background, often more times than not, have more untreated caries than non-Hispanic whites (Statistics National Center for Health 1994).



**Figure 3. Percentage of Children with Untreated Caries by Ethnicity, Poverty Status, Age Group and Dentition.** Poverty is based on 200 percent of the federal poverty line. Adapted from Vargas et al. 1998.

#### **IV. Agriculture Affluence**

According to the United States Department of Agriculture (USDA), areas with low-income families, primarily minorities areas, are more likely to be a food desert(United States Department of Agriculture of Economic Research Service 2009). Even if one has never been desert, you can assume that it is a geographical area in which healthy food options are absent and not available to families living in these rural areas. Food deserts are also important to oral health, showing another alternative cause to higher prevalence of ECC in minority children who live in these deserted areas. Nutrients that children put into their mouth can influence the state of their primary dentition. Children with access to healthier food options or live in close proximity to supermarkets are more likely to not develop dental caries(Satcher and Nottingham 2017; United States Department of Agriculture of Economic Research Service 2009; Watson et al. 2010). With the functions of each class primary dentition, we can see the importance of keeping them healthy, as they are required for everyday function such as eating.

With over 23 million people living in food deserts it is important to recognize that even with access to primary dentist, one could still be at risk for development of dental caries and periodontal disease but not having access to proper nutrition. The development of ECC is a multifactorial process that is influenced by the amount of carbohydrates that one takes consumes. The metabolic activity by acidogenic bacteria that causes demineralization of teeth and is dependent on a host's diet(Nyvad 1996). Most ECC cases come from a child's diet that can lead to degradation of their teeth(Kaste et al. 1992; Johnsen et al. 1987). Health disparities in minority children are often found in access to

proper nutrition due to food deserts that cause dietary restrictions such as malnutrition of vitamins in these children(Watson et al. 2010). Access to organic foods that are beneficial to a child's oral health in low-income neighborhoods, however there are many urban farm initiatives erecting throughout the world to combat this food desert(Watson et al. 2010; Tiwari and Albino 2017).

## **V. Current State of Literature**

Recent literature in research has deemed that there is still a problem amongst minorities and their relationship to high prevalence of ECC. According to the 2016 Surgeon General's report on oral healthcare, Hispanics were least likely to utilize the dentist and non-Hispanics Blacks were the lowest amount of dental visits per year (Murthy 2016). This literature was consistent in identifying the disparity within minorities; however, it did not mention the percentage by age group.

There were multiple studies that did confirm that children come from low-income backgrounds have the highest prevalence of ECC (Como et al. 2019). This literature focus was on African American children and identifies multiple factors in which can uncover some of the etiological nascence of ECC in African American children such as family. Factors such as your family truly matter because children are very dependent on their family to meet proper dental needs. However, through literature we can discover that also geographical location of dentists could deem to be a reason family are not bringing their children to the dentist. Other literature suggest that the problem could be from lack of coverage.

Insurance and other affordable programs are imperative to reducing the prevalence of ECC within minority children. Griffin et al. (2000) identifies the cost and dental services that can lead to health problems beyond a dentist reach, hospitalization. One of the main factors in developing ECC is not going to the dentist, but what is important to note here is that this could be from the lack of minorities with insurance. However, there have been programs put in place that have help provide more dental care services for minority children such as Medicaid. In 1998, Medicaid mandated that no child under the age of 21 would be denied dental insurance coverage and services called the EPSDT program (Health National Institutes of 2000). This report was important because it not only showed the disparity within different races but also revealed the progress that had been made.

Caries in children are a product of both cariogenic bacteria and carbohydrate fermentation, which in conjunction lower the pH in one's mouth. Oral health starts with what goes in your mouth because if one lives in an area where there are only processed food options, then they have a higher rate of dental caries due to the lack of organic food options. Children that are living within the confinement of these areas is a product of sociocultural influence and there needs to be policy reformation and creation in order to place more supermarkets and urban farms within low-income areas. Low-income areas have historically housed minority populations. These populations that lack the resources to know and afford dental care for their children. An agricultural revolution would help to provide organic foods to those who cannot afford it and it can also, through

dissemination, provide a healthier oral health by just consuming less carbohydrates that can be fermented and potentially lead to ECC.

## **VI. Objective**

Having considered the literature, it is apparent that there is an absence of consistent, available, dental care for many minority children. These disparities range from a lack of education of preventative care, to access to healthcare coverage, and ultimately to the lack of an organic or healthy diet. Affordable dental insurance has been provided for these children however there still is a low percentage of Hispanic and African American children that do not attend the dentist which brings the sociocultural aspect into focus. Policy creation that will address the advertising of affordable coverage and shifting dental visits to becoming a necessity within every household. It is only then that we can see an increase in the number of dental visits by children and ultimately creating a policy that gears towards the reduction of ECC in minority children.

The objective of this study to evaluate the current state of ECC prevalence in minority children. Not only this, but to also observe etiological factors that will help in creating new plans and structure to the current dental healthcare system. Currently for the past fifty years minority children have shown to rank highest in development of ECC and rank highest to go to the dentist for emergencies due to lack of regular visits to the dentist (Vargasand Ronzio 2006; Heng 2016). The federal government has implemented certain programs that are geared toward to elimination of the current norm of not being able to

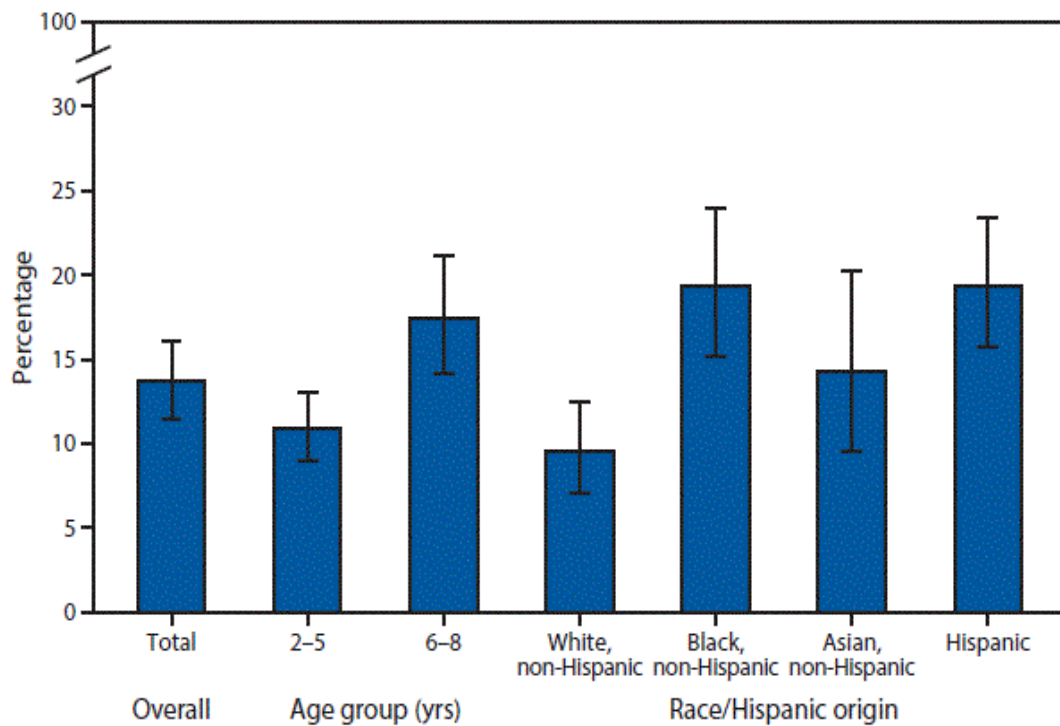
go to the dentist. Knowing that you and your children are covered might increase the rate at which minorities go to the dentist. However, it is not enough to depend on Medicaid to provide dental care because there is also a responsibility of a parent and guardian to obtain a primary dentist for their child within the first year of them being born. Failure to have this dentist leaves room and time for dental plaque to develop and further lead to more severe dental problems. Dental care and needs should be looked at on the same level of medical healthcare so that the lack of outcry for dental coverage can diminish.

We hypothesize that without proper policy creation and change there will be a higher prevalence of dental caries in children from minority backgrounds. We seek to discover different paradigms in order to identify factors that show the high prevalence and how it can be improved.

## PUBLISHED STUDIES

Data was gathered from multiple sources including scientific journals, textbooks, webpages, and national reports. The etiological factors of what constitutes ECC were compiled by multiple scientific journals that would help provide data in which would help in understanding the process of ECC development. The *Oral Health in America: A report of the Surgeon General* (National Institute of Dental and Craniofacial Research (NIDCR) 2000) in conjunction with other scientific journal was used to provide a broader recognition of the problem within minority communities. There were webpages used in order to get a more accurate number on the amount of people living in areas where they might not have access to dentist but also no access to organic foods.

Overall, there is still considerable prevalence dental caries in the US with some remaining untreated (**Figure 4**) (Center for Disease Control and Prevention (CDC), 2017). According to the figure there were more Black-non-Hispanic with untreated caries than any other ethnicity which agrees with Como et al. (2019) in that there is a clear disparity amongst African-American children. When looking at the CDC report from 2017 the age groups also differed in their percentages of untreated dental caries with 6-8-year-old having above 15 % of children with ECC which children 2-5 years old were around 10%. However, looking into a more current report with the CDC there were more 2-5 years old with untreated dental caries.



**Figure 4: Difference in Untreated Dental Caries amongst Children from the Age 2-8 years of age.**

\*With 95% confidence intervals indicated with error bars.

† Untreated dental caries (i.e., dental cavities) are defined as tooth decay that has not received appropriate treatment. Data were collected by dentists in the mobile examination center as part of the oral health component of the National Health and Nutrition Examination Survey. Figure taken from CDC, 2017.

Upon analyzing the differentiation between children age 2-5 (**Table 2**) and 6-11 (**Table 3**) disparities exist due to both racial inequities and socioeconomic issues. Some can get consistent dental care versus the children from low-income areas, there is a clear difference in the prevalence of ECC (**Table 2**) (CDC, 2019). Although there is a high prevalence of dental caries in minority children, we can currently see that there is in fact a small decrease in prevalence since the 1990's. It is notable to see the decrease in prevalence of ECC in children from 1999-2004, demonstrating the effects of public awareness of ECC (Centers for Disease Control and Prevention 2019).

This information from **Table 1** is consistent with the literature on public insurance. In the late 1990's there were amendments that were implemented in order to encourage more children to go to the dentist. Ultimately amongst both groups of children analyzed in **Tables 2 and 3** there was a 10% decrease overall in children with untreated dental caries. In the ages 2-5 years of age there was a 10% drop in untreated caries, while in the age group of 6-8 years old there was a 16% decrease. The age difference plays a factor into the difference in in percentage drops amongst the two age groups.

The older age group, seen in **Table 2**, might have a larger percentage drop due to maturity within the child and being able to communicate their oral discomfort to their parent/guardian. This could also be a larger percentage drop due to the level of the untreated caries being severe earlier in their life and not wanting to have such severe oral health problems. The age group difference is very imperative but also looking at the difference of sociodemographic is important as well. There was an 8% drop within the Mexican American group which would decrease their untreated dental caries to 33%

**Table 2.** As stated above, there seems to be a clear disparity gap in minority children when it comes to the development of ECC. The CDC found in this report seen in Tables 2 and 3 that from 2011-2016 there was a significant difference in untreated caries, where minority children were 1-2 times at higher risk of dental caries compared to nonhispanic whites (**Tables 2 and 3**)(CDC, 2019).

Children 6-8 years old in the study showed no significant difference in sociodemographic from 1999-2004 which shows the difference in maturity level can really make a difference on a child's oral health (**Table 3**). There was an overall drop in percentage across all the minorities with an overall drop of 11%. However, from 2011-2016 Mexican Americans still ranked the highest in untreated dental caries, with Non-Hispanic Black following behind with a percentage of 22%. This is still relatively a big percentage of minorities with untreated dental caries compared to non-Hispanic whites. Since then we can see that children are going to the dentist more which is helping to decrease the amount of dental caries in children. The decrease has been able to come from all ethnicities which is helping provide a better presence of dental healthcare in low income neighborhoods that are typically underserved and historically having unmet dental needs (CDC, 2019).

**Table 2. Prevalence of Dental Caries in Primary Teeth ages 2-5 years old. Adapted from CDC 2019.**

Characteristic	1999–2004		2011–2016		Change % <sup>b</sup>
	%	SE	%	SE	
<b>Total</b>	27.9	1.29	23.3	1.38	-4.6*
<b>Sex</b>					
Male <sup>c</sup>	30.1	2.12	24.0	1.63	-6.1*
Female	25.8	1.50	22.4	1.86	-3.4
<b>Race and ethnicity</b>					
White, non-Hispanic <sup>c</sup>	23.8	1.83	17.9	1.68	-5.9*
Black, non-Hispanic	31.6	2.24	28.0*	2.25	-3.6
Mexican American	41.3	1.99	32.9*	2.26	-8.4*
<b>Poverty status</b>					
<100% FPL	41.8	2.26	33.9*	1.65	-7.8*
100%–199% FPL	30.4	3.21	24.4*	2.24	-6.0
≥200% FPL <sup>c</sup>	17.8	1.53	15.7	1.82	-2.1
<b>Poverty status</b>					
<200% FPL	36.2	2.09	29.6*	1.54	-6.6*
≥200% FPL <sup>c</sup>	17.8	1.53	15.7	1.82	-2.1

Note: All estimates are adjusted by age (single years) to the US 2000 standard population. SE = standard error. FPL = federal poverty level; <100% FPL = poor; 100%–199% FPL = near-poor; <200% FPL = poor and near-poor combined; and ≥200% FPL = not-poor.

\*  $P < 0.05$  based on t-test for differences between two periods or two groups within each characteristic.

<sup>a</sup> Defined as having one or more untreated decayed or filled primary teeth among children with at least one primary tooth.

<sup>b</sup> Change in percentage points from 1999–2004 to 2011–2016. Positive value = increase; negative value = decrease.

<sup>c</sup> Reference group for comparisons within each characteristic, 2011–2016.

**Table 3. Prevalence of Dental Caries in Primary Teeth ages 6-8 and 9-11 years old.** Adapted from CDC, 2019.

Characteristic	1999–2004		2011–2016		Change % <sup>b</sup>
	%	SE	%	SE	
<b>Total</b>	7.7	0.85	5.2	0.44	-2.4*
<b>Age (years)</b>					
6–8 <sup>c</sup>	4.1	0.73	2.7	0.43	-1.3
9–11	11.1	1.33	7.6*	0.77	-3.5*
<b>Sex</b>					
Male <sup>c</sup>	7.5	1.02	4.9	0.53	-2.6*
Female	7.9	1.13	5.5	0.61	-2.4
<b>Race and ethnicity</b>					
White, non-Hispanic <sup>c</sup>	5.6	1.17	4.3	0.63	-1.3
Black, non-Hispanic	8.7	1.01	7.1*	0.81	-1.6
Mexican American	12.7	1.07	7.5*	1.14	-5.2*
<b>Poverty status</b>					
<100% FPL	11.8	1.74	8.1*	0.81	-3.6
100%–199% FPL	11.9	1.95	5.6	1.06	-6.3*
≥200% FPL <sup>c</sup>	3.6	0.66	3.5	0.54	0.0
<b>Poverty status</b>					
<200% FPL	11.9	1.38	6.9*	0.71	-5.0*
≥200% FPL <sup>c</sup>	3.6	0.66	3.5	0.54	0.0

Note: All estimates are adjusted by age (single years) to the US 2000 standard population. SE = standard error. FPL = federal poverty level; <100% FPL = poor; 100%–199% FPL = near-poor; <200% FPL = poor and near-poor combined; and ≥200% FPL = not-poor. 0.0 = zero due to rounding.

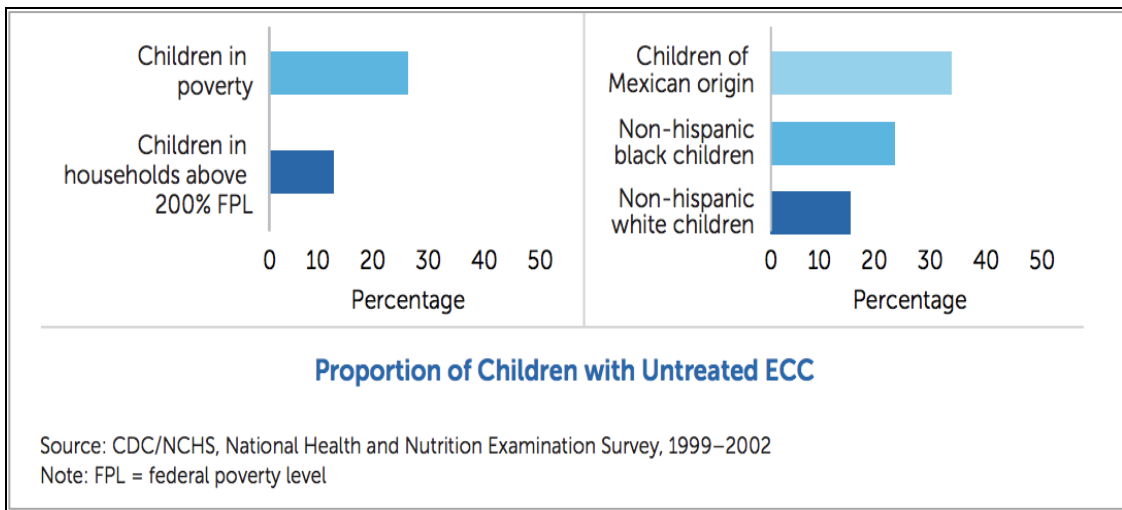
\*  $P < 0.05$  based on t-test for differences between two periods or two groups within each characteristic.

<sup>a</sup> Defined as having one or more untreated decayed permanent teeth among children with at least one permanent tooth.

<sup>b</sup> Change in percentage points from 1999–2004 to 2011–2016. Positive value = increase; negative value = decrease.

<sup>c</sup> Reference group for comparisons within each characteristic, 2011–2016.

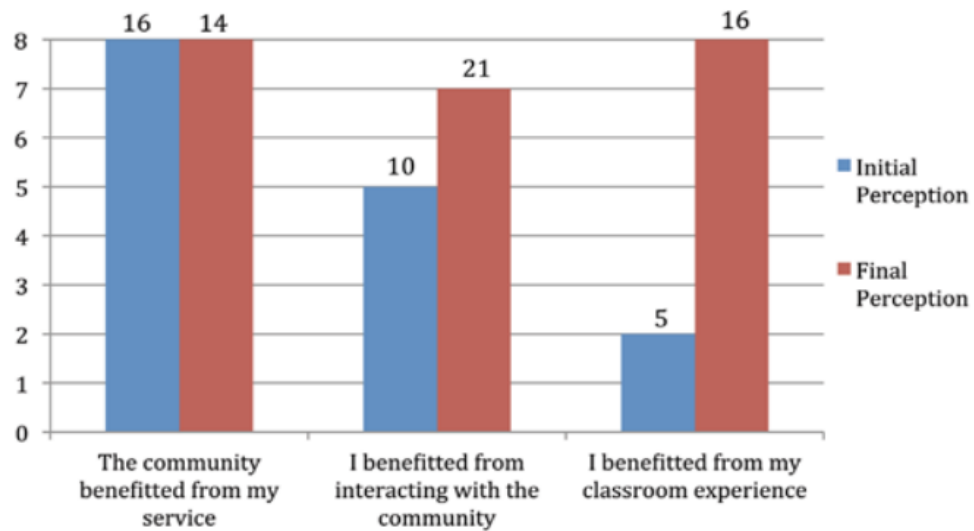
Although Medicaid has made many strides to help reduce the amount of unmet dental needs for those who cannot afford expensive restorative dental services, there are still many without dental care. Being that children are so dependent on their guardian to take them to the dentist it can be said that the parents must also be involved in this movement however they are often left out of the literature and results. The amount of food deserts in these areas that have high prevalence of ECC is unremarkable and reveals a possible etiological connection in between minorities and their high rate of unmet dental care needs **Figure 5** (Council, 2013). In Mexican American children there is a high percentage of children who are living with untreated ECC, while Non-Hispanic Black children follow them next in second highest percentage of untreated ECC, and non-Hispanic White children having the lowest percentage of untreated ECC. Amongst the different ethnicities there is also a difference in geographical locations, and this could draw gaps when analyzing the literature because there are less dentist that perform work in low-income neighborhoods making it hard for low-income families to get proper dental care (Council, 2013). Dental providers use the age of children in order to gauge the risk for terms of coverage. As stated above, there are specific mandates that allow children to have their dental care needs met if they are of a certain age. However, it is still the parents or guardians and their engagement with regular dental visits that will help hurt or develop a dental treatment for their child. When ECC develops it requires restorative treatment in order to save their primary dentition, without it can lead to hospitalization. With more policy being created there will eventually be a big reduction in minority children with ECC.



**Figure 5. Untreated ECC disproportionately affects children from low-income minority households.** Adapted from (Council 2013)

Introducing urban agriculture as a service-learning program has deemed to have a positive effect on children in learning and ingesting healthier foods through service learning i.e. urban farms (**Figure 6**). Community Food Security Scholars is a program designed to teach students about food inequalities while also teaching basic agriculture skills (Grossman 2012). Grossman et al. surveyed students that participated in a local urban farm that taught children from low-income backgrounds about environmental agriculture. Programs like this are imperative to the oral health disparities as they provide

an educational opportunity for children to learn the benefits to having proper nutrition that could ultimately help in their oral health.



**Figure 6. Student Perspective of Benefits Resulting from the Service-learning Perspective.** Student responses to “in what ways did you benefit, or provide benefit for others, through you service-learning experience?” Y-axis is number of students commenting on given benefit; number above column signifies total number of student comments about the benefit recorded during pre- and post-service interviews. Figure from Grossman 2012.

Several researchers have investigated oral health disparities specifically in Black children. Como et al., (2019) completed a thorough review in his recent publication where he assessed the structural, social, cultural and/or familial factors that may be relevant in understanding and ultimately limiting these disparities. The CDC literature helped also identify some disparities amongst not only minorities but also amongst the different age groups. Within the CDC literature (2017, 2019) we can find that minority children do still have the highest percentage of untreated dental caries, however we can also see the prevalence of ECC decreasing from different periods of times. There was a clear decrease overall in both tables showing that there is an increasing decrease in children that are getting their dental needs met but also there is still room for improvement. The AAPD (2019) helped to also identify the disparities but also provided a highly informative look into the classification of different healthcare plans. Looking into the these plans we can identify the proper mode of preventative care for ECC in minorities in order to continue the decrease in prevalence of ECC amongst minority children (**Table 4**) (Council 2013)).

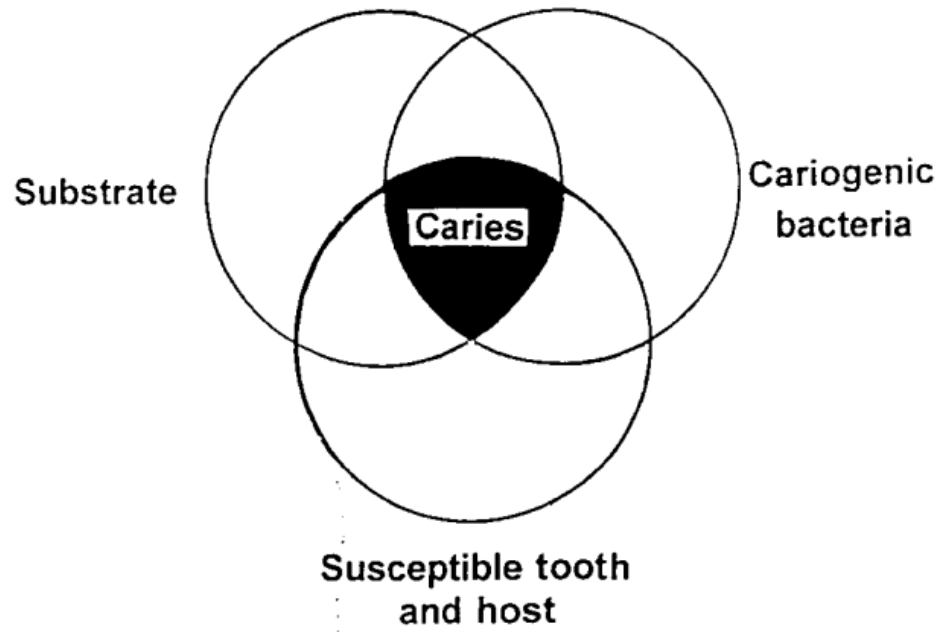
**Table 4. Risk assessments and care plans promote ECC prevention and management** Data from the American Academic of Pediatric Dentistry AAPD) (2019)

Prevention and management component	Objectives
<b>Individual risk assessment</b>	<ul style="list-style-type: none"> <li>• To determine whether a child is at low, moderate, or high risk of developing ECC, from infancy to age 6               <ul style="list-style-type: none"> <li>—Based on a child’s biological risks, protective factors, and clinical findings</li> </ul> </li> <li>• To help the health care provider and family understand the disease factors for a specific child and aid in individualizing conversations about prevention and management</li> <li>• To anticipate disease progression or stabilization</li> </ul>
<b>Individual care plan</b>	<ul style="list-style-type: none"> <li>• To establish the types and frequency of diagnostic, preventive, management, and restorative care for an individual child</li> <li>• To recommend dietary counseling that could lead to change in eating and brushing habits and other behaviors               <ul style="list-style-type: none"> <li>—Based on a child’s age, risk level, and level of patient/parent cooperation</li> </ul> </li> <li>• To promote treatment of the disease process instead of treatment of the disease outcome (that is, cavities)</li> </ul>

Source: American Academy of Pediatric Dentistry. "Guideline on Caries-Risk Assessment and Management for Infants, Children, and Adolescents." Chicago, IL: American Academy of Pediatric Dentistry, 2014. Available at [http://www.aapd.org/media/Policies\\_Guidelines/G\\_CariesRiskAssessment.pdf](http://www.aapd.org/media/Policies_Guidelines/G_CariesRiskAssessment.pdf).

## DISCUSSION

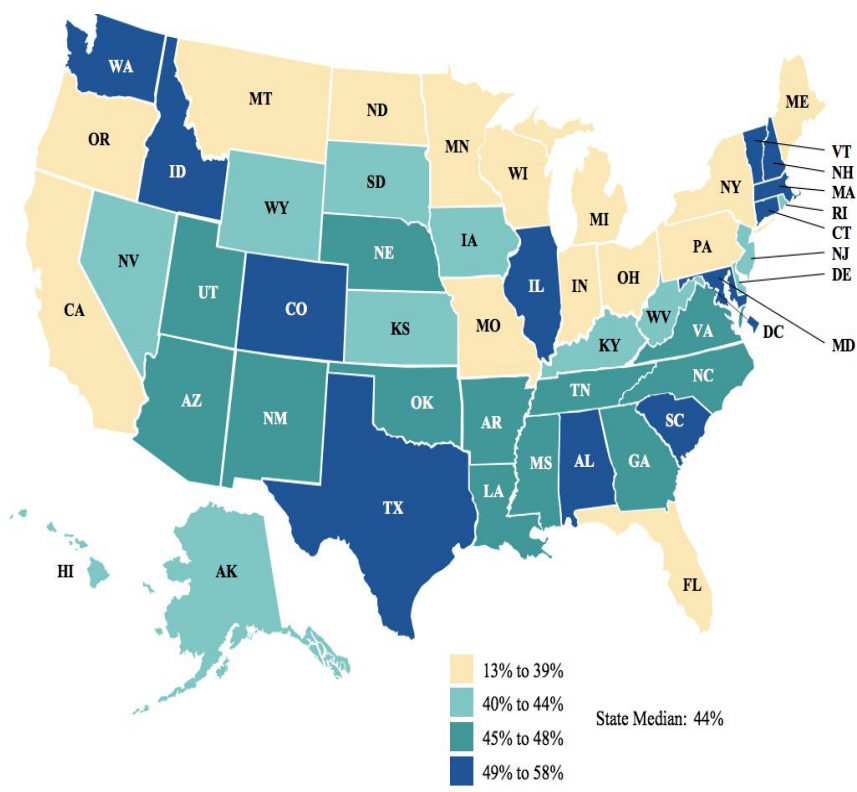
Although there has not been a clear solution to the high prevalence of dental caries in minority children, the data does show that there has been some reduction from previous reports. The source of the dental carie can come from acidogenic bacteria but also we must include the carbohydrate substrate which together help ignite the acidic degeneration of teeth (**Figure 7**) (Seow 1998). The diet of a child is important in determining the overall healthcare of one's mouth. Children who are living in less rural areas have access to proper nutrition, whereas in rural areas some supermarkets are over 10 miles away with no public transportation. There have been many studies that have identified these concerns and now there is policy creation to attempt to rid this lack of proper nutrition. I personally have seen and volunteered in urban farms and seen the benefit that it can have on a community. In Ron Finley, a pioneer in urban farming, said that, "If children grow kale and other healthy foods then they will eat kale." (Ted Talk, n.d.). This quote is important because there cannot just be supermarkets but instead involvement in the community through agriculture. With these current barriers and abundance of food deserts demonstrates the absence of children's diet in policy creation.



**Figure 7. Etiological Factors in Dental Caries.** Adapted from Keyes 1963.

The population across the United States of America is quite different and is not the same for many of the states who participate in federally funded insurance (**Figure 8**) (Mann, 2013). There lies a problem in unity amongst these states. The lack of unity has created an epidemic of ECC in those states that do not have high percentages of met dental health care needs. Preventative dentistry is just as important as any other factor mentioned in this literature. States like California, Oregon, Montana, Nebraska, Minnesota, Wisconsin, Missouri, Indiana, Michigan, Ohio, Pennsylvania, New York, Maine, and Florida all have 13% to 39% of children that receive preventative dentistry services. Overall, the state median was 44% which is less than half of the children that are in the United States. However, the geographic variation of children receiving just dental treatment in general was different from the preventative care in that it had a smaller state median (**Figure 9**) (Mann, 2013). This study has shown something especially important and that is that there are less annual dental visits by children insured by public insurance than by those of private insurance. This make sense because families with private insurance can afford to pay for it and therefore inherently visit the dentist on a more regular basis. According to the Centers for Medicare and Medicaid Services (CMS), the number of children receiving preventative care is below their guidelines (Mann, 2013). Upon being born a child should be seen by the dentist within a year, but often these children who are publicly insured are not getting their dental care needs met due to not having a primary dentist.

Findings from NHANES survey study demonstrated a composite state example that showed 40% of children under the age of 19 years of age develop dental caries. In 2012, Dodd et al. demonstrated the variation across the minority children with dental service utilization through Medicaid. Black non-Hispanics had the lowest of 32% enrollees receiving preventative care and 18% of enrollees receiving treatment services (**Table 5**)(Dodd et al. 2014; Anon 2013). This information is consistent with the theme of this review. Minorities are continually being the highest percentage of children with ECC. However there seems to be no significant difference in enrollees that are receiving preventative care which is a step in the right direction and showing a good depiction of what the oral health care system should and could look like in the future.



**Figure 8. Geographic Variation in the Percentage of Children Ages 1 to 20 Receiving Preventative Dental Services, Federal Fiscal Year, 2011** Adapted from Mann, 2013.



**Table 5. Utilization of Dental Services by Children in Medicaid in 2012, by Selected Characteristics: Composite State Example.** Adapted by Anon 2013.

Demographic Characteristics	Total Population		Enrollees Receiving Preventive Care		Enrollees Receiving Treatment Services	
<b>Age</b>						
1–2	25,000	9%	2,250	9%	1,750	7%
3–5	62,500	23%	22,600	36%	10,300	16%
6–9	72,500	26%	31,800	44%	19,150	26%
10–12	50,000	18%	19,350	39%	11,300	23%
13–19	65,000	24%	16,800	26%	10,750	17%
<b>Residence</b>						
Non-Urban	125,000	45%	43,425	35%	25,375	20%
Urban	150,000	55%	49,375	33%	27,875	19%
<b>Race/Ethnicity</b>						
White Non-Hispanic	108,750	40%	37,850	35%	22,500	21%
Black Non-Hispanic	91,250	33%	29,150	32%	16,050	18%
Other Non-Hispanic	33,750	12%	11,275	33%	6,250	19%
Hispanic	41,250	15%	14,525	35%	8,450	20%
<b>Total</b>	<b>275,000</b>		<b>92,800</b>	<b>34%</b>	<b>53,250</b>	<b>19%</b>

In the same study Dodd et al. observed CHIP enrollees receiving preventative care and enrollees receiving treatment services in which non-Hispanic Black ranked lowest in both categories. Both the literature and survey shows that dental care is fundamental in the lives of children, and that there needs to be more public awareness (**Table 6**)(Anon, 2013). Children under the age of 6 because of their low percentage of preventative care which could in turn lead to dental caries in their permanent teeth. The NHANES study also demonstrated that more CHIP enrollees utilize their dental preventative care and treatment at a higher rate than those enrollees who use Medicaid. In this composite example it is important to note the increase in Hispanic children receiving dental care with 27%, they make the highest percentage of children enrolled in CHIP receiving preventative care (Dodd et al. 2014; Anon 2013). There apparent gap and disparities will one day be closed but there is still lack of public awareness to act as a catalyst to oral health disparities in children.

A product of different healthcare programs has showed that there have been improvements to the current state of dental healthcare. In another report from the CDC in 2018, we can still see disparities with minority children ranking amongst the highest with dental caries, but also there is a decrease across the different ethnicities as time progressed (**Table 7**). Looking at the ages of 5-19 years old in 1988-1994 African Americans had the highest percentage of untreated dental caries which was 33.9%. From 2013-2016 there was 20.2% decrease (33.9%, 13.7%) in African Americans which shows a positive increase in children going to the dentist which would fit with the overall theme of the review. This decrease really affirms the importance of having programs available

to children that help meet their unmet dental needs. However, in 2013 when Hispanic or Latino children were accounted for in this report the largest percentage would still be African Americans but following them the next highest percentage group would be Hispanic and Latino children.

**Table 6. Utilization of Dental Services by Children in Enrolled in CHIP in 2012, by Selected Characteristics: Composite State Example.** Adapted by Anon, 2013.

Demographic Characteristics	Total Population		Enrollees Receiving Preventive Care		Enrollees Receiving Treatment Services	
<b>Age</b>						
1-2	10,000	6%	3,000	10%	800	8%
3-5	37,500	23%	13,875	37%	6,375	17%
6-9	43,500	27%	18,670	43%	12,915	30%
10-12	30,000	19%	12,000	40%	7,500	25%
13-19	39,000	24%	12,870	33%	8,680	22%
<b>Residence</b>						
Non-Urban	71,500	45%	28,700	40%	17,895	25%
Urban	88,500	55%	31,715	36%	18,375	21%
<b>Race/Ethnicity</b>						
White Non-Hispanic	64,000	40%	24,735	39%	14,720	23%
Black Non-Hispanic	53,500	33%	19,210	36%	11,185	21%
Other Non-Hispanic	19,000	12%	6,800	37%	4,120	22%
Hispanic	23,500	15%	9,670	42%	6,245	27%
<b>Total</b>	<b>160,000</b>		<b>60,415</b>	<b>38%</b>	<b>36,270</b>	<b>23%</b>

**Table 7. Dental Caries Untreated in the United States from 1988-1994 to 2013-2016 ages 5-19.** Table adapted from CDC, 2018.

Sex, race and Hispanic origin, <sup>1</sup> and percent of poverty level	5-19 years			
	1988-1994	1999-2002	2005-2008	2013-2016
	Percent of persons with			
Total <sup>2</sup>	24.3	22.5	16.6	16.9
Sex				
Male	23.6	23.7	17.6	17.4
Female	25.0	21.3	15.5	16.4
Race and Hispanic origin				
Not Hispanic or Latino:				
White only	19.4	18.5	13.3	16.1
Black or African American only	33.9	29.2	22.6	21.0
Asian only	---	---	---	13.7
Hispanic or Latino				
Mexican origin	37.9	33.9	22.4	19.3
Percent of poverty level <sup>3</sup>				
Below 100%	39.0	31.9	25.4	22.8
100%-199%	29.6	29.7	19.3	20.4
200%-399%	16.6	18.0	14.7	14.8
400% or more	*10.4	8.9	9.3	9.8
Race and Hispanic origin, and percent of poverty level <sup>3</sup>				
Not Hispanic or Latino:				
White only:				
Below 100% of poverty level	33.8	28.0	25.0	25.5
100% or more of poverty level	17.3	16.5	11.6	14.7
Black or African American only:				
Below 100% of poverty level	37.4	36.7	27.3	24.2
100% or more of poverty level	31.2	25.0	19.5	18.2
Asian only:				
Below 100% of poverty level	---	---	---	22.1
100% or more of poverty level	---	---	---	12.0
Hispanic or Latino:				
Below 100% of poverty level	---	---	---	20.4
100% or more of poverty level	---	---	---	16.3
Mexican origin:				
Below 100% of poverty level	47.5	40.2	25.9	19.0
100% or more of poverty level	28.0	27.0	20.5	19.9

## CONCLUSION

The data evaluated in this study did not demonstrate that dental health disparities no longer exist and unfortunately confirms that minority children continue to face these issues especially when it comes to preventative dental care. Additionally, this study did not demonstrate any current effective policy that would eliminate the disparities but did demonstrate that progress has been made where publicly funded insurance is more available to those in need, especially for children under the age of 19. Policy creation is an imperative part of the reformation of the current dental healthcare system. Although this study did not find significant data that would fully support the hypothesis, it did however provide a sense of curiosity and suggestions for the future that would likely help in reducing ECC in minority children. Suggestions such as more public awareness of programs like Medicaid and CHIP to increase the number of enrollees from geographical areas where historically not only minorities are found but also low-income families reside. The consideration of a more organic diet or more urban farms within low-income neighborhoods would surely reduce the prevalence of dental caries in children and aid overall in improving overall health and wellbeing.

The literature reviewed provided data that can demonstrate the current outcome of ECC amongst those children that come from a minority background. The time to invest in the future of dental healthcare is now, and the future lies within the children. Primary dentition is imperative to the health of permanent dentition, meaning it is best to start

early with regular dental care visits. It is the job of current healthcare providers to provide a space of collaboration between dental and medical professionals in order to create policy and collaboration to promote the prevention of chronic disease such as ECC from being so prevalent in the communities that have been historically disadvantaged.

Through collaboration and public awareness among community and public health officials, medical and dental practitioners, as well as government officials the prevalence of ECC in minority children can be resolved by our healthcare system. It is our fervent hope to one day achieve this goal to better the lives all children across the world. Hope to eliminate the differentiation across different ethnicities when it comes to regular preventative dental care and treatment. Hope to provide coverage to more and more children each year ultimately reducing the prevalence of ECC annually for all children. Hope to live in a world where low-income areas have proper organic nutrition so less acidity is accumulated in the mouth of children. Finally, hope that will not just capture the attention of its readers but also encourage them to find their advocacy within oral healthcare.

## REFERENCES

- Anon 2013. Keep kids smiling: Promoting oral health through the Medicaid benefit for children and adolescents. Available at: <https://www.medicaid.gov/sites/default/files/2019-12/keep-kids-smiling.pdf> [Accessed: 7 April 2020].
- Beil, H., Rozier, R.G., Preisser, J.S., Stearns, S.C. and Lee, J.Y. 2014. Effects of early dental office visits on dental caries experience. *American Journal of Public Health* 104(10), pp. 1979–1985.
- Cagetti, M.G., Wolf, T.G., Tennert, C., Camoni, N., Lingström, P. and Campus, G. 2020. The Role of Vitamins in Oral Health. A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health* 17(3), pp. 938 .
- Centers for Disease Control and Prevention 2018. *National Center for Health Statistics*. Centers for Disease Control and Prevention.
- Centers for Disease Control and Prevention 2019. Oral Health Surveillance Report: Trends in Dental Caries and Sealants, Tooth Retention, and Edentulism, United States, 1999-2004 to 2011-2016 [Online]. Available at: <https://www.cdc.gov/oralhealth/publications/OHSR-2019-dental-caries-primary-teeth.html> [Accessed: 18 July 2020].
- Como, D.H., Stein Duker, L.I., Polido, J.C. and Cermak, S.A. 2019. The persistence of oral health disparities for African American children: A scoping review. *International Journal of Environmental Research and Public Health* 16(5), pp. 710.
- Council on Clinical Affairs 2008. Definition of Early Childhood Caries (ECC). *American Academy of Pediatric Dentistry* 15.
- Council on Clinical Affairs 2013. Guideline on Caries-risk Assessment and Management for Infants, Children, and Adolescents. *American Academy of Pediatric Dentistry* 37, pp. 132–139.
- Dodd, V.J., Logan, H., Brown, C.D., Calderon, A. and Catalanotto, F. 2014. Perceptions of oral health, preventive care, and care-seeking behaviors among rural adolescents. *The Journal of School Health* 84(12), pp. 802–809.

- Dye, B.A., Tan, S., Smith, V., et al. 2007. Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital and health statistics. Series 11, Data from the national health survey* (248), pp. 1–92.\
- Finley, R. (n.d.) Ted Talk. Gardener. Retrieved on July 20, 2020 from [https://www.ted.com/speakers/ron\\_finley](https://www.ted.com/speakers/ron_finley)
- Fisher-Owens, S.A., Isong, I.A., Soobader, M.-J., et al. 2013. An examination of racial/ethnic disparities in children’s oral health in the United States. *Journal of Public Health Dentistry* 73(2), pp. 166–174.
- Griffin, S.O., Gooch, B.F., Beltrán, E., Sutherland, J.N. and Barsley, R. 2000. Dental services, costs, and factors associated with hospitalization for Medicaid-eligible children, Louisiana 1996-97. *Journal of Public Health Dentistry* 60(1), pp. 21–27.
- Grossman, J., Sherard, M., Prohn, Seb M., Bradley, L., Goodell, L.S., and Andrew, K. 2012. An Exploratory Analysis of Student-Community Interactions in Urban Agriculture. *Journal of Higher Education Outreach and Engagement* 16(2), pp. 179–196.
- Heng, C. 2016. Tooth decay is the most prevalent disease. *Federal practitioner : for the health care professionals of the VA, DoD, and PHS* 33(10), pp. 31–33.
- Henshaw, M.M. and Singhal, A. 2017. *Dental Public Health, an Issue of Dental Clinics of North America, E-Book*. Elsevier Health Sciences.
- Johnsen, D.C., Schechner, T.G. and Gerstenmaier, J.H. 1987. Proportional changes in caries patterns from early to late primary dentition. *Journal of Public Health Dentistry* 47(1), pp. 5–9.
- Kaste, L.M., Marianos, D., Chang, R. and Phipps, K.R. 1992. The assessment of nursing caries and its relationship to high caries in the permanent dentition. *Journal of Public Health Dentistry* 52(2), pp. 64–68.
- Keyes, P.H. 1963. *Mechanism of hard tissue destruction*. Harris, R. S. ed. New York: NY: Academic Press.
- Mann, C. 2013. *CMS Oral Health Initiative: Setting Baselines and Goals*. Department of Health and Human Services.
- McLeroy, K.R., Bibeau, D., Steckler, A. and Glanz, K. 1988. An ecological perspective on health promotion programs. *Health Education Quarterly* 15(4), pp. 351–377.

- Murthy, V.H. 2016. Oral Health in America, 2000 to Present: Progress made, but Challenges Remain. *Public Health Reports (Washington, D.C. : 1974)* 131(2), pp. 224–225.
- National Center for Health Statistics 1994. Plan and operation of the third National Health and Nutrition Examination Survey, 1988-94. Hyattsville, MD: US Department of Health and Human Services. *Public Health Service, CDC*.
- National Institutes of Health 2000. Report of the National Reading Panel: Teaching children to read (NIH Publication No. 00-4769. Retrieved September 14. <https://www.nichd.nih.gov/publications/pubs/nrp/smallbook>
- Nunn, M.E., Dietrich, T., Singh, H.K., Henshaw, M.M. and Kressin, N.R. 2009. Prevalence of early childhood caries among very young urban Boston children compared with US children. *Journal of Public Health Dentistry* 69(3), pp. 156–162.
- Nyvad, F. 1996. Development, structure, and pH of dental plaque. In: Copenhagen: Munksgaard ed. *Textbook of clinical cariology*. pp. 89–110.
- Phulari, R.G.S., 2019. *Textbook of Dental Anatomy, Physiology & Occlusion*. 2<sup>nd</sup> Edition. New Delhi: Jaypee Brothers, Medical Publishers Pvt. Limited.
- Ramos-Gomez, F.J., Huang, G.F., Masouredis, C.M. and Braham, R.L. 1996. Prevalence and treatment costs of infant caries in Northern California. *ASDC Journal of Dentistry for Children* 63(2), pp. 108–112.
- Riedy, C.A., Weinstein, P., Mancl, L., et al. 2015. Dental attendance among low-income women and their children following a brief motivational counseling intervention: A community randomized trial. *Social Science & Medicine* 144, pp. 9–18.
- Satcher, D. and Nottingham, J.H. 2017. Revisiting Oral Health in America: A Report of the Surgeon General. *American Journal of Public Health* 107(S1), pp. S32–S33.
- Seow, W.K. 1998. Biological mechanisms of early childhood caries. *Community Dentistry and Oral Epidemiology* 26(1 Suppl), pp. 8–27.
- Smith, R.E., Badner, V.M., Morse, D.E. and Freeman, K. 2002. Maternal risk indicators for childhood caries in an inner-city population. *Community Dentistry and Oral Epidemiology* 30(3), pp. 176–181.

Tiwari, T. and Albino, J. 2017. Acculturation and pediatric minority oral health interventions. *Dental Clinics of North America* 61(3), pp. 549–563.

United States Department of Agriculture of Economic Research Service 2009. Access to Affordable and Nutritious Food-Measuring and Understanding Food Deserts and Their Consequences [Online]. Available at: <https://www.ers.usda.gov/publications/pub-details/?pubid=42729> [Accessed: 25 June 2020].

Vargas, C.M., Crall, J.J. and Schneider, D.A. 1998. Sociodemographic distribution of pediatric dental caries: NHANES III, 1988-1994. *Journal of the American Dental Association* 129(9), pp. 1229–1238.

Vargas, C.M. and Ronzio, C.R. 2006. Disparities in early childhood caries. *BMC Oral Health* 6 Suppl 1, p. S3.

Watson, J.T., Fields, M. and Martin, D.L. 2010. Introduction of agriculture and its effects on women's oral health. *American Journal of Human Biology* 22(1), pp. 92–102.

**CURRICULUM VITAE**

