

A SYSTEMATIC REVIEW OF LITERATURE ON SOCIOECONOMIC DISPARITIES IN  
THE PREVALENCE OF DENTAL CARIES

By

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2010

## DEDICATION

I dedicate my work to my family members and my mentors for all their guidance and valuable support.



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By

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School of Public Health

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## PREFACE

I started working on this thesis as a part of my Master's curriculum. However, I soon realized this could be a very good prospect to explore the various interesting topics and would provide me with a valuable opportunity to display my skills and knowledge. With the support of my mentors and my family members I was able to achieve the goal of completing this thesis and my degree program and would like to thank them again for their guidance and love.

## ACKNOWLEDGEMENTS

I would like to acknowledge my committee members: Dr Luisa Franzini and Dr Lisa Pompeii for their valuable guidance and knowledge which made this thesis possible. I will always be thankful for their endless support and encouragement. I would also like to thank my family members for their love and support to encourage me to achieve my goal.

# A SYSTEMATIC REVIEW OF LITERATURE ON SOCIOECONOMIC DISPARITIES IN THE PREVALENCE OF DENTAL CARIES

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School of Public Health, 2010

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Dental caries, also known as tooth decay, are a disease of the oral cavity that affects the tooth structure and leads to the occurrence of cavities in teeth. Dental caries are one of the leading chronic diseases in the population and are very common in childhood. If not treated appropriately, dental caries have debilitating effect on the oral and general health of individuals.

Objectives: The aims of this review are to (1) analyze and elucidate the relationship between the social and economic determinants of health like income, education and race/ethnicity and the prevalence of dental caries and (2) identify and understand the pathways/underlying causes through which these factors affect the occurrence of dental caries. This review will provide a foundation for formulation of better oral health policies in future by identifying the key socio-economic factors and pathways affecting the prevalence of dental caries. Knowledge about these socioeconomic factors could be incorporated in the design of future policies and interventions to achieve greater benefits.

Methods: This review includes information from all pertinent articles, reviews, surveys, reports, peer reviewed literature and web sources that were published after 2000. The selection criterion includes literature focusing on individuals between the ages of 1 to 65 years, and individuals from different subgroups of community based on income, education and race/ethnicity. The analyses of literature include identifying if a relationship between

income/education/race and the prevalence of dental caries exists by comparing the prevalence of dental caries in different socio-economic groups. Also included in this review are articles that are relevant to the mechanisms/pathways through which income/education/race affect the prevalence of dental caries.

Results: Analyses of available literature suggests that disparities in the prevalence of dental caries may be attributed to differences in income, education and race/ethnicity. Higher prevalence of dental caries was observed in African-American and Mexican-American individuals, and in people with low income and low education. The leading pathways through which the socioeconomic factors affect the prevalence of dental caries are the lack of access to dental care, lack of awareness about good oral hygiene beliefs and habits, oral health, inability to afford dental care, lack of social support to maintain oral health and lack of dental insurance.

Conclusion: Disparities in the prevalence of dental caries exist in various socio-economic groups. The relationship between socio-economic factors and dental caries prevalence should be considered in the development of future policies and interventions that are aimed at reducing the prevalence of dental caries and enhancing oral health status.

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## INTRODUCTION

Oral health serves as an excellent model for understanding health disparities because oral infections can be a source of systemic infections in individuals with weakened immune systems, and the oral signs and symptoms often indicate general health condition. [1] The literature suggests an association between chronic oral infections and health problems, including diabetes, heart disease, and adverse pregnancy outcomes. [1] Dental caries are an essential characteristic used for the determination of oral health status. Also dental caries are one of the leading chronic diseases in the U.S. population and are very common in childhood. [2]

Dental caries, also known as tooth decay, are caused by a bacterial infection that damages the hard surfaces of tooth such as enamel, dentin and cementum. [3, 4] Untreated tooth decay can lead to pain, chronic infection of the dental tissues, surrounding gingiva and bone, and eventual tooth loss. [5]

Dental caries are a widely distributed chronic illness that are been ignored because of the economic constraints and social misbelieves. Literature suggests the existence of disparities in prevalence of dental caries due to different socio-economic factors. There is a significant association between the social, economic and behavioral risk factors and the national prevalence of dental caries. [1] Various economic and social determinants of health; such as race/ethnicity, income and education; render a significant effect on the prevalence and distribution of dental caries by providing risk factors for the disease such as poor oral hygiene [1], lack of access to proper dental care [1, 22] and absence of awareness regarding the importance of maintenance of good oral health. [19] Thus the study of the effects of socio-economic factors on the prevalence of dental caries is essential to understand the underlying causes of disparities, such as lack of awareness about importance of oral health due to poor education and lack of access to dental care due to poverty and oral health beliefs present in specific racial/ethnic groups. Findings from these studies provide a basis for better oral health policies and interventions.

This review discusses the disparities in the prevalence of dental caries and also reports the association between income, education and race/ethnicity and dental caries disparities and investigates the pathways/underlying causes through which these socioeconomic factors affect the prevalence of dental caries and focuses on the literature from past 20years involving individuals between 1 to 65years of age from all income, education and race/ethnicity group in the community that exhibit disparities in prevalence of dental caries.

### **PUBLIC HEALTH SIGNIFICANCE**

A disparity in the prevalence of dental caries is a serious public health issue world-wide and may be severe in vulnerable population. Various policies and organizations are working towards the goal of reducing the disparities in prevalence dental caries.

Literature suggests a range of different social and economic factors that affect the prevalence of dental caries and includes race/ethnicity, income and education. [1] These factors may have an individual or combined effect on the prevalence of dental caries. Studies indicate that these socio-economic factors cause disparities in the prevalence of dental caries by affecting the individual's health choices regarding the selection of food items, habits and beliefs about the oral health practices, their access to dental care and awareness about the importance of good oral health.

This review of the literature provides an overview of the disparities in prevalence of dental caries in various subgroups of the community like the different income, education and racial/ethnic groups. This review also focuses on the pathways in association between economic and social determinants of health and the dental caries prevalence.

The review aims to provide a knowledge basis for developing improved policies and interventions.

### **BACKGROUND**

Oral health is believed to be the mirror of general health and good oral health is considered a foundation of good health. [1] The mouth is a readily accessible part of the body and often

indicates the status of general health through oral symptoms. [1] The mouth can show the early signs of nutrition deficiency in the body [1] and can provide early warning signs of poor oral health such as non-healing ulcers, for diseases such as HIV infection and other immune-deficiency disorders. [1]

In the U.S., 20% of the children between the ages of 2 to 4 years and 80% of the children at the age of 17 years have experienced a dental decay. Two thirds of adults between the ages of 35 to 44 years have lost at least one tooth as a result of the tooth decay.

The first national survey that included a clinical assessment of dental caries among the adults was conducted by the National Center for Health Statistics (NCHS) during the period of 1960-62 and indicates a higher prevalence of dental caries in low income and low education individuals and also among Mexican-American children and the Non-Hispanic black adult population. This survey was followed by similar national surveys conducted through the period of 1963-70 that included children (6-11years of age) and adolescents (12-17years of age). These surveys were a part of the NCHS National Health Examination series which is now recognized as the National Health and Nutrition Examination Survey (NHANES). [8]

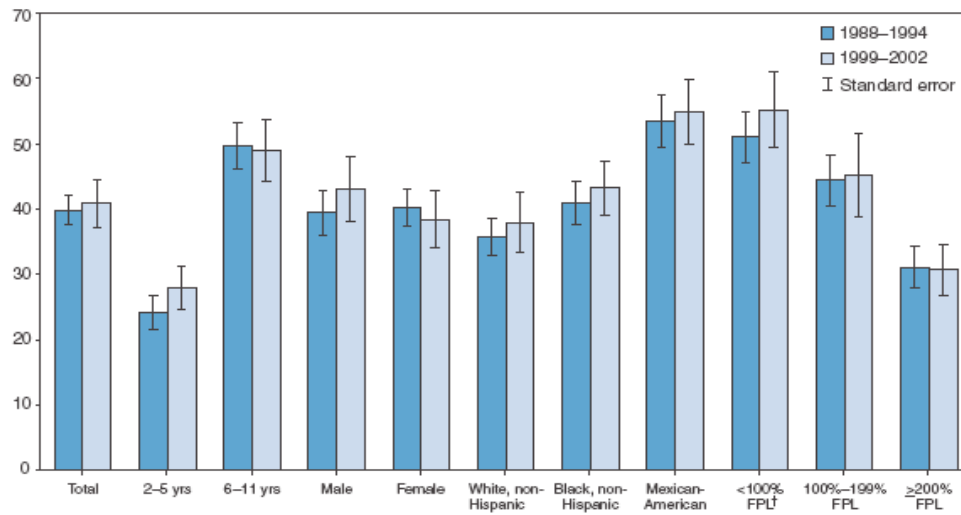
Dental caries disparities were significantly noticed in the year 2000 when the first Surgeon General's Report on Oral health was published and stated that profound disparities exist in the prevalence of dental caries in the US population. [1] Since this report, research studies focus on the identification of disparities in different socio-economic groups. In a study conducted by Antunes JLF and colleagues (2004), a relationship between the indices of socioeconomic status and the prevalence and distribution of dental caries is displayed that indicates a higher prevalence of dental caries in lower socio-economic status group. [6] A study conducted by Reid et. al. (2004) measured the impact of the material and behavioral factors on the prevalence of dental caries in the various racial and ethnic groups and concluded that addressing the material factors like income and education may provide a greater reduction in caries disparities in various racial groups when compared to the traditional approach of existing policies. [7]

It is evident from the literature that Mexican Americans/Hispanics exhibit a higher prevalence of dental caries than African Americans and White individuals in primary dentition among children between ages of 2 to 11 years. [1, 8, 9] Also a higher prevalence of dental caries in permanent dentition is observed in adults of African American community as compared to the Mexican American and White individuals. [8, 9, 10] Literature also indicates higher prevalence of dental caries in people with low income or people under Federal Poverty Level (FPL). [8, 11, 12, 13, 14]

Figures 1 and 2 below demonstrates the characteristics of disparities in the prevalence of dental caries in children and adults derived from the results of NHANES I and III studies.

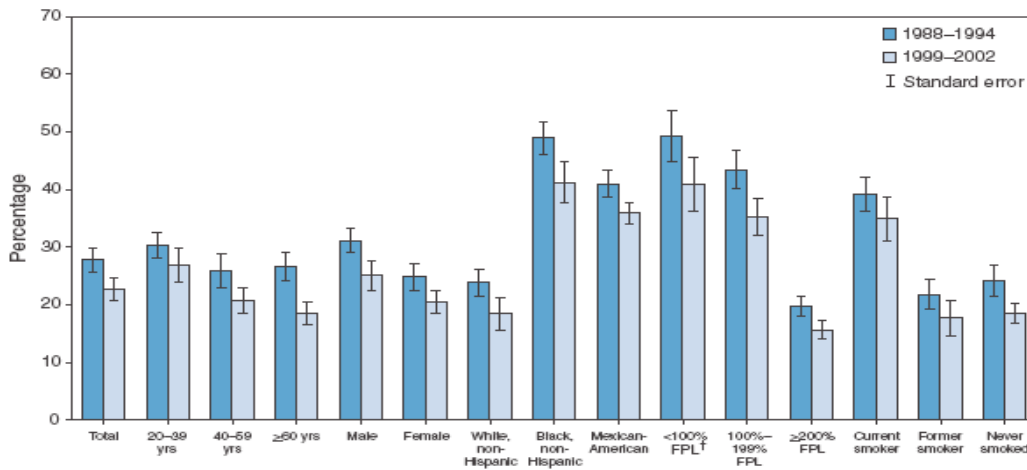
Data from NHANES I and NHANES III surveys demonstrated in these figures indicate the highest prevalence of dental caries in Mexican-American children and adults of Non-Hispanic Black population. [11] Higher prevalence of dental caries is observed in both children and adults below federal poverty level and also in individuals who have a less than high school education. [8] Literature suggests that the prevalence of dental caries in Non-Hispanic Black and Non-Hispanic White population is comparable but still there are differences in the treatment of dental caries and access to dental care and are affected by oral health beliefs and habits and affordability of dental care. [1]

Figure 1. Prevalence of dental caries among children



Data Source: Center for Disease Control and Prevention, MMWR, 1988-94, 1999-2002.

Figure 2. Prevalence of untreated tooth decay in adults



Data Source: Center for Disease Control and Prevention, MMWR, 1988-94, 1999-20

Table 1 below displays the prevalence of dental caries in different age, race/ethnic, gender, income and education groups observed in the First and Third National Health and Nutrition Examination Surveys (NHANES I and NHANES III) 1988-1994. Data from this table indicates higher prevalence of dental caries was observed among children between age of 2 to 8 years, of Mexican-American population in both NHANES I AND III. A higher prevalence of dental caries was observed among Non-Hispanic Black adolescents between the age of 12 to 15 years in NHANES I and higher prevalence of dental caries was observed among Non-Hispanic Black adults between the age of 35 to 44 years in NHANES III. Higher prevalence of dental caries is observed in both children and adults below federal poverty level and also in individuals who have a less than high school education in both NHANES I and III.

Table 1: Prevalence of dental caries relevant to different socio-economic factors.

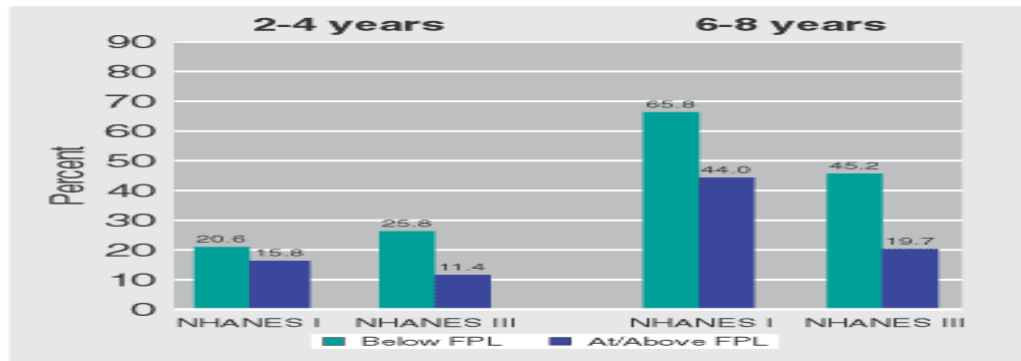
	Prevalence (95% CI)					
	2-4 Years - Primary (ds)		6-8 Years - Primary (ds)		6-8 Years - Permanent (DS)	
	NHANES I	NHANES III	NHANES I	NHANES III	NHANES I	NHANES III
<b>Total</b>	16.68 (14.30, 19.06)	15.90 (13.83, 17.98)	48.65 (44.36, 52.93)	26.52 (23.29, 29.76)	20.98 (16.81, 25.15)	6.34 (4.55, 8.14)
<b>Race/ethnicity</b>						
Non-Hispanic white	15.02 (12.77, 17.27)	10.79 (8.36, 13.23)	44.87 (40.09, 49.64)	20.69 (16.65, 24.72)	19.08 (13.79, 24.38)	4.47 (2.22, 6.72)
Non-Hispanic black	18.95 (13.24, 24.66)	22.00 (18.12, 25.87)	50.87 (43.72, 58.02)	33.48 (30.26, 36.67)	23.70 (17.40, 30.00)	7.28 (4.69, 9.87)
Mexican American	31.53 (16.43, 46.62)	30.11 (27.36, 32.86)	78.61 (64.48, 92.74)	44.75 (38.27, 51.24)	35.95 (18.67, 53.24)	10.49 (7.40, 13.58)
<b>Gender</b>						
Male	17.74 (14.18, 21.30)	16.25 (13.61, 18.90)	49.79 (44.45, 55.13)	24.18 (20.26, 28.11)	21.98 (17.54, 26.43)	4.32 (2.29, 6.36)
Female	15.54 (12.31, 18.77)	15.53 (12.71, 18.36)	47.46 (42.06, 52.87)	29.23 (24.54, 33.93)	19.97 (14.42, 25.53)	8.60 (5.20, 12.01)
<b>Federal poverty level (FPL)</b>						
Below FPL	20.58 (15.19, 25.96)	25.79 (21.20, 30.39)	65.79 (58.42, 73.16)	45.24 (39.13, 51.35)	28.09 (19.84, 36.33)	9.95 (5.53, 14.36)
At or above FPL	15.77 (13.44, 18.10)	11.40 (9.65, 13.15)	43.99 (39.39, 48.59)	19.74 (16.16, 23.33)	19.02 (14.51, 23.52)	4.99 (3.04, 6.93)
<b>Education (head of household)</b>						
Less than 12th grade	23.78 (17.36, 30.21)	25.69 (20.72, 30.66)	63.31 (56.64, 69.97)	41.56 (35.00, 48.13)	27.42 (21.52, 33.31)	9.36 (6.23, 12.50)
12th grade	17.84 (13.97, 21.72)	16.26 (13.63, 18.88)	46.77 (40.37, 53.17)	28.12 (22.63, 33.61)	20.15 (11.45, 28.85)	6.38 (2.97, 9.80)
More than 12th grade	7.57 (4.95, 10.18)	9.36 (6.97, 11.75)	31.28 (22.93, 39.62)	16.27 (11.39, 21.16)	11.72 (7.15, 16.28)	4.65 (1.88, 7.43)
	Prevalence (95% CI)					
	12-15 Years - Permanent (DS)		35-44 Years - Permanent (DS)			
	NHANES I	NHANES III	NHANES I	NHANES III		
<b>Total</b>	53.19 (48.95, 57.44)	16.91 (13.86, 19.96)	40.30 (37.22, 43.37)	26.12 (23.60, 28.65)		
<b>Race/ethnicity</b>						
Non-Hispanic white	48.70 (43.81, 53.59)	13.64 (9.78, 17.49)	37.72 (34.11, 41.34)	21.90 (18.87, 24.93)		
Non-Hispanic black	65.15 (58.91, 71.39)	27.35 (22.59, 32.12)	43.39 (38.83, 47.96)	45.92 (41.60, 50.25)		
Mexican American	51.06 (40.80, 61.32)	28.34 (24.42, 32.25)	46.81 (22.93, 70.69)	33.49 (29.91, 37.08)		
<b>Gender</b>						
Male	51.03 (46.52, 55.54)	15.97 (12.53, 19.41)	43.99 (39.33, 48.66)	28.55 (25.05, 32.04)		
Female	55.42 (49.93, 60.90)	17.89 (13.38, 22.40)	36.89 (33.91, 39.86)	23.96 (20.29, 27.62)		
<b>Federal poverty level (FPL)</b>						
Below FPL	69.26 (64.17, 74.36)	29.42 (21.26, 37.59)	60.87 (53.36, 68.38)	50.74 (45.71, 55.76)		
At or above FPL	50.17 (45.59, 54.75)	13.54 (10.23, 16.84)	38.20 (35.27, 41.13)	23.07 (20.36, 25.78)		
<b>Education (head of household)*</b>						
Less than 12th grade	67.15 (62.29, 72.00)	28.71 (23.73, 33.68)	48.81 (45.13, 52.50)	47.57 (41.12, 54.01)		
12th grade	49.23 (43.21, 55.26)	20.09 (14.79, 25.39)	39.78 (35.07, 44.48)	33.14 (28.81, 37.48)		
More than 12th grade	35.68 (29.14, 42.21)	7.29 (4.22, 10.37)	32.16 (28.10, 36.22)	15.50 (13.00, 18.00)		

Data Source: The First and Third National Health and Nutrition Examination Survey (NHANES I and III) 1971-1975 and 1988-1994 respectively, National Center for Health Statistics, Center for Disease Control and Prevention.

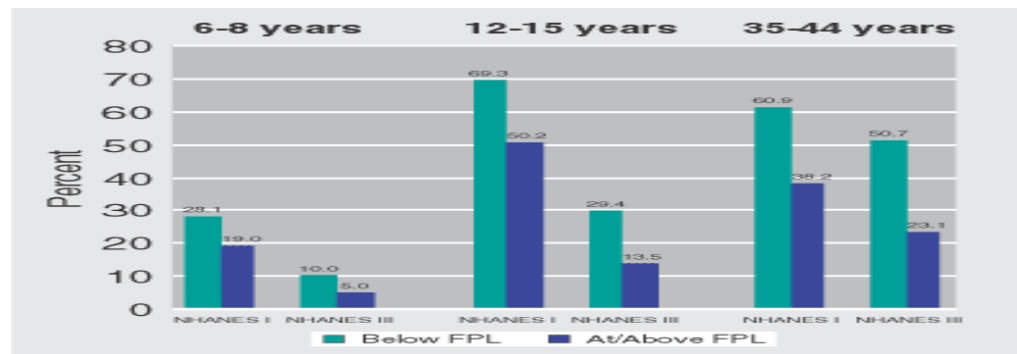
Figures 3 and 4 below display the prevalence of untreated dental caries in primary and permanent dentition that are influenced by income disparities in the population of United States. These graphs demonstrate the prevalence of dental caries among the national population of United States based on federal poverty level and clarifies that income level

significantly affects the distribution of dental caries amongst the population and follows an inverse equation. Data form these figures indicates a higher prevalence of dental caries was observed in both children and adult population that is below Federal Poverty Level (FPL) in both NHANES I and III.

**Figure 3:** Prevalence of dental caries in primary dentition by federal poverty level.



**Figure 4:** Prevalence of dental caries in permanent dentition by federal poverty level.

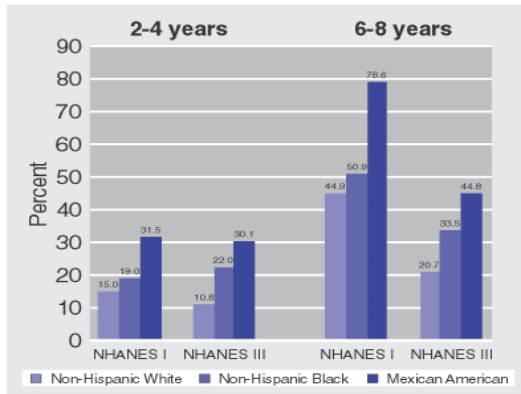


Data Source: The First and Third National Health and Nutrition Examination Survey (NHANES I and III) 1971-1975 and 1988-1994 respectively, National Center for Health Statistics, Center for Disease Control and Prevention.

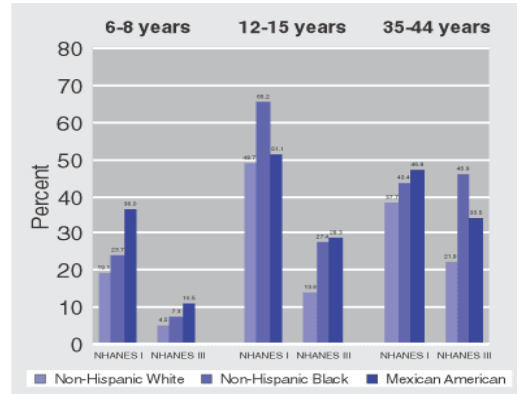
Figures 5 and 6 below demonstrate the prevalence of untreated dental caries in primary and permanent dentition influenced by racial disparities in population of United States. Data form these figures indicates a higher prevalence of dental caries was observed in Mexican-American children between the age of 6 to 8 years and a higher prevalence of dental caries in

Non-Hispanic Black adolescents between the age of 12 to 15 years in NHANES I. A higher prevalence of dental caries was also observed in the Non-Hispanic adult population between the age of 35 to 44 years in NHANES III

**Figure 5:** Prevalence of dental caries in primary dentition by age group and race/ethnicity.



**Figure 6:** Prevalence of dental caries in permanent dentition by age group and race/ethnicity.



Data Source: The First and Third National Health and Nutrition Examination Survey (NHANES I and III) 1971-1975 and 1988-1994 respectively, National Center for Health Statistics, Center for Disease Control and Prevention.

According to these surveys a significant disparity in the prevalence of dental caries is observed and is strongly affected by various economic and social determinants.

The disparities in the prevalence of dental caries caused by race/ethnicity, income and education are reduced over the past few years but have remained pervasive for several years in the US despite all the gains in the measures to improve oral health and the application of policies to reduce the burden of dental caries. [8, 9] Research indicates a linkage between income, education and race/ethnicity and the prevalence of dental caries. [10, 11, 12, 13, 14]

However, the disparities in prevalence of dental caries require continuous research in order to understand how the socioeconomic factors affect the oral health disparities for example through the lack of dental insurance, poor access to dental care, poor oral hygiene habits, cultural beliefs about dental diseases and treatment and lack of awareness about the

importance of oral health. This review evaluates the association between the socio-economic factors and dental caries disparities and aids the investigation of pathways through which income, education and race/ethnicity affect the prevalence of dental caries leading to the oral health disparities in these groups. Thus this review of literature, on the disparities in prevalence of dental caries and their underlying causes may lead to formulation of better policies and interventions to reduce the burden of dental caries and achieve a better oral health for all.

The aims of this review are to: (1) analyze and elucidate the relationship between the social and economic determinants of health like income, education and race/ethnicity with the prevalence of dental caries; and, (2) identify and understand the pathways through which these factors affect the occurrence of dental caries. This review will provide a foundation for formulation of better oral health policies by identifying the key socio-economic factors and pathways affecting the prevalence of dental caries.

## **METHODS**

This is a systematic review of literature on socioeconomic disparities in the prevalence of dental caries. All the relevant articles, surveys and reports published in English language, in past 20 years, since the year 1990 to 2010, were considered as potential references. Some web-based resources that provide information regarding dental caries prevalence in US between the year 1990 to 2010 such as the publicly available data on the websites for the Center for Disease Control and Prevention (CDC), National Institute of Health (NIH) and the National Institute of Dental and Craniofacial Research (NIDCR) were also considered in the references. The search for relevant literature was limited to data applicable to the U.S.

The search strategy included probing for pertinent peer reviewed literature, articles, surveys and reports from various sources that include the popular search engines such as Pub med, Medline and Google and the citation linker from the online library resource at the University of Texas, School of Public Health. The literature used for the purpose of this review includes articles from various peer viewed journals. The websites for the Center for Disease Control

and Prevention (CDC), National Institute of Health (NIH) and the National Institute of Dental and Craniofacial Research (NIDCR) were also included in the search for relevant data. Literature from the various published surveys' like National Health and Nutrition Examination Survey (NHANES) was also searched for the required data.

Search terms were formulated to ascertain literature relevant to the prevalence and causes of dental caries, disparities in the prevalence of dental caries caused by differences in race/ethnicity, income and education, the pathways through which these socio-economic factors lead to the disparities in the prevalence of dental caries and the current policies that aim to reduce the prevalence of dental caries. Key search terms that were designed and included are but were not limited to the following:

- dental caries
- prevalence of dental caries
- causes of dental caries disparities
- history of dental caries
- policies to reduce prevalence of dental caries
- oral health policies
- oral health statistics
- causes of dental caries
- socio-economic factors affecting prevalence of dental caries
- pathways affecting prevalence of dental caries
- symptoms of dental caries
- oral health disparities
- access to dental care

- oral health beliefs
- oral hygiene habits
- awareness about importance of oral hygiene
- social support regarding dental caries
- affordability of dental care

The literature search yielded a total of 80 relevant articles, surveys and reports. However only 13 articles, 3 reports and 2 surveys complied with the inclusion criteria and were used.

Inclusion criteria: All the articles used for the purpose of this review were selected if they complied with all the requirements of following selection criterion:

- Published in English language
- Published after the year 1990 to present.
- Disparities in dental caries prevalence in the various racial/ethnic, income and education groups in U.S. were included in the reporting, analysis and discussion of the paper or report.
- Included information about all/either the poverty index/income level, education status or the racial/ethnic status of the sample population and its effect on the prevalence of dental caries.
- Included participants between the ages of 1-65years
- Sample size included at least 40 participants

The various sub groups included in the above main groups, for the purpose of selection include the following:

Race/ethnicity: All the race/ethnicity groups identified in U.S..

Income: All the groups distinguished on the basis of Federal Poverty Level (FPL), individual income and family income.

Education: All the education groups identified in the studies/literature used for the purpose of this review.

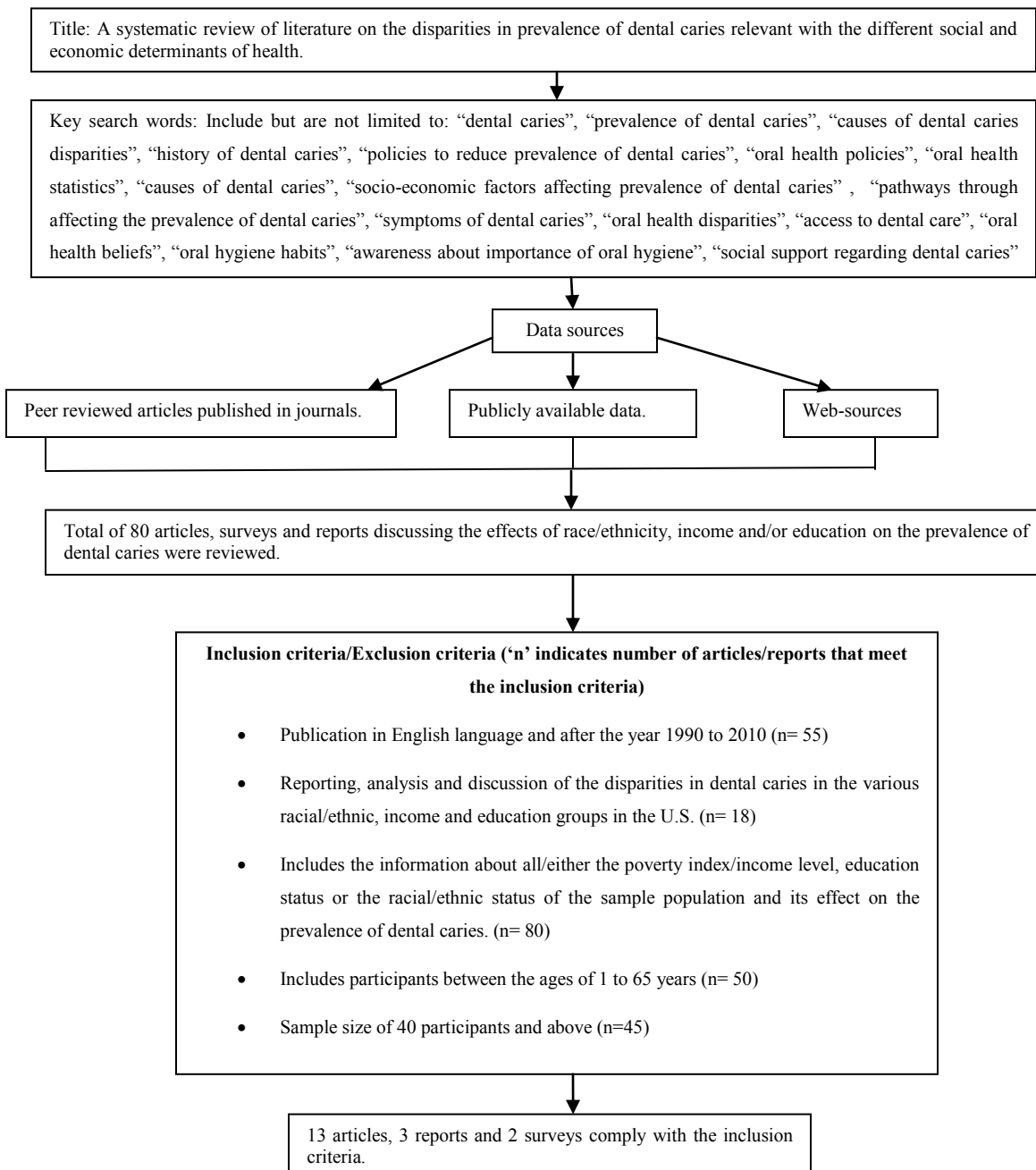
All the above factors are known to affect the prevalence of dental caries [1] due to the cultural beliefs and habits that are pertinent to the various racial/ethnic groups [7], by affecting access to dental care which is affected by the income level [22] and the basic knowledge about good general and oral health required to understand the significance of better health and the steps that are essential to maintain a good oral hygiene [17]. The age group selection for the purpose of this review is based on the fact that occurrence of dental caries is cited even at the earliest age of 1 year and most of the adults above the age of 65 years have lost their natural teeth due to some reason. [9, 20] The selection criteria for the articles and studies also required the sample size of 40 participants and above to be included in the research because a sample size of 40 participants and above provides a better representation of the community.

Exclusion criteria: All the relevant articles, studies, surveys and reports that do not completely comply with the inclusion criteria were excluded from this review.

A total of 62 articles, surveys and reports from the related literature search results for this review were excluded for reason of noncompliance with inclusion criteria.

Figure 7 below demonstrates the flowchart that describes the steps followed in the methodology during the search for relevant literature for the purpose of this review.

Figure 7: Methodology flowchart.



**Analysis:**

Data selection: A total of 80 published articles, surveys and reports were initially scrutinized that were relevant to the topic of the disparities in dental caries and discussed the effects of race/ethnicity, income and/or education on the dental caries prevalence. However 62 articles did not completely comply with the inclusion criteria and only 13 articles, 3 reports and 2 surveys fulfilled all the inclusion requirements.

Validity of data: The selected articles were scrutinized for their validity using a checklist provided in the Preferred Reporting Items for Systematic reviews and Meta Analysis (PRISMA) statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions. [31] PRISMA statement was developed by experienced authors and methodologists to provide a guideline for systematic reviews and meta analyses of evaluations of health care interventions. [31] The PRISMA statement provides a checklist of 27 items that are considered vital for transparent reporting of a systematic review [31] and is summarized with relevant examples from this review, in table 2 below. The strength of each study used in this review was calculated depending on the number of criteria in the PRISMA checklist fulfilled by the study.

Table 2: Summary of the checklist items and their examples used in the PRISMA statement. [31]

Checklist item	Example
Title: Identify the report as a systematic review, meta-analysis, or both.	“A systematic review of literature on socioeconomic disparities in the prevalence of dental caries.”
Structured summary: Provide a structured summary including, as applicable; background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	<p>“Dental caries, also known as tooth decay, are a disease of the oral cavity that affects the tooth structure and leads to the occurrence of cavities in teeth. Dental caries.....individuals.</p> <p>Objectives: The aims of this review are to (1) analyze and elucidate the relationship between the social and economic determinants of health like income, education and race/ethnicity and the prevalence of dental caries and (2) identify and understand the pathways/underlying causes through which these factors affect the occurrence of dental caries. This review.....achieves greater benefits.</p> <p>Methods: This review includes information from all the pertinent articles, reviews, surveys, reports and peer reviewed literature and web sources that were published after the year of 2000. The selection criterion.....prevalence of dental caries.</p> <p>Results: Analysis of the available literature suggests that the disparities in the prevalence of dental caries may be attributed to the differences in income, education and race/ethnicity. Higher prevalence of dental caries.....dental insurance.</p> <p>Conclusion: Disparities in the prevalence of dental caries exist in various socio-economic groups. The relationship.....oral health status.”</p>
Rationale: Describe the rationale for the review in the context of what is already known.	<p>“Various economic and social determinants of health; like race/ethnicity, income and education; render a significant effect on the prevalence and distribution of dental caries by providing risk factors for the disease like.....good oral health. Thus the study of the effects of socio-economic factors on the prevalence of dental caries is essential to understand the underlying causes of disparities, like lack of awareness about importance of oral health due to poor education, lack of access to dental care due to poverty and oral health beliefs present in specific racial/ethnic groups. Findings from these studies would provide a base for better oral health policies and interventions.</p> <p>This review discusses the disparities in the prevalence of dental caries and also reports the association between income, education and race/ethnicity and dental caries disparities and investigates the pathways/underlying causes</p>

	through which these socioeconomic factors affect the prevalence of dental caries.”
Objectives: Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	“This systematic literature review discusses the disparities in the prevalence of dental caries and also reports the association between income, education and race/ethnicity and dental caries disparities and investigates the pathways/underlying causes through which these socioeconomic factors affect the prevalence of dental caries and focuses on the literature from past 20yrs involving individuals between 1-65yrs of age from all income, education and race/ethnicity group in the community that exhibit disparities in prevalence of dental caries.”
Protocol and registration: Indicate if a review protocol exists, if and where it can be accessed and, if available, provide registration information including registration number.	Methods of the analysis and inclusion/exclusion criteria were specified in advance and documented in a thesis proposal.
Eligibility criteria: Specify study characteristics and report characteristics used as criteria for eligibility, giving rationale.	<p>“Inclusion criteria: All the articles used for the purpose of this review were selected if they comply with all the requirements of following selection criterion: Publication in English language and after the year 1990 to present.....participants and above.</p> <p>Exclusion criteria: The articles and literature were excluded form this review based on the following guidelines: Published in a language other than English.....less than 40 participants.”</p>
Information sources: Describe all information sources in the search and date last searched.	“All the relevant articles, surveys and reports published in English language, in past 20years, since the year 1990 to 2010, were considered as potential references.”
Search: Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	<p>“The search strategy included probing for pertinent peer reviewed literature, articles, surveys and reports from various sources that include the popular search engines like..... searched for the required data.”</p> <p>“Key search terms that were designed and included are but were not limited to: dental caries..... affordability of dental care”</p>
Study selection: State the process for selecting studies	“The literature search yielded total of 80 articles, surveys and reports relevant with the objectives of this review. However only 13 articles, 3 reports and 2 surveys complied with the inclusion criteria and are used for the purpose of this review.”
Data collection process: Describe method of data extraction from reports and any processes for obtaining and confirming data from	“The search strategy included probing for pertinent peer reviewed literature, articles, surveys and reports from various sources that include the popular search engines like Pub med, Medline and Google and the citation linker from

investigators.	the online library resource for University of Texas School of Public Health at Houston. The literature used for the purpose of this thesis includes articles from various peer viewed journals like the Community Dentistry and Oral Epidemiology Journal, Journal of American Dental Association, Journal of Public Health Dentistry, Public health reports, Community Dental Health, Academic Pediatrics and the American Journal of Public Health. The websites for the Center for Disease Control and Prevention (CDC), National Institute of Health (NIH) and the National Institute of Dental and Craniofacial Research (NIDCR) were also included in the search for relevant data. Literature from the various published surveys' like National Health and Nutrition Examination Survey (NHANES) was also searched for the required data."
Data items: List and define all variables for which data were sought and any assumptions and simplifications made.	"Search terms were formulated to find the literature relevant to the prevalence and causes of dental caries, disparities in the prevalence of dental caries caused by differences in race/ethnicity, income and education, the pathways through which these socio-economic factors lead to the disparities in the prevalence of dental caries and the current policies that aim to reduce the prevalence of dental caries. Key search terms that were designed and included are but were not limited to: dental caries.....affordability of dental care."
Risk of bias in individual studies: Describe methods used for assessing risk of bias of individual studies and how this information is to be used in any data synthesis.	N/A
Summary measures: State the principal summary measures.	Table 3
Synthesis of results: Describe the methods of handling data and combining results of studies, if done, including measures of consistency for each meta-analysis.	"The literature from the selected articles, reports, websites, search engines and survey's was analyzed by the comparison of results and conclusions of the selected articles and studies and was used for the purpose of this systematic review."
Risk of bias across studies: Specify any assessment of risk of bias that may affect the cumulative evidence	N/A
Additional analyses: Describe methods of additional analyses if done, indicating which were pre-specified.	"The selected articles were scrutinized for their validity using a checklist provided in the Preferred Reporting Items for Systematic reviews and Meta Analysis (PRISMA) statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions."
Study selection: Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	"A total of 80 published articles, surveys and reports were initially scrutinized that were relevant to the topic of the disparities in dental caries and discussed the effects of race/ethnicity, income and/or education on the dental caries prevalence. However 62 articles did not completely comply with the inclusion criteria and only 13 articles, 3 reports and 2 surveys fulfilled all the inclusion

	requirements.”
Study characteristics: For each study, present characteristics for which data were extracted	Table 4, Table 5 and Table 6
Risk of bias within studies: Present data on risk of bias of each study and, if available, any outcome-level assessment.	“To ascertain the validity of eligible randomized trials, pairs of reviewers working independently and with adequate reliability determined the adequacy of randomization and concealment of allocation, blinding of patients, health care providers, data collectors, and outcome assessors; and extent of loss to follow-up (i.e. proportion of patients in whom the investigators were not able to ascertain outcomes)”.
Results of individual studies: For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.	Table/figure summarizing the results of the studies: Table 4, Table 5 and Table 6
Synthesis of results: Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies: Present results of any assessment of risk of bias across studies.	N/A
Additional analysis: Give results of additional analyses, if done	“The selected articles were scrutinized for their validity using a checklist provided in the Preferred Reporting Items for Systematic reviews and Meta Analysis (PRISMA) statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions.”
Summary of evidence: Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups	“An analysis of the literature suggests that race/ethnicity, income and education affect the prevalence of dental caries and leads to disparities in different subgroups of community. The socio-economic factors have indirect effect on the level of dental caries and act through different pathways to influence the underlying factors that influence the prevalence of dental caries.”
Limitations: Discuss limitations at study and outcome level and at review level	<p>“The studies used in this review demonstrate few limitations that should be considered during the interpretation and analysis of the data. The cross-sectional study design..... social inequality like income level and education level.”</p> <p>“This review identifies the socio-economic factors affecting the prevalence of dental caries leading to disparities and also describes the pathways through which these factors affect the dental caries. However it does not elaborate on the methods to improve the oral health policies and interventions but provides a base for the policies in future by describing the relationship between the</p>

	socio-economic factors that should be addressed during policy design.”
Conclusions: Provide a general interpretation of the results in the context of other evidence, and implications for future research.	<p>“This review provides a better knowledge and understanding of the relationship...the prevalence of dental caries.”</p> <p>“This review identifies.....the socio-economic factors that should be addressed during policy design.”</p>
Funding: Describe sources of funding for the systematic review and other support role of funders for the systematic review.	N/A

Data analysis: The literature from the selected articles, reports, websites, search engines and survey's was analyzed by the comparison of results and conclusions of the selected articles and studies and was used for the purpose of this systematic review. The analysis included identifying a relation between income/education/race and the prevalence of dental caries by comparing the prevalence of dental caries in the different socio-economic groups included in the studies used for the purpose of this review. The articles were also explored to recognize and understand the mechanisms that link race/ethnicity, income and education to the prevalence of dental caries. The conclusions, derived from the results achieved after the analysis of various articles and studies included in the research are limited to the United States.

## RESULTS

A total of 80 published articles, surveys and reports, relevant to the topic of the disparities in dental caries, were reviewed and 13 articles, 3 reports and 2 surveys met the inclusion criteria and were selected for analyses. Analyses of the literature suggest that disparities exist in the prevalence of dental caries in various subgroups of community. [1] Evidence indicates a linkage between income, education and race/ethnicity and the disparities in prevalence of dental caries. [1, 11] Table 3 provide the initial summary of the disparities observed in different socio-economic groups of the community from the analyses of included literature and aids the understanding of trends in disparities of oral health relevant to socio-economic factors.

Table 3: Disparities in the prevalence of dental caries relevant to race/ethnicity, income and education.

Characteristic	Effect on the disparities in prevalence of dental caries
Overall	Non-Hispanic blacks, Hispanics, and American Indians and Alaska Natives generally have the poorest oral health of all racial and ethnic groups in the United States.
Racial/ethnic	Highest prevalence of dental caries is observed in the Mexican American and black, non-Hispanic children between 2-4yrs and 6-8yrs of age. Highest prevalence of dental caries is observed in the Black, non-Hispanic, and Mexican American adults between the ages of 35–44 years.
Education	Adults between the ages of 35–44 years with less than a high school education experience dental caries nearly three times that of adults with at least some

	college education.
Income	Highest prevalence of dental caries is observed in income groups below federal poverty level.

Tables were constructed to summarize the characteristics and key findings of the articles/studies/report used in this review to identify the association between race/ethnicity, income and education and the disparities in prevalence of dental caries. They include an explanation of the mechanism through which income, education and race/ethnicity affect the prevalence of dental caries leading to the disparities. These tables aid to better understand the association between the different socio-economic factors and the prevalence of dental caries.

#### Summary of findings:

This review includes literature from 13 articles, 3 reports and 2 surveys and the characteristics and key findings of these studies are listed in table 4. Tables 5 and 6 summarize the pathways indicated in the included literature that lead to disparities in prevalence of dental caries.

All the included literature discusses the effects of socioeconomic factors on the prevalence of dental caries however not every study uses all the included socioeconomic factors and the distribution is as follows: 12 studies discuss the effects of race/ethnicity on prevalence of dental caries, 12 studies discuss the effects of income level on prevalence of dental caries and 10 studies discuss the effects of education level on prevalence of dental caries.

Race/ethnicity: 7 studies indicate higher prevalence of dental caries in African-American/Non-Hispanic Black adult population. 10 studies indicate higher prevalence of dental caries in children of Mexican-American population

Income: 12 studies indicate higher prevalence of dental caries in low income children and adult population.

Education: 10 studies indicate higher prevalence of dental caries in low education children and adult population.

Analyses of included literature indicates the different pathways through which socioeconomic factors lead to the disparities in prevalence of dental caries and their effect on dental caries are mentioned below including the number of studies (n) that studied these pathways:

Race/ethnicity→ Cultural oral health beliefs, oral hygiene habits, social support regarding maintenance of oral hygiene , behavior patterns, religiosity→higher prevalence of dental caries in Non-Hispanic blacks, Hispanics, American Indians and Alaska Natives. (n= 7)

Income→Access to dental care, dental insurance status, affordability of dental care, access healthy foods, dental visit, treatment cost→ higher prevalence of dental caries is observed in low income groups. (n=5)

Education→ awareness about oral health, oral hygiene habits, food choices, cynicism towards dentist, frustration about dental care, brushing habits, sugar intake→ higher prevalence of dental caries is observed in low education children and adults. (n=5)

Table 4 summarizes the characteristics and key findings of the included articles, surveys and reports. Identifying characteristics will provide the information about the indicator of socio-economic factor that is affecting the dental caries prevalence, used in the study. Key findings will aid in clarification of the relation between the specific socio-economic factor and the prevalence of dental caries.

Table 4: Characteristics and key findings of studies used for this review

Name of the study	Objectives of the study/ Hypothesis tested in the study.	Methods	Results	Limitations	Strength of the study
<p><b>Articles</b></p> <p>Psychological factors and early childhood caries among low-income African-American children in Detroit</p> <p>Authors: Finlayson TL, Siefert K, Ismail AI, Sohn W</p> <p>Publication: Journal of Community Dentistry and Oral Epidemiology; 2007</p> <p>Reference: [15]</p>	<p>Objectives:</p> <p>To enhance knowledge of social determinants of health by studying how specific maternal health beliefs, behaviors and psychological factors relate to children's early childhood caries status in low income African-American population.</p>	<p>-Study design: Cross sectional study</p> <p>-Setting: Detroit</p> <p>-Participants: 1021 African-American families with at least one child under the age of 6years and living in 39 low income Census tracts in Detroit.</p> <p>-Variables: Mother's health belief scale, child's early childhood caries status</p> <p>-Data sources/ measurement: Mother's health belief scale included mother's self-efficacy, feelings of fatalism, knowledge about bottle use and children's oral hygiene needs, brushing habits, psychological measures of depressive symptoms, parenting stress and availability of social support. Child's early childhood caries status was measured using child's age, dental insurance status, dental visit history and 1-week brushing frequency and International Caries Detection and Assessment System for caries detection.</p> <p>-Study size: Data were collected from 1021 African-American families. However analysis was limited to 719 children between the age of 1-5years and their biological mothers.</p> <p>-Analytical methods: Imputation was done for individual items using Imputation and Variance Estimation software before calculating the scores for belief scales. Cases with missing demographic data were not imputed and were excluded from the analysis. Descriptive statistics for all the variables were calculated to examine their distributions.</p>	<p>Results:</p> <p>High prevalence of early childhood dental caries was observed in children living with low income African-American families. Lower rates of dental caries were found in children living with parents that have higher income and education.</p>	<p>Limitations</p> <p>The process by which social stratification leads to poor oral health in early childhood is not well understood and requires further research.</p>	<p>23/27</p>

<p>Race/ethnicity and untreated dental caries: the impact of material and behavioral factors.</p> <p>Authors: Reid BC, Hyman JJ, Macek MD</p> <p>Publication: The journal of Community Dentistry and Oral Epidemiology; 2004.</p> <p>Reference: [7]</p>	<p>Objectives:</p> <p>To use nationally representative data and group variables into categories of material and behavioral factors, and assess their relative contribution to racial/ethnic variation in untreated caries.</p>	<p>-Study design: Cross sectional study</p> <p>-Setting: U.S. population</p> <p>-Participants: Participants between the age of 20 to 50 years were derived from the Third National Health and Nutrition Examination Survey (NHANES III),.</p> <p>-Variables: Material and behavioral factors. Material factors were income, education, employment status, dental insurance status, and urban residence. Behavioral factors were marital status, tobacco use, alcohol use, obesity, and social support. Outcome variable was carious teeth.</p> <p>-Data sources/measurement: Data were derived from NHANES III and were collected through interviews and oral examination.</p> <p>-Analytical methods: Bivariate and multivariate analysis of the data was done.</p>	<p>Results:</p> <p>Non-Hispanic blacks and Mexican-Americans displayed higher prevalence of untreated caries.</p>	<p>Limitations:</p> <p>The cross-sectional study design prohibited analysis of temporal relationships and cohort effects. The lack of radiographs and the use of a conservative examination underestimated the true prevalence of dental caries among survey respondents.</p>	25/27
<p>Dental attitudes: proximal basis for oral health disparities in adults.</p> <p>Authors: Riley JL III, Gilbert GH, Heft MW</p> <p>Publication: The journal of Community dentistry and Oral epidemiology; 2006.</p> <p>Reference: [16]</p>	<p>Objectives:</p> <p>To examine longitudinal correlates of oral health and dental care using groups of people having similar attitudes and beliefs.</p>	<p>-Study design: Cross sectional study</p> <p>-Setting: Florida</p> <p>-Participants: 873 participants between the age of 35 to 55 years were included from Florida Dental Care Study</p> <p>-Variables: Classified in two categories</p> <p>Attitudinal variables: Quality of recent dental visit, Importance of preventing dental problems, eventuality of dental decline, cost has delayed dental treatment, cynicism toward dentists, effectiveness of dental care, personal influence on oral health, frustration about dental care.</p> <p>Access variables: Present financial status, dental insurance status.</p> <p>-Data sources/measurement: Data were derived from Florida Dental Care Study and were collected through interviews.</p> <p>-Study size: 873 study participants.</p> <p>-Analytical methods: Differences across clusters on oral health and oral health behaviors were tested using the Pearson chi-square test for dichotomous variables, the</p>	<p>Results:</p> <p>Individuals with higher income and education had better attitude towards oral health and had lower prevalence of dental caries.</p>	<p>Limitations:</p> <p>The dental treatment and the pain-related variables are based on self report and subject to an individual's interpretation. Also the specific reasons for treatment choices are unknown and may reflect the role of patients' choices of treatment as well as the recommendations made by their dentists. In addition the researchers did not ask about attitudes and beliefs related to the specific dental treatments.</p>	27/27

		Mantel–Haenszel chi-square trend test for ordinal variables, and Analysis of Variance for continuous variables.			
<p>Oral health disparities in children of immigrants: Dental caries experience at Enrollment and during Follow-Up in the New England Children's Amalgam Trial</p> <p>Authors: Nancy NM, ScD; Felicia T, PhD; Catherine Hayes, DMD, SM, DrMedSc; Mary Tavares, DMD, MPH</p> <p>Publication: Journal of Public Health Dentistry; 2008</p> <p>Reference: [17]</p>	<p>Objectives:</p> <p>To compare the children of immigrants to the children of US-born caregivers in their caries experience at enrollment and their new caries increments during the 5-year New England Children's Amalgam Trial</p>	<p>-Study design: Randomized controlled trial</p> <p>-Setting: Boston</p> <p>-Participants: Boston-area children aged between 6 to 10years with untreated caries.</p> <p>-Variables: Socio-demographic factors and immigrant status of caregiver and caries prevalence in children.</p> <p>-Data sources/ measurement: Data were derived from participants of New England Children's Amalgam Trial and were collected through questionnaire and oral examination.</p> <p>-Study size: 283 Boston-area children aged between 6 to 10years</p> <p>-Analytical methods: Negative binomial Model was used to evaluate the association between having an immigrant caregiver and number of carious surfaces at baseline, adjusting for age, gender, race/ethnicity.</p>	<p>Results:</p> <p>Children with immigrant parents demonstrated higher incidence of dental caries.</p>	<p>Limitations:</p> <p>Researchers ability to compare immigrant caregivers by birth country was prohibited by limited data and small sample sizes, as New England Children's Amalgam Trial was not designed to analyze directly the various effects of immigration status. Also there is substantial variability in immigrant families depending on origin country and thus the participants may not be the representative of all the children of the immigrants.</p>	24/27
<p>Assessment of the relationship between neighborhood characteristics and dental caries severity among low income African-Americans: A multilevel approach.</p>	<p>Objectives:</p> <p>To assess the relationship between neighborhood effects and the severity of dental caries among low-income African-Americans.</p>	<p>-Study design: Cross sectional study</p> <p>-Setting: Detroit</p> <p>-Participants: Adults between the age of 20 to 65 years.</p> <p>-Variables: Employment, perception of mouth and teeth, religiosity, social support, oral hygiene, total sugar intake, age, availability of dental services</p> <p>-Data sources/ measurement: This analysis uses data from the first wave of investigation of determinants of oral health disparities that was conducted by the Detroit Center for Research on Oral Health Disparities. Data were collected through questionnaire and oral examination</p>	<p>Results:</p> <p>Higher prevalence of dental caries was observed in low income African-American individuals.</p>	<p>Limitations:</p> <p>The online yellow pages directory used to obtain the number of dentists, grocery stores and churches may be incomplete, and therefore some underestimation in these exposures is possible. Also the cross-sectional nature of the data did not allow the</p>	22/27

<p>Authors: Marisol Tellez, BDS, MPH, PhD; Woosung Sohn, DDS, DrPH, PhD; Brian A. Burt, BDS, MPH, PhD; Amid I. Ismail, BDS, MPH, DrPH</p> <p>Publication: Journal of Public Health Dentistry; 2006.</p> <p>Reference: [19]</p>		<p>-Study size: 27 neighborhood clusters</p> <p>-Analytical methods: The statistical program SUDAAN was used to obtain estimates of the distribution of each individual level predictor and the bivariate association estimate with the main outcome of interest through analysis of variance.</p>		<p>investigation of the directionality of the associations or the opportunity to clarify the time frame of the exposures.</p>	
<p>Socioeconomic inequalities in oral health in childhood and adulthood in a birth cohort</p> <p>Authors: Thomson WM, Poulton R, Milne BJ, Caspi A, Broughton JR, Ayers KMS</p> <p>Publication: The journal of Community dentistry and Oral epidemiology; 2004</p> <p>Reference: [20]</p>	<p>Objectives: To determine whether adult oral health is predicted by (a) childhood socioeconomic advantage or disadvantage or (b) oral health in childhood and (c) whether oral health in adulthood is affected by changes in socioeconomic status (SES).</p>	<p>-Study design: Cohort study</p> <p>-Setting: Dunedin</p> <p>-Participants: Data for this study were obtained from assessments conducted at ages 0, 3, 5 and 26 years as part of the Dunedin Multidisciplinary Health and Development Study, a longitudinal study of children born in Dunedin during 1972–73.</p> <p>-Variables: SES in childhood, oral health status in childhood and adult SES status</p> <p>-Data sources/ measurement: Data was derived from participants of Dunedin Multidisciplinary Health and Development Study through systematic dental examination for dental caries and tooth loss at ages 5 and 26 years.</p> <p>-Study size: 789 participants</p> <p>-Analytical methods: Regression models were used to test the study hypotheses.</p>	<p>Results: Higher prevalence of dental caries was observed in low income and low education individuals.</p>	<p>Limitations: The measures of SES were limited to occupational status (parental occupation for childhood SES; study member occupation for adult SES), ignoring other potential indicators of social inequality.</p>	24/27
<p>Socioeconomic factors in adolescents'</p>	<p>Objectives: To determine whether there is</p>	<p>Study design: Cross sectional study</p> <p>-Setting: Pennsylvania.</p>	<p>Results: Lower socioeconomic</p>	<p>Limitations: The lack of use of radiographs in clinical</p>	25/27

<p>oral health: are they mediated by oral hygiene behaviors or preventive interventions?</p> <p>Authors: Polk DE, Weyant RJ, Manz MC</p> <p>Publication: The Journal of Community Dentistry and Oral Epidemiology; 2010</p> <p>Reference:[32]</p>	<p>a socioeconomic status disparity in caries experience in an adolescent sample from Pennsylvania and to determine whether differences in oral hygiene behaviors and preventive interventions account for this disparity.</p>	<p>-Participants: 9<sup>th</sup> grade and 11th grade students across Pennsylvania</p> <p>-Variables: Decayed Missing Filled Teeth (DMFT) index, socioeconomic status, brushing rate and use of dental sealants, use of dental services</p> <p>-Data sources/ measurement: Data was derived from a representative sample of 9<sup>th</sup> grade and 11th grade students across Pennsylvania and a subset of 530 parents through clinical assessment. Participating students completed a brief questionnaire regarding their oral hygiene behaviors. From this group of students, a random subsample of 530 parents completed a questionnaire assessing socioeconomic status, fluoride exposure, and recency of receipt of dental services.</p> <p>-Study size: 2251 participants</p> <p>-Analytical methods: Structural equation modeling (Mplus 5.1) was used for statistical analysis</p>	<p>status was associated with higher prevalence of DMFT and higher prevalence of severe caries.</p>	<p>examination could result in the under diagnosis of proximal lesions.</p>	
<p>Caries conditions among 2-5-year old immigrant Latino children related to parents' oral health knowledge, opinions and practices</p> <p>Authors: Watson MR, Horowitz AM, Garcia I, Canto MT</p> <p>Publication: The journal of Community Dentistry and Oral Epidemiology;</p>	<p>Objectives:</p> <p>To collect baseline data prior to initiating a community based, oral health promotion program in an inner city Latino community in Washington DC, populated by Central American immigrants.</p>	<p>Study design: Cross sectional study</p> <p>-Setting: Washington DC</p> <p>-Participants: Children between age of 2 to 5 year and their parents.</p> <p>-Variables: child's age and oral health status, parents knowledge, opinions and practices regarding oral health.</p> <p>-Data sources/ measurement: Data were derived from clinical oral examination of participating children and the survey completed by participating parents. Participating children were clinically examined for findings of dental caries. Parental interviews were carried out by trained bilingual interviewers, as part of a parallel knowledge, opinions and practices survey of parents and pregnant women.</p> <p>-Study size: 142 Children and 121 parents</p> <p>-Analytical methods: Data were analyzed for statistical associations using univariate odds ratios, Fisher's exact tests, and multiple logistic regression.</p>	<p>Results:</p> <p>The oral health status of the children and the oral health KOP of the parents in this community are alarmingly deficient.</p>	<p>Limitations:</p> <p>This study uses convenience sample and thus the findings cannot be generalized to the overall population of Washington DC inner city Latino children, ages 2-5</p>	25/27

1999 Reference:[33]					
<p>Prevalence of early childhood caries among very young urban Boston children compared with US children</p> <p>Authors: Martha E. Nunn, DDS, PhD; Thomas Dietrich, DDS, MD, MPH; Harpreet K. Singh, BS, MPH; Michelle M. Henshaw, DDS, DPH; Nancy R. Kressin, PhD</p> <p>Publication: Journal of Public health dentistry; 2009</p> <p>Reference: [34]</p>	<p>Objectives:</p> <p>To compare prevalence of early childhood caries (ECC) in 1- to 3-year-old children seeing primary-care pediatricians at two urban medical centers in Boston to the prevalence of ECC in similarly aged US children surveyed as part of the Third National Health and Nutrition Examination Survey and to assess risk factors for ECC among this cohort of children compared with risk factors among similarly aged US children.</p>	<p>Study design: Cross sectional study</p> <p>-Setting: Boston</p> <p>-Participants: Children between age of 2 to 5 years.</p> <p>-Variables: Early childhood caries, demographic and social characteristics</p> <p>-Data sources/ measurement: Data were derived from clinical oral examination of participating children and the survey completed by participating parents. Clinical oral examination was conducted on participating children and demographic, socioeconomic, and behavioral information was collected from parents/caregivers who agreed to participate in the study.</p> <p>-Study size: 787 children from two urban Boston medical centers were compared with those of 3,644 similarly aged US children surveyed as part of NHANES III.</p> <p>-Analytical methods: A multiple logistic regression model was used to assess putative risk factors and difference between groups simultaneously.</p>	<p>Results:</p> <p>Race, age, previous dental visit, parents' education, and household income were significantly associated with ECC prevalence. Parents' place of birth was a significant effect modifier with lower ECC among Boston children of immigrants than among US children of immigrants.</p>	<p>Limitations: N/A</p>	24/27
<p>Oral Health Status of San Francisco Public School Kindergarteners 2000-2005</p> <p>Authors: Lisa H. Chung, DDS, MPH; Sara G Shain, DrPH, MS; Samantha M.</p>	<p>Objectives:</p> <p>To determine the prevalence of dental caries and oral health disparities in San Francisco kindergarten public school children from 2000-2005.</p>	<p>Study design: Cross sectional study</p> <p>-Setting: San Francisco</p> <p>-Participants: Children between age of 2 to 6 years</p> <p>-Variables: prevalence of caries experience, untreated caries, treatment needs, and caries severity by child's sex, race/ethnicity, residential zip code, and a proxy for socioeconomic status.</p> <p>-Data sources/ measurement: Data were obtained from the</p>	<p>Results:</p> <p>Despite signs of improvement, caries remains a public health problem especially in Asian and Hispanic children, and children living in certain sections of San Francisco.</p>	<p>Limitations:</p> <p>The nature of oral screenings made it difficult to identify conditions not visually apparent. Since radiographs were not included, the reported levels of caries most likely underestimated the true disease prevalence. Also there</p>	24/27

<p>Stephen, RDH, MS; Jane A. Weintraub, DDS, MPH</p> <p>Publication: Journal of Public health dentistry; 2006</p> <p>Reference: [35]</p>		<p>annual Kindergarten Dental Screening Project(KDSP) conducted by the San Francisco Unified School District (SFDPH) in collaboration with the San Francisco Dental Society (SFDS) and National Dental Association (NDA) from 2000-2005 through clinical examination.</p> <p>-Study size: 3,354-3,527 participants</p> <p>-Analytical methods: Descriptive analysis with percentages and 95% confidence intervals was used to compare the proportions of dental health outcomes in various groups.</p>		<p>was annual variability in the number of participating schools and children.</p>	
<p>Dental caries prevalence and treatment levels in Arizona preschool children</p> <p>Authors: Tang JM, Altman DS, Robertson DC, O'Sullivan DM, Douglass JM, Tinanoff N.</p> <p>Publication: Public health reports; 1997</p> <p>Reference: [36]</p>	<p>Objectives: To assess the prevalence of dental caries in a large group of preschool children, to determine the extent to which the children received dental treatment, to examine the association between demographic and socioeconomic factors and the prevalence of caries, and to compare these findings with those from previous studies of preschool populations in the United States.</p>	<p>Study design: Cross sectional study</p> <p>-Setting: Arizona</p> <p>-Participants: Dental caries exams were performed on 5171 children ages 5 months through 4 years, and a parent or other caregiver was asked to complete a questionnaire giving information about the child and her or his household.</p> <p>-Variables: Caries prevalence in child, child's age, ethnicity, type of setting and type of community (urban-rural) and caregiver's reported household income and education level</p> <p>-Data sources/ measurement: Clinical examination of the participating children and questionnaire from parent/caregiver of participating children</p> <p>-Study size: 5171 participants</p> <p>-Analytical methods: A logistic regression model was employed to evaluate the association of various risk factors with caries levels.</p>	<p>Results: Children with caregivers in the lowest income category had a mean dmft score four times higher than those with caregivers in the highest category.</p>	<p>Limitations: N/A</p>	25/27
<p>Urban Mexican-American mother's beliefs about caries etiology in children</p> <p>Authors: Hoefft KS, Barker JC,</p>	<p>Objectives: To sought contextual understanding of urban, low-income Mexican-American mothers' beliefs, perceptions, knowledge and behavior surrounding causes of caries.</p>	<p>Study design: Cross sectional study</p> <p>-Setting: San Jose</p> <p>-Participants: Mexican-American adult women between age of 20 to 40 years.</p> <p>-Variables: Mother's age, number of children in family, family income, mother's education, child oral hygiene habits, number of years of residence of mother in US.</p>	<p>Results: Mothers rarely recognized cariogenic foods beyond candy, did not know or perform recommended oral hygiene routines,</p>	<p>Limitations: Limitations of this study include a small, convenience sample from a single location and socioeconomic level.</p>	25/27

<p>Masterson EE</p> <p>Publication: The Journal of Community Dentistry and Oral Epidemiology; 2010</p> <p>Reference: [37]</p>		<p>-Data sources/ measurement: Data were collected from face to face interview of Mexican-American mothers of young children from urban San Jose, California about their beliefs and knowledge about the causes of caries.</p> <p>-Study size: 48 mothers of young children</p> <p>-Analytical methods: QSR International's NVivo 7 software package (QSR International, Doncaster, Victoria, Australia) was used to assist with data analysis.</p>	<p>and demonstrated confusion and uncertainty about exactly how baby bottles are detrimental to teeth.</p>		
<p>Rural Mexican immigrant parents' interpretation of children's dental symptoms and decisions to seek treatment.</p> <p>Authors: Horton S, Barker JC</p> <p>Publication: Community Dental Health; 2009</p> <p>Reference: [38]</p>	<p>Objectives:</p> <p>To examine low-income Mexican immigrant caregivers' interpretations of their children's dental symptoms and evaluations of the need for treatment.</p>	<p>Study design: Cross sectional study</p> <p>-Setting: Small city in US (name of the city was not mentioned in the study)</p> <p>-Participants: Adults between age of 25 to 55 years.</p> <p>-Variables: Caregiver's race/ethnicity and income, immigrant caregivers' interpretations of their children's dental symptoms and evaluations of the need for treatment</p> <p>-Data sources/ measurement: Data were collected from face to face interview of low income Mexican-American immigrant caregivers from a small rural city in US about their interpretations of children's dental symptoms and evaluations of the need for treatment</p> <p>-Study size: 49 low income Mexican American immigrant caregivers.</p> <p>-Analytical methods: All interviews and fieldnotes were analyzed qualitatively through a series of readings and codings. A conceptual model of caregivers' decision-making processes was developed</p>	<p>Results: Mexican-origin children have higher rates of decay and lower dental utilization rates than children from all other racial/ethnic groups. Caregivers' interpretations of decay were shaped by their lack of experience with children's decay in rural Mexico</p>	<p>Limitations: N/A</p>	<p>24/27</p>

<p><b>Surveys</b></p> <p>NHANES III</p> <p>Authors: Nationwide survey</p> <p>Publication: 1971-75</p> <p>Reference: [11]</p>	<p>Objectives:</p> <p>To obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations.</p>	<p>-Study design: Cross sectional study</p> <p>-Setting: U.S. population</p> <p>-Participants: 33,994 persons ages 2 months and older who participated in the survey nationwide.</p> <p>-Variables: age, gender, race, ethnicity, income, education, and marital status and oral health status</p> <p>-Data sources/measurement: nationwide survey that included interview and oral examination</p> <p>-Study size: 33,994 participants</p>	<p>Results:</p> <p>Higher prevalence of dental caries is observed in low income and low education individuals. Higher prevalence of dental caries was seen in Mexican-American children and the Non-Hispanic black adult population.</p>	<p>Limitations: N/A</p>	<p>26/27</p>
<p>NHANES I</p> <p>Authors: Nationwide survey</p> <p>Publication: 1988-94</p> <p>Reference: [11]</p>	<p>Objectives:</p> <p>To obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations.</p>	<p>-Study design: Cross sectional study</p> <p>-Setting: U.S. population</p> <p>-Participants: 32,000 persons between ages of 1-74years who participated in the survey nationwide.</p> <p>-Variables: age, gender, race, ethnicity, income, education, and marital status and oral health status</p> <p>-Data sources/measurement: nationwide survey that included interview and oral examination</p> <p>-Study size: 32,000 participants</p>	<p>Results:</p> <p>Higher prevalence of dental caries is observed in low income and low education individuals. Higher prevalence of dental caries was seen in Mexican-American children and the Non-Hispanic black adult population.</p>	<p>Limitations: N/A</p>	<p>26/27</p>
<p><b>Reports</b></p> <p>Oral health in America: A surgeon general report.</p> <p>Authors: Department of Health and Human Services</p> <p>Publication: A report of the Surgeon</p>	<p>Objectives:</p> <p>To define, describe and evaluate the interaction between oral health and general health and well being through the life span, in the context of changes in society.</p>	<p>-Study design: Systematic literature review</p> <p>-Setting: This report is based on a review of the published scientific literature.</p> <p>-Participants: Involved the participants included in the different studies in literature.</p> <p>-Variables: age, gender, race, ethnicity, income, education, and marital status and oral health status</p> <p>-Data sources/measurement: scientific literature</p> <p>-Study size: Nationwide participants between the ages of 2-65years</p>	<p>Results:</p> <p>Higher prevalence of dental caries was observed in low income and low education groups. Higher prevalence of dental caries was seen in Non-Hispanic black individuals.</p>	<p>Limitations: N/A</p>	<p>27/27</p>

general; 2000. Reference: [1]					
<p>Update on disparities in oral health and access to dental care for America's children.</p> <p>Authors: Edelstein BL, Chinn CH</p> <p>Publication: Academic Pediatrics; 2009</p> <p>Reference: [39]</p>	<p>Objectives:</p> <p>To update federal survey findings on children's oral health and dental care since release of Oral Health in America: A Report of the Surgeon General in 2000.</p>	<p>-Study design: Systematic literature review</p> <p>-Setting: This report is based on a review of the published scientific literature.</p> <p>-Participants: Involved the participants included in the different studies in literature.</p> <p>-Variables: age, gender, race, ethnicity, income, education, and marital status and oral health status</p> <p>-Data sources/measurement: scientific literature</p> <p>-Study size: Nationwide participants between the ages of 2-65years</p>	<p>Results:</p> <p>Dental caries experience continued at high levels, impacting 40% of all children aged 2 to 11 years, with greater disease and untreated disease burden borne by poor and low-income children and racial/ethnic minorities.</p>	Limitations: N/A	27/27
<p>The contribution of dietary factors to dental caries and disparities in caries.</p> <p>Authors: Mobley C, Marshall TA, Milgrom P, Coldwell SE</p> <p>Publication: Academic Pediatrics; 2009</p> <p>Reference: [40]</p>	<p>Objectives:</p> <p>To analyze the contribution of dietary factors to dental caries and disparities in dental caries.</p>	<p>-Study design: Systematic literature review</p> <p>-Setting: This report is based on a review of the published scientific literature.</p> <p>-Participants: Involved the participants included in the different studies in literature.</p> <p>-Variables: age, gender, race, ethnicity, income, education, and dietary habits and choices.</p> <p>-Data sources/measurement: scientific literature</p>	<p>Results:</p> <p>Lack of availability of quality food stores in rural and poor neighborhoods, food insecurity, and changing dietary beliefs resulting from acculturation, including changes in traditional ethnic eating behaviors, can further deter healthful eating and increase risk for early childhood caries and obesity.</p>	Limitations: N/A	26/27

The tables 5 and 6 below summarize the findings of the studies focusing on the effects of race/ethnicity, income and education on the prevalence of dental caries. They focus on the mechanisms that link race/ethnicity; income and education to the prevalence of dental caries respectively. These tables demonstrate the measure of the socio-economic factor used in the study to focus on the identification of an individual factor affecting the dental caries prevalence. The following tables also indicate the theoretical mechanism invoked in the study to aid the understanding of the pathways through which these socio-economic factors affect the prevalence of dental caries and also provide information about the key findings of the studies and their implications.

Table 5: Studies focusing on the effects of race/ethnicity on the prevalence of dental caries.

Name of the study	Population of interest (Racial/ethnic group studied)	Theoretical mechanism invoked in the study	Variables used to test the empirical pathway	Pathways through which race/ethnicity affects dental caries prevalence
<p>Race/ethnicity and untreated dental caries: the impact of material and behavioral factors.</p> <p>Authors: Reid BC, Hyman JJ, Macek MD</p> <p>Publication: The journal of Community Dentistry and Oral Epidemiology; 2004.</p> <p>Reference: [7]</p>	<p>Participants were from the Third National Health and Nutrition Examination Survey (NHANES III) aged 20–50 years and from following racial/ethnic background: Non-Hispanic black, Mexican-American and Non-Hispanic white</p>	<p>To assess the relative contribution of material and behavioral factors, to racial/ethnic variation in untreated caries.</p>	<p>Variables were classified as material and behavioral factors. Material factors were income, education, employment status, dental insurance status and urban residence. Behavioral factors were marital status, tobacco use, alcohol use, obesity, and social support. Outcome variable was carious teeth.</p>	<p>Key results: Non-Hispanic blacks and Mexican-Americans displayed excess risk of untreated caries.</p> <p>Pathways: Race/ethnicity affects the distribution of dental caries in the community by affecting the factors like social support, income, education and use of tobacco/alcohol .</p>
<p>Assessment of the relationship between neighborhood characteristics and dental caries severity among low income African-Americans: A multilevel approach.</p> <p>Authors: Marisol Tellez, BDS, MPH,</p>	<p>Multilevel analyses focused on 27 neighborhood clusters and involved a combination of individual (Level-1) and neighborhood (Level-2) data including census and geocoded information and involved low income African-American families.</p>	<p>Assess the relationship between neighborhood effects and the severity of dental caries among low-income African-Americans.</p>	<p>Employment, perception of mouth and teeth, religiosity, social support, oral hygiene, total sugar intake, age, availability of dental services</p>	<p>Key results: Higher prevalence of dental caries was observed in low income African-American individuals.</p> <p>Pathways: Race/ethnicity affects the distribution of dental caries in the community by affecting factors like social support, oral hygiene habits, religiosity and oral health beliefs.</p>

PhD;				
<b>Name of the study</b>	<b>Population of interest (Racial/ethnic group studied)</b>	<b>Theoretical mechanism invoked in the study</b>	<b>Variables used to test the empirical pathway</b>	<b>Pathways through which race/ethnicity affects dental caries prevalence</b>
<p>Woosung Sohn, DDS, DrPH, PhD; Brian A. Burt, BDS, MPH, PhD; Amid I. Ismail, BDS, MPH, DrPH</p> <p>Publication: Journal of Public Health Dentistry; 2006.</p> <p>Reference: [19]</p>				
<p>Urban Mexican-American mother's beliefs about caries etiology in children</p> <p>Authors: Hoelt KS, Barker JC, Masterson EE</p> <p>Publication: The journal of</p>	<p>Convenience sample of Mexican-American mothers of young children from urban San Jose, California.</p>	<p>To sought contextual understanding of urban, low-income Mexican-American mothers' beliefs, perceptions, knowledge and behavior surrounding causes of caries.</p>	<p>Oral health beliefs, perceptions, knowledge and behavior surrounding causes of caries</p>	<p>Key results: Higher prevalence of dental caries was observed in children of low income Mexican-American caregivers.</p> <p>Pathways: Mothers rarely recognized cariogenic foods beyond candy, did not know or perform recommended oral hygiene routines, and demonstrated confusion and uncertainty about exactly how baby bottles are detrimental to teeth. Thus Race/ethnicity affects the distribution of dental caries in the community by affecting factors like oral health beliefs and oral hygiene habits.</p>

Community Dentistry and Oral Epidemiology; 2010 Reference: [37]				
<b>Name of the study</b>	<b>Population of interest (Racial/ethnic group studied)</b>	<b>Theoretical mechanism invoked in the study</b>	<b>Variables used to test the empirical pathway</b>	<b>Pathways through which race/ethnicity affects dental caries prevalence</b>
Rural Mexican immigrant parents' interpretation of children's dental symptoms and decisions to seek treatment.  Authors: Horton S, Barker JC  Publication: Community Dental Health; 2009 Reference: [38]	Low income Mexican immigrant caregivers in a small rural city in US.	To examine low-income Mexican immigrant caregivers' interpretations of their children's dental symptoms and evaluations of the need for treatment.	Interpretations of children's dental symptoms and evaluations of the need for treatment	Key results: Mexican-origin children have higher rates of decay and lower dental utilization rates than children from all other racial/ethnic groups.  Pathways: Caregivers' interpretations of decay were shaped by their lack of experience with children's decay in rural Mexico. Thus Race/ethnicity affects the distribution of dental caries in the community by affecting factors like interpretation of dental symptoms and evaluation of treatment needs.

<p>Caries conditions among 2-5year old immigrant Latino children related to parents' oral health knowledge, opinions and practices</p> <p>Authors: Watson MR, Horowitz AM, Garcia I,</p>	<p>2-5year old immigrant Latino children and their parents in an inner city Latino community in Washington DC, populated by Central American immigrants.</p>	<p>To collect baseline data prior to initiating a community based, oral health promotion program</p>	<p>Child's age and level of dental caries, parents knowledge, opinions and practices regarding oral health.</p>	<p>Key results: Higher prevalence of dental caries was observed in these 2-5year old immigrant Latino children. The oral health status of the children and the oral health knowledge, opinion and practice of the parents in this community are alarmingly deficient.</p> <p>Pathways: Race/ethnicity affects the distribution of dental caries in the community by affecting factors like oral health knowledge, opinion and practice of the parents.</p>
<b>Name of the study</b>	<b>Population of interest (Racial/ethnic group studied)</b>	<b>Theoretical mechanism invoked in the study</b>	<b>Variables used to test the empirical pathway</b>	<b>Pathways through which race/ethnicity affects dental caries prevalence</b>
<p>Canto MT</p> <p>Publication: The journal of Community Dentistry and Oral Epidemiology; 1999</p> <p>Reference: [33]</p>				
<p>NHANES III</p> <p>Authors: Nationwide survey</p> <p>Publication: 1971-75</p> <p>Reference: [11]</p>	<p>33,994 persons ages 2 months and older who participated in the survey nationwide.</p>	<p>To obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations.</p>	<p>Oral health beliefs, oral hygiene habits and social support</p>	<p>Key results: Higher prevalence of dental caries was seen in Mexican-American children and the Non-Hispanic black adult population.</p> <p>Pathways: Race/ethnicity affects the distribution of dental caries in the community by affecting factors like oral health beliefs, oral hygiene habits and social support.</p>
<p>NHANES I</p> <p>Authors: Nationwide survey</p> <p>Publication:</p>	<p>32,000 persons between ages of 1-74years who participated in the survey nationwide.</p>	<p>To obtain nationally representative information on the health and nutritional status of the population of the United States through</p>	<p>Oral health beliefs, oral hygiene habits and social support</p>	<p>Key results: Higher prevalence of dental caries was seen in Mexican-American children and the Non-Hispanic black adult population.</p> <p>Pathways: Race/ethnicity affects the distribution of dental caries in the community by affecting factors</p>

1988-94 Reference: [11]		interviews and direct physical examinations.		like oral health beliefs, oral hygiene habits and social support.
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Table 6: Studies focusing on the effects of income and education on the prevalence of dental caries.

Name of the study	Population of interest (Income and/or Education group studied)	Theoretical mechanism invoked in the study	Variables used to test the empirical pathway	Pathways through which income and education affects dental caries prevalence
<p>Socioeconomic inequalities in oral health in childhood and adulthood in a birth cohort</p> <p>Authors: Thomson WM, Poulton R, Milne BJ, Caspi A, Broughton JR, Ayers KMS</p> <p>Publication: The journal of Community dentistry and Oral epidemiology; 2004</p> <p>Reference: [20]</p>	<p>Data for this study were obtained from assessments conducted at ages 0, 3, 5 and 26 years as part of the Dunedin Multidisciplinary Health and Development Study, a longitudinal study of children born in Dunedin during 1972–73 based on their SES and level of education.</p>	<p>To determine whether adult oral health is predicted by (a) childhood socioeconomic advantage or disadvantage or (b) oral health in childhood and (c) whether oral health in adulthood is affected by changes in socioeconomic status (SES).</p>	<p>Access to dental care in childhood and in adulthood</p>	<p>Key results: Higher prevalence of dental caries was observed in low income and low education individuals.</p> <p>Pathways: Income and education affect the distribution of dental caries in the community by causing lack of access to dental care.</p>
<p>Dental attitudes: proximal basis for oral health disparities in adults.</p> <p>Authors: Riley JL III, Gilbert</p>	<p>873 participants were included from Florida Dental Care Study based in level of income and education.</p>	<p>To examine longitudinal correlation of oral health and dental care using groups of people having similar attitudes and beliefs but different income and education levels.</p>	<p>Classified in two categories:</p> <p>Attitudinal variables: Quality of recent dental visit, Importance of preventing dental problems, eventuality of dental decline, cost has delayed dental treatment, cynicism toward dentists,</p>	<p>Key results: Individuals with higher income and education had better attitude towards oral health and had lower prevalence of dental caries.</p> <p>Pathways: Income and education affect the distribution of dental caries in the community by affecting factors like attitude towards oral health, affordability of dental care and dental insurance status.</p>

GH, Heft MW Publication: The journal of Community dentistry and Oral			effectiveness of dental care, personal influence on oral health, frustration about dental care.	
<b>Name of the study</b>	<b>Population of interest (Income and/or Education group studied)</b>	<b>Theoretical mechanism invoked in the study</b>	<b>Variables used to test the empirical pathway</b>	<b>Pathways through which income and education affects dental caries prevalence</b>
epidemiology; 2006. Reference: [16]			Access variables: Present financial status, dental insurance status.	
Socioeconomic factors in adolescents' oral health: are they mediated by oral hygiene behaviors or preventive interventions?  Authors: Polk DE, Weyant RJ, Manz MC  Publication: The Journal of Community Dentistry and Oral Epidemiology; 2010 Reference:[32]	Clinical assessment was conducted on a representative sample of 9 <sup>th</sup> grade and 11th grade students across Pennsylvania.	To determine whether there is a socioeconomic status disparity in caries experience in an adolescent sample from Pennsylvania and to determine whether differences in oral hygiene behaviors and preventive interventions account for this disparity.	Decayed Missing Filled Teeth (DMFT) index, brushing rate and use of dental sealants, use of dental services	Key results: Lower socioeconomic status was associated with higher prevalence of DMFT and higher prevalence of severe caries.  Pathways: Income and education affect the distribution of dental caries in the community by affecting factors like brushing rate, use of dental sealants and use of dental service.
NHANES III Authors: Nationwide survey  Publication: 1971-75	33,994 persons ages 2 months and older who participated in the survey nationwide.	To obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical	Oral health beliefs, oral hygiene habits and social support	Key results: Higher prevalence of dental caries is observed in low income and low education individuals.  Pathways: Income and education affects the distribution of dental caries in the community by affecting factors like access to dental care, awareness about oral health, affordability of dental service and dental insurance status.

Reference: [11]		examinations.		
NHANES I Authors: Nationwide survey Publication: 1988-94 Reference: [11]	32,000 persons between ages of 1-74years who participated in the survey nationwide.	To obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations.	Oral health beliefs, oral hygiene habits and social support	Key results: Higher prevalence of dental caries is observed in low income and low education individuals.  Pathways: Income and education affects the distribution of dental caries in the community by affecting factors like access to dental care, awareness about oral health, affordability of dental service and dental insurance status.

A study implemented by Dasanayake AP and colleagues, who studied the access to oral health care services in Alabama Medicaid children suggests a significant racial disparity in the utilization of dental services, leading to a higher prevalence of dental caries, even in the Medicaid children exists and that it is the result of a complex interaction of race with the other factors such as age, gender and location. [22]

A study conducted by Reid BC and his colleagues measured the impact of material and behavioral factors among the various racial and ethnic groups concludes that addressing the material factors like income, education, employment status and dental insurance status may provide a greater reduction in untreated caries disparities among various racial groups. [7]

Analyses of all the studies used for the purpose of this review suggest that race/ethnicity, income and education affect the prevalence of dental caries and through different pathways lead to the disparities in prevalence of dental caries in different subgroups of the community. The initial analyses indicate that a higher prevalence of dental caries is observed in the African-American and Mexican-American individuals and in persons with low income and low education.

The table 4 summarizes the characteristics and key findings of the articles, surveys and the report that were used for the purpose of this review. This table aids the understanding of the relationship between the socioeconomic factors and dental caries prevalence and indicates that disparities in dental caries prevalence can be attributed to the differences in these socioeconomic factors. It can be concluded from the findings listed in table 4 that higher prevalence of dental caries is observed in the African-American and Mexican-American individuals and also in the low income and low education groups in community.

Tables 5 and 6 summarize the findings of the studies focusing on the effects of race/ethnicity, income and education on the prevalence of dental caries respectively. They focus on the mechanisms that link race/ethnicity; income and education to the prevalence of dental caries. It is evident from the findings listed in tables 5 and 6 that the socioeconomic factors cause disparities in dental caries prevalence by affecting following factors:

- Access to dental care

- Affordability of dental care
- Dental insurance status
- Awareness of importance of good oral hygiene
- Oral health beliefs
- Attitude towards oral health
- Oral health habits
- Social support

## **DISCUSSION**

Overall the evidence from the studies used in this review suggests that the socioeconomic factors like race/ethnicity, income and education significantly affect the prevalence of dental caries, leading to oral health disparities.

The growing literature on the disparities in oral health, caused by the racial/ethnic, income and education factors, documents significantly poorer oral health in the low-income and low education groups and in the non-Hispanic African Americans when compared to the high income and high education groups and the non-Hispanic whites, respectively. [1,8] Analysis of the data from these studies aids the identification of pathways through which the various socioeconomic factors lead to the oral health disparities.

Pathways through which the social and economic determinants affect the prevalence and distribution of dental caries:

Race/Ethnicity:

Race and ethnicity play a significant role in the distribution of dental caries in the community. Evident studies have proved that the prevalence of dental caries is high in the Non-Hispanic blacks and the Mexican-Americans. [3, 12, 13, 14]

Studies used in this review suggest that race and ethnicity affect the distribution of dental caries by influencing the cultural beliefs/practices and behavior patterns of an individual, [7] of specific

race/ethnicity, like the choice of food and seeking dental care which may be correlated to the specific habits/beliefs of an ethnic group. [16] Analyses of the studies used for the purpose of this study indicate that factors like religiosity, social support and oral hygiene beliefs and habits affect the prevalence of dental caries. [16, 19]

#### Income and education:

Income and education are also the key determinants of distribution of dental caries in the population. Various studies suggest that the prevalence of dental caries has an inverse proportion with the income level concluding a higher prevalence of dental caries in the lower income groups of the community and vice versa. [1, 9] In case of the children from the low income families, income status of parents, indirectly affects the child's access to dental care rendering him/her at a higher risk of occurrence of dental caries. [15] Studies from this review indicate that education plays a key role in influencing the prevalence of dental caries by affecting the awareness about the oral and general health in the population. [16] A basic high school education provides the basis for better understanding of the significance of good oral hygiene and thus aids in the better selection of food and habits to maintain a good oral health. [16] Education plays a significant role even in the children who are still in school and dependent on their parents for maintaining oral and general health. [15] Parent's education and level of awareness might indirectly affect the children's choices of food and habits and thus affect their oral health. [17] Literature provides the results of many previous studies which measured income by the eligibility for free or reduced meal program and established that the prevalence of dental caries in the elementary school children eligible for the free or reduced meal program was significantly higher than the prevalence among the children not eligible for the program and was observed as being 68% and 48% respectively. [24, 25] Literature also suggest that about 48% of the older adults with less than a high school education have lost all of their teeth as compared to 10% of the older adults with more than a high school education. [1, 16]

Analyses of studies used for the purpose of this study also indicates that income and education affect the prevalence of dental caries by affecting the factors like access to dental care, importance of good oral hygiene and affordability to receive dental care.

Table 7 below aids the understanding of various pathways through which the socioeconomic factors lead to oral health disparities by summarizing the various socioeconomic factors affecting the prevalence of dental caries and the different variables influenced by these socioeconomic factors leading to the disparities in oral health and their effect on the prevalence of dental caries.

Table 7: Pathways through which socioeconomic factors lead to oral health disparities

<b>Socioeconomic factor</b>	<b>Variables, influenced by socioeconomic factors, leading to oral health disparities</b>	<b>Effect on prevalence of dental caries</b>
Race/ethnicity	Cultural oral health beliefs, oral hygiene habits, social support, behavior patterns	Non-Hispanic blacks, Hispanics, and American Indians and Alaska Natives generally have the poorest oral health of all racial and ethnic groups in the United States.
Income	Access to dental care, dental insurance status, affordability dental care, access healthy foods.	Highest prevalence of dental caries is observed in income groups below federal poverty level.
Education	awareness about oral health, oral hygiene habits, food choices	Adults with less than a high school education experience dental caries nearly three times that of adults with at least some college education.

An analysis of the literature suggests that race/ethnicity, income and education affect the prevalence of dental caries and leads to disparities in different subgroups of community. The socio-economic factors have indirect effect on the level of dental caries and act through different pathways to influence the underlying factors that influence the prevalence of dental caries.

Limitations: The studies used in this review demonstrate few limitations that should be considered during the interpretation and analysis of the data.

The cross-sectional study design for some of the studies prohibits the analysis of temporal relationships between socioeconomic factors and prevalence of dental caries. [7, 15] The dental treatment and the pain-related variables used in a study are based on self reporting and thus are relevant to an individual's interpretation. [16] In the study with dental status of children with

immigrant parents there is significant variability in immigrant families depending on country of origin and thus the participants may not represent all the children of the immigrants. [17] The study using online yellow pages directory to obtain the number of dentists, grocery stores and churches may have incomplete/incorrect data, and may lead to biased values of these exposures. [19] In other study used for this review the measures of socioeconomic status were limited to occupational status (parental occupation for childhood SES; study member occupation for adult SES). This leads to the ignorance of other potential indicators of social inequality like income level and education level. [20]

## **CONCLUSION**

This review provides a better knowledge and understanding of (1) the relationship between the social and economic determinants of health; like the income, education and race/ethnicity; and the prevalence of dental caries and (2) the key role of these factors in causation of disparities in the prevalence of dental caries.

Dental caries are a preventable illness in both the children and adults if appropriate measures are undertaken. [26] Various policies and organizations were used to reduce the burden of higher prevalence of chronic dental caries and eliminate the disparities. [27, 28] However these policies were not customized to address the specific needs of the target population based on the different socio-economic factors. [29, 30] Thus many of the earlier policies failed to eliminate the disparities in dental caries. A multilevel approach is required to address this critical issue of high prevalence of dental caries. This review provides a foundation for formulation of better oral health policies in future that will be designed around the relationship between the income, education and race/ethnicity and the prevalence of dental caries to achieve a maximum impact and benefits to help reduce the burden of dental caries and aid the achievement of a better oral health.

This review identifies the socio-economic factors affecting the prevalence of dental caries leading to disparities and also describes the pathways through which these factors affect the dental caries. However it does not elaborate on the methods to improve the oral health policies and interventions but provides a base for the policies in future by describing the relationship

between the socio-economic factors that should be addressed during policy design. Oral health, at the individual and community level, is one of the key characteristics of population that must be addressed and improved in order to build a healthy society.

#### **TERMS AND ABBREVIATIONS USED IN THIS REVIEW**

FPL: Federal Poverty Level

NCHS: National Center for Health Statistics

NHANES: National Health and Nutrition Examination Survey

NIDR: National Institute of Dental Research

NIDCR: National Institute of Dental and Craniofacial Research

CDC: Center for Disease Control and Prevention

NIH: National Institute of Health

SES: Socioeconomic Status

PRISMA: Preferred Reporting Items for Systematic reviews and Meta Analyses

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

DMFT: Decayed Missing Filled Teeth index

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