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# A Gender-Based Approach to Oral Health Changes Across the Lifespan

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# A Gender-Based Approach to Oral Health Changes Across the Lifespan

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As many other aspects of human health, oral health differs between men and women, especially at specific life stages. Since many stages of the female life are characterized by vast changes in reproductive hormones, there are corresponding changes that occur throughout the body, including the oral cavity. The sex and age specific changes and risk factors associated with oral health are often overlooked by health care professionals and the general population. This review seeks to elucidate the particular risk factors to which women are susceptible as they age, and point out where during the life course female oral health differs from that of males. Since men and women experience different changes in general and oral health during the course of their lives, health care professionals need to make care more gender and age specific. Dentists are in a particularly good position to implement sex and age specific care because of the regularity with which it is recommended people visit their dentists. Acknowledgement that women of different ages have specific oral health concerns will likely lead to improved oral health status in women of all ages.

## **Disciplines**

Anthropology

A GENDER-BASED APPROACH TO ORAL HEALTH CHANGES ACROSS THE  
LIFESPAN

By

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In

Anthropology

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Department of Anthropology

University of Pennsylvania

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**Abstract:**

As many other aspects of human health, oral health differs between men and women, especially at specific life stages. Since many stages of the female life are characterized by vast changes in reproductive hormones, there are corresponding changes that occur throughout the body, including the oral cavity. The sex and age specific changes and risk factors associated with oral health are often overlooked by health care professionals and the general population. This review seeks to elucidate the particular risk factors to which women are susceptible as they age, and point out where during the life course female oral health differs from that of males. Since men and women experience different changes in general and oral health during the course of their lives, health care professionals need to make care more gender and age specific. Dentists are in a particularly good position to implement sex and age specific care because of the regularity with which it is recommended people visit their dentists. Acknowledgement that women of different ages have specific oral health concerns will likely lead to improved oral health status in women of all ages.

**Introduction:**

As many other aspects of human health, oral health differs between men and women and changes throughout the lifespan (Fukai et al, 1999). The issue of gender as it pertains to oral health is one that needs to be considered both from a biological and an environment point of view, as both factors play a major role in shaping the differences in oral health that are observed between men and women in all societies(Lukacs, 2008). The origin of differences in oral health may be linked to the emergence of agriculture, but there is also evidence that it may be related to certain genes on the X-chromosome related to hormones; this trend is especially evident in a woman's

reproductive life history, again showing that sex differences in oral health are influenced by both biological and environmental factors (Lukacs, 2011).

Oral health can be defined as being free of oral maladies; it is “a state a state of being free from mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal (gum) disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual’s capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing” (Sa’adu et al,2012, WHO fact sheet, 2012). There are a number of generally accepted measures that women are suggested to take in order to help maintain their oral health, including: minimizing alcohol consumption, ceasing to use tobacco, engage in physical activity, and practice good general health maintenance measures, such as eating a healthy diet (Burakoff, 2003). Maintaining good oral health is important to being a healthy individual and has a role in an individual’s longevity and happiness (Burakoff, 2003).

In this review I explore the ways that oral health changes as women age, focusing primarily on Western papers. With this data I hope to offer insight into the field of gender-based dentistry and argue how this approach could benefit all women. I start with a history of oral health research in the United States, and by defining some of the common terms used to assess oral health. I then look at factors that contribute to poor oral health within a society that are not directly related to gender and age, such as socioeconomic status and race/ethnicity. Then I summarize oral health during various life stages from childhood to menopause. Finally, I offer some recommendations for the future.

Oral Health research in the United States was recognized as a major area for improvement after World War II when government officials realized that the major reason for rejecting eligible men from the army was missing teeth (Sheridan, 1988). This inspired the

United States government to form the third section of the Institutes of National Health, National Institute of Dental Research (NIDR) in 1984 under President Truman (Sheridan, 1988). A major focus of the NIDR was to reduce the instance of dental caries among people living in the United States (Sheridan, 1988). Dental caries, even today, are used as a proxy of oral health. As Patrician Sheridan describes, “dental caries is an infectious, transmissible disease. Researchers identified the caries process as a combination of the effects of a cariogenic diet, susceptible tooth surface, and the bacterium *Streptococcus mutans* (Sheridan, 1988).” It is estimated that 51 million school hours per year are lost by American school children due to dental related illness, most commonly dental caries (McDonald et al, 2010).

During the 1970’s in the United States, the NIDR also started to look at how non-biological or microbial factors might influence oral health: these factors included behavioral, social, cultural and economic variables (Sherida, 1988). These are all issues that pertain to women, who often make less money than men and often have socially and culturally defined roles. Another factor that takes into account both the environment and biological factors is the unfortunate practice of son preference, which occurs around the world in different levels of severity, that often leads young girls to be neglected and therefore more likely to develop poor oral health, which is then left untreated (Lukacs, 2011). Furthermore, these studies focus on functions, metabolisms, and pathologies in addition to human behavior that affects oral health, oral disease preventative measures, infections, genetic aspects of oral conditions, culture and society (Sheridan, 1988). It is also important to remember that poor oral health can pose a threat to one’s quality of life, even in indirect ways, for example having decayed or missing teeth makes an individual feel less self-worth (Chavers et al, 2004). From an analysis of these factors, it is clear that certain portions of the community are at a higher risk of developing poor oral

health, and using dentistry to treat already existing conditions, as opposed to a primarily preventative measure can greatly improve oral health (Gift et al.1994). From this data it is clear that policies in the United States need to focus on making dental services more available to certain, predictable groups in the country. One of these groups that needs to be the focus of more specific dental care is women. In particular it is important that women of different life stages be given care that takes into account gender and life stage specific differences in oral health.

Oral health is a somewhat general term, but there are a number of standardized tests used to measure it. In order to look at oral health, it is important a basic understanding of the structures of the mouth, as well as an understanding of the caries process. Humans grow two sets of teeth during their lives: the primary dentition and the permanent dentition. Humans have twenty primary teeth that include four central incisors, four lateral incisors, four canines, four first molars and four second molars; these teeth are distributed symmetrically from left to right and from the top and bottom of the mouth (Wheeler, 2010). As the age, people lose their primary teeth and their permanent teeth, of which there are 32, begin to emerge. The adult dentition is different from the primary dentition in that teeth are larger and there are eight premolars and 12 molars. Each tooth has a crown portion above the gum line that is made of enamel and a root portion below the gum line that is primarily composed of cementum (Wheeler, 2010). Inside the crown and extending into the root, the tooth has a pulp chamber that connects to the pulp canal and connects the tooth to the circulatory and nervous systems (Wheeler, 2010). The outer layer of enamel is the most resistant to caries formation and demineralization; once the outer layer of enamel starts to be dissolved by cariogenic bacteria, it is increasingly for the bacteria to dissolve the tooth and eventually form a cavity (McDonald et al, 2010). Dental caries involve demineralization of part of a tooth in a specific location and are readily identifiable by trained

professionals, and can even be identified in skeletal remains, allowing caries incidence to be measured in the fossil record (Lukacs, 2008). This means that it is possible to look at dental caries throughout much of human history, and get a picture of how the dental caries process has changed with society. Dental caries form when certain aciduric bacteria—bacteria that can survive and thrive in high acid environments—combine on a tooth with sugar to produce an acid that can dissolve the enamel surrounding a tooth (McDonald et al, 2010). The sugars that are most likely to lead to caries development are simple sugars, in particular sucrose because it allows the cariogenic bacteria to form a compound called glycan, which allows the bacteria to stick to the teeth better and reduces the ability of saliva to mitigate the cariogenic bacteria by diffusing the acid and buffering the environment (Tinanoff, 2005). Cariogenic bacteria react with sugars and reduce the pH of surrounding a tooth (make the area more acidic), which is a problem when the pH is reduced to 5.2-5.5, the pH region where demineralization of enamel is observed (Tinanoff, 2005). Demineralization of enamel is a problem because it compromises the integrity of the tooth and leads to cavitation when left untreated (McDonald et al, 2010). It should also be noted that caries is considered an infectious disease because cariogenic bacteria is transmitted from mother to child through an unknown mechanism; in the absence of cariogenic bacteria, no caries formation is observed, regardless of how much simple sugar is consumed (McDonald et al, 2010). It has been suggested that if dental plaque is removed from the teeth within twelve hours of its deposition on a tooth, that enamel dissolution from exposure to sucrose will be reversed within 10 minutes due to properties of human saliva (McDonald et al, 2010). However, if the plaque is not removed within twelve hours, it takes the saliva an increasingly long time to restore the tooth and the cariogenic bacteria has a better chance of causing damage; thus it is recommended that people brush their teeth two times daily (McDonald et al, 2010).



In addition to analyzing caries, another commonly used technique for assessing an individual's oral health is the DMFT variable that looks at decayed, missing, and filled teeth (Lukacs, 2008). The higher the DMFT measurement is, the worse the status of an individual's oral health. The NIDR's discovery that increasing exposure of teeth to fluoride led to a decrease in dental decay, and that the water supply could be safely fluorinated in order to treat the maximum amount of people is the start of disease prevention in dentistry, and applies to both genders, regardless of age (Sheridan, 1988).

The environmental factors that affect oral health are many and have not all yet been studied. An individual's environment is multifaceted, but a critical environmental factor to analyze when looking at oral health is one's social environment which includes race and ethnicity, education level, social stress, peer group, community involvement, as well as the physical location where one lives. The biological factors that affect oral health are also many because both oral health and general health have a significant influence on each other (Murphey, 2012). Genetic factors underlying differences in oral health include, but are not limited to, genes that determine enamel formation, oral ecology, diversity of oral bacteria, and saliva content (Lukacs, 2011 and Tabak, 2006). It should also be noted that there does seem to be a genetic component to poor oral health within families that affects both boys and girls, and that oral bacteria passed from the mother to her child during early life introduces cariogenic bacteria to the child (McDonald et al, 2010). Remembering the interplay between the two major forces of the environment and genetics is the only way to really understand sex differences in oral health.

This paper is going to take a life history approach, meaning that it will look at changes that occur during different predictable life stages in women. Life history theory looks at evolutionary explanations to provide insight into the timing of life events, focusing on the age-

timing of fertility, growth and death, often looking at the conflict between the current generation and the resources needed from an individual to support the next generation (Hill and Kaplan, 1999). Typical life stages for humans are based on energy allocation of an individual to growth, maintenance or reproduction, with the understanding that humans are designed to allocate their energy in a way that is adaptive (Hill and Kaplan, 1999). An important aspect of this model looks at how energy is allocated to the self versus one's offspring, something that is very important when considering female oral health, particularly during pregnancy and breastfeeding (Hill and Kaplan, 1999). This model is the basis for the life stages that will be used to analyze female oral health (childhood, adolescence, young adulthood, pregnancy, menopause and old age). Although not all the aspects of female oral health have an obvious adaptive function, this is a useful framework to use in order to structure an analysis of oral health status in women of different stages of growth and development. The pattern of development and fertility in women is likely linked to women's predisposition for poor oral health in the absence of modern dentistry (Lukacs, 2011).

### **Background to Research Problem:**

There are a number of variables that lead to people around the world having different oral health statuses, one of which is gender. Other important variables include differences in race and ethnicity, differences in attitudes toward dentistry, generational differences, differences in socioeconomic status and differences in education. It is difficult to isolate a single variable when analyzing oral health because all of these factors can exacerbate or diminish the effect that gender has on one's oral health status. It is important to understand these other, non-gender based trends in oral health in order to have a full understanding of the role of gender as it pertains to modern dentistry and general health and to understand which aspects of female oral

health are based on gender in contrast to those that are primarily attributable to other factors and circumstances. It is also important to remember that the following issues are only the major variables that affect oral health and that there are more trends affecting women's oral health.

### **Race and Ethnicity:**

There have only been a few studies that look at differences in oral health between different racial and ethnic groups, but the data from the few studies seem to be in agreement. When looking at individuals that still had a least one tooth remaining in a sample of Black and White adults of at least 45 years of age in economically poor areas of Florida, Gilbert and colleagues found that African Americans were more likely than whites to have poor oral health (Gilbert et al, 1997). Specifically they found that: African Americans in this region were using dentistry to treat conditions they already had, and not as a preventative measure, unlike the white respondents, African Americans had less regular dental care, African Americans were less likely to have procedures recommended to them by dentists, African Americans were more likely to have a diseased tooth removed rather than trying non-removal procedures, and African Americans were more likely to have a tooth extraction performed by a non-professional, most often by the respondent him/herself (Gilbert et al, 1997). It is interesting to note that Gilbert and associates look at dentists' treatment and recommendations to patients as one of their variables in assessing dental health according to racial lines. Perhaps it would be more telling is the race and ethnicity of the dentists visited were also included. Another study looking at oral health in New York City looked at use of oral health services among Blacks, Puerto Ricans, Jews, White Protestants and White Catholics, with the findings that African Americans and Latinos tend to have the poorest oral health and oral hygiene and Jews tends to have best oral health and oral hygiene behaviors, followed closely by the White Protestants and Catholics (Suchman and Rothman, 1969). It is

important to note that these trends were observed regardless of the social environment of the groups, meaning that race and ethnicity may be playing an important role in the health differences between the groups (Suchman and Rothman, 1969). The authors propose that the differences in oral health between the five studied groups can be traced back to cultural factors and not social or biological ones (Suchman and Rothman, 1969). Race is a socially defined category and not a biological one, so it is not surprising that oral health studies find cultural factors related to race are responsible for differences in oral health status between races. In line with this research, other investigations have found that Whites in the United States tend to have better knowledge of dental practices, such as the reason for fluoridation of water, compared with other racial and ethnic groups (Gift et al, 1994). It was found, in particular, that across all age groups African Americans and Hispanics are the least knowledgeable about water fluoridation, how best to prevent tooth decay, preventative purpose of dental sealants, and the signs of gum disease, when compared with other racial and ethnic groups in the United States (Gift, 1994). African Americans were also the most likely group to perform self-tooth extractions and have negative attitudes towards dentists (Gilbert, 1997). All the research on oral health differences between racial and ethnic groups seems to come to the conclusion that the groups with better oral health are those that are more knowledgeable about oral related practices and behaviors (Gift et al, 1994; Suchman and Rothman, 1969; Gilbert et al, 1997). Blacks in the United States may be at a greater risk because stress is found to be cariogenic and the experience of being a minority, particularly African American, in the United States is often seen as creating high levels of stress (Hudson et al, 2007). It is found that Whites have both more knowledge about oral health and use more preventive dental behaviors than other groups in the United States (Swank, 1986). Interestingly, in a study conducted looking at dental caries development in pre-school aged

children, it was found that Hispanic children tend to have the lowest levels of *S. mutans* in their teeth, in addition to the lowest DMFT values leading the researchers to conclude that although knowledge of oral medicine and behaviors helps adults, it is not protective against dental caries and other oral diseases (Litt et al, 1995). It is interesting that the studies tend to focus on White, Hispanic and Black groups in the United States, and perhaps future research could look into the experience of other groups as well. Furthermore, it is difficult to disentangle factors that only associated with race and ethnicity from those that are attributable to other factors like socioeconomic status or education level, and to determine how much biological versus environmental factors contribute to an individual's oral health.

#### **Rural Versus Urban Community:**

It tends to be observed that those living in urban areas have better oral health and hygiene than those living in more rural areas, perhaps due to increased access to dentists and other related professionals (Suchman and Rothman, 1969). A five year study addressing the oral health issues of impoverished children in rural Kentucky where the water was originally not fluorinated found that rural children in the United States have worse oral health and oral hygiene compared to their peers living in less rural and more urban environments (Heise et al, 1973). At the end of the study, the children participating had received, on average, greater amounts of dental care than a typical child in the United States, but still had a higher rate of untreated dental caries and higher potential to develop more caries in the future (Heise, 1973). This result indicates that even before age 6, good preventive oral behaviors need to be in place to prevent poor oral health later in life. Other studies have found that urban dwellers are more likely to see a dentist for a preventative visit than those living in more rural areas, and thus tend to have less experience of chronic oral disadvantage (Chavers et al, 2004). This may be explained by the fact that there are fewer

options for dental care in rural areas, and thus there are more barriers to seeing a dentist faced by a rural-living person (Chavers et al, 2004).

### **Attitude Regarding Dentistry:**

In addition to many people not having easy access to dental professionals, another cause of poor oral health and oral behaviors has been linked to negative attitudes relating to the dental profession (Gilbert et al, 1997). It has been suggested that the link between low socioeconomic status individuals and poor oral health may be related to negative feelings toward oral health, more so than the lack of ability to pay for dental treatments, dental insurance, and ability to travel to see a dentist (Gilbert et al, 1997; Grembowski and Conrad, 1984). Those that had little information and knowledge regarding dental services—who were also found to be disproportionately African American—also had the most negative views towards dentist in a study of rural and urban dwelling adults in Florida (Gilbert et al, 1997). It was also found in this study that people with negative attitudes toward dentistry only seek oral treatment when a problem has established itself, contrasting with the observation that dentistry is best at promoting oral health when used primarily as a preventative measure (Gilbert et al, 1997; Greenberg et al, 1991; Gift et al, 1994). In another study, Gilbert found that those who use dentistry as a preventative measure, regardless of other social factors, tend to have better oral health, oral hygiene, be less likely to use tobacco and have a more complete understanding of dental science (Gilbert et al, 2000). From this research it is clear that negative attitudes toward dental professions are related to poor oral health.

### **Socioeconomic Status:**

All the research conducted looking at non-biological causes of poor oral health in a population have found a strong positive correlation between socioeconomic status and oral health. In

particular, when there is low socioeconomic status, researchers find that there is also poor oral health (Hudson et al, 2007). One of the most interesting studies investigating low socioeconomic status and oral health by measuring the DMFT, patterns of dental caries, tooth brushing, flossing, and use of dental services found that being poor at any point during childhood, even if an individual later experienced an increase in socioeconomic status, was related to worse oral health (Peres et al, 2007). The group placed adolescents who they had been following since birth into four socioeconomic categories (always poor, poor, but became non-poor, non-poor, but became poor, and never poor) (Peres et al, 2007). After analyzing the proxies selected for oral health, it was found that the always poor group had the worst oral health, and the never poor group had the best, but the results from the groups that experienced being poor at some point between childhood and adolescence were indistinguishable (Peres et al, 2007). In the five year rural Kentucky study, it was found that poor children have more caries, more negative oral health predispositions and problems, less access to dental professionals, and no way to pay for dental services (Heise et al, 1973). Even after five years of receiving the best dental care with no cost—including transportation of children to and from the dental clinic—the children in the Kentucky study still had worse teeth than the average (higher-income) American child (Heise et al, 1973). One of the problems facing poor children is that once an individual starts to develop dental caries, they have an increased risk of developing more (Litt et al, 1995). The children starting with high caries rates, especially before their adult teeth grow in, require more dental care to be at the same oral health levels as non-poor children (Heise et al, 1973). Dental caries are declining in children in the United States, even in low socioeconomic groups, mostly due to the fluorination of drinking water, however there is still much work to be done to help poor children have better oral health (Litt et al, 1995).

Socioeconomic status does not only affect the oral health of children, but also the adults. It makes sense the low socioeconomic status would be correlated with poor oral health, because dental care is often expensive and can even be viewed as a luxury, when it should be viewed as a human right (Suchman and Rothman, 1969). One study has found that not only does low socioeconomic status lead to decreased oral health, but that decreased oral health may have a strong impact on social, physical and socioeconomic status, making it even harder for an individual to receive and pay for the treatments he/she may need (Hudson, 2007). The idea is that good dentition promotes positive social interactions, while poor dentition promotes the opposite, an addition to causing stress and depression in the individual with poor dentition (Hudson, 2007). Being in a low socioeconomic group, it is more likely that an individual will experience dental extraction, as opposed to more costly measures to try and keep the tooth (Hudson, 2007). It is also important to note that low socioeconomic status individuals still have worse general health, even in countries where there is universal access to health care, so it is not simply access that is causing the poor oral health (Robert and House, 2000). People in low income groups are more likely to know less about dental care, be less trusting of dental professionals, and have more symptoms of chronic oral disadvantage (Gilbert et al, 1997; Chavers et al, 2004). As a result, it is unsurprising that the worst oral health in the United States is seen in the poorest groups (Chavers et al, 2004).

### **Historical Gender Trends:**

While it is important to understand other socially based oral health complications, the focus of this paper is modern female oral health, from a life history approach. The current situation of female oral health is very different what it has been historically and what it was while humans were evolving. To understand how the current situation was reached it is necessary to look at



female oral health historically. Although females tend to have better oral hygiene than their male counterparts at all ages and across many cultures, females have higher caries rates (Peres et al, 2007; Lukacs, 2008). A common explanation for this sex difference has been traced back to the emergence of agriculture and explained by changes in diet, and sexual division of labor, causing women to eat more cariogenic foods (Lukacs, 2008). Caries are formed from a combination of specific bacteria, acid and sugar deposited on the surface of teeth (McDonald, Avery, Stookey, Chin, Kowolik, 2010). During the agricultural revolution, the diet had a major transition from net basic (anti-cariogenic) to net acidic (pro-cariogenic); this trend seems to have influenced women more than men due to estrogen's innate cariogenic properties and the division of labor that had women primarily exposed to gathered items and men to meats—which have a lower sugar and acid content (Lukacs, 2008). With increased agriculture, there was increased settlement in one place, which led to increased fertility of the population (Lukacs, 2011). With increased number of pregnancies, the general oral health shows a greater decline in women, while men are unaffected (Lukacs, 2011). The disparity in oral health increases between the genders as a population ages, which may relate to the combination of hormones, pregnancy, dieting, morning sickness during pregnancy and other social factors applied to women (Lukacs, 2011). This explanation alone does not actually account for women's historically poor oral health. When looking at dental caries in rats, Muhler and Shafer found that increased levels of estrogen—as seen in human females—are related to an increase in dental caries rates (Muhler and Shafer, 1954). Importantly, androgens, such as testosterone, are not associated with dental caries rates, showing that male sex hormones do not have an obvious effect on oral health while female sex hormones antagonize oral health (Muhler and Shafer, 1954). There are also a number of aspects of female saliva that make women more prone to develop dental caries than men: female saliva

flows at a lower rate than in males, which leads to less clearance of foreign material deposited on teeth, and the chemical composition of saliva in women changes during pregnancy to be less able to destroy microbes and less able to buffer against ingested material (Dodds et al, 2005; Dowd, 1999; Tabak, 2006; Laine et al, 1988). Researchers have also found that changes during pregnancy in food cravings, aversions, and “morning sickness,” while beneficial to the offspring may combine to make the environment of the mouth more susceptible to dental caries (Flaxman and Sherman, 2000; Vallianatos, 2007).

Interestingly, in many cultures women now have better oral health than their male counterparts. In spite of women’s innate pro-cariogenic physiology and lifestyle, some studies have found males to have higher rates of poor oral health, such as the Peres study in Pelotas, Brazil in 1982 looking at changes in oral health from childhood to adolescence (Peres, 2007). Using different proxies of oral health (i.e. not looking only at dental caries) may yield different trends (Lukacs, 2008). It has also been found that women tend to use preventative dental behavior—defined by reason for last dental visit, time of last dental visit, frequency of brushing and/or flossing, annual dental visits, amount of carious tooth salvage, and attitude regarding water fluoridation— than men, so perhaps women’s biological predisposition to developing caries is strongly mitigated by new dental behaviors (Swank et al, 1986). It is clear that women and men have differences in oral health, regardless of the specific mechanism involved, and that these differences should be investigated to improve oral health care for both groups.

### **Methods and Results:**

This analysis of sex differences in oral health across the life span was compiled by searching for keywords on databases such as PubMed, EBSCO and JSTOR, as well as searching the contents of the University of Pennsylvania’s Dental Medicine Library, in order to find scholarly journal

articles that were relevant to oral health in women across the life span. Original keywords used to generate the articles obtained for this analysis included: female oral health, gender differences in oral health, and life history approach to female oral health. Filters were applied to the results so that only recently published articles from reputable journals looking at studies only in humans were collected. Using this approach, only a sparse number of articles were collected. The search criteria were then expanded to include key words such as: oral health during pregnancy, oral health during childhood, oral health during menopause, oral health during adolescence, effect of oral hygiene on oral health, sex difference in oral hygiene, oral health throughout life, life history theory, and life history of oral health. These new keywords were searched using similar filtering, but with a larger range of publication dates. This second round of searching yielded enough data to investigate sex differences in oral health throughout the life span. Once sufficient articles had been collected and studied, the references cited sections of those papers were used to find additional articles and studies that could contribute more information to the topic being investigated. The scarcity of articles directly pertaining to this topic indicates that more research needs to be conducted and published in order for these gender and life stage difference to be manipulated in a way that results in each individual receiving the best dental and general health care.

The articles were then separated according to the life stages to which they pertained. It was not possible to find data for every stage of development, so the articles were separated into the following categories: childhood (here taken to be age after breast-feeding ceases to age of adolescence), adolescence (age of puberty to the age of 18), young adulthood (age 18 until first pregnancy), pregnancy and early life (mother's age during first through last pregnancy and breast feeding, child's age from conception to end of breastfeeding), and older adults (age of

menopause to end of life). The ages during some of these categories may overlap, for instance there are adolescents who may become pregnant, and women also become pregnant during many stages during their lives. Another problem is that life history timing may be different between more and less Westernized cultures, making it difficult to have precisely defined categories in a paper that looks at data from around the world (Hill and Kaplan, 1999). Once the data was categorized, it was analyzed for trends that could be identified in women at different stages of their growth and development. The focus of this paper looks at trends in modern, more Western cultures, with a particular focus on the United States. However, limiting the data to only those criteria does not yield enough data for a proper analysis. Some data from before the modern era was included to demonstrate trends that have existed for much of the human experience. Despite the limitations in available data, a review of the current understanding of women's oral health across the lifespan was compiled.

## **Discussion:**

### **Childhood:**

For the purpose of this review, childhood will be defined as the stage between the age when the individual stops consuming exclusively breast milk or infant formula (between six months old and 1 year) to when they reach puberty (around the age 12). It should be noted that there are not many gender differences investigated in people during this age range, aside from in researching patterns of tooth emergence and eruption. Childhood is an important life stage for oral health because many habits are established during this period that will affect the child's predisposition to certain conditions and preferences later in life (Tinanoff, 2005). The general topics discussed in this section will include the impacts and importance of childhood diet and nutrition, oral hygiene, caries and cavitation, and tooth eruption. This is a stage where the parents or guardians

are responsible for much of an individual's oral health, establishing health promoting behaviors and avoidance of cariogenic promoting factors and taking the child to regular dental appointments as soon as the baby teeth have emerged. One barrier to oral health is that parents are not always aware of their responsibilities and/or timing of certain practices (such as dental visits, washing the gums, and avoiding sugar drinks at snack times) (McDonald et al, 2010). One study found that when parents are given guidelines on proper oral hygiene and nutrition for their children, at four years old their children had 65% fewer caries experiences than the children in the study whose parents did not receive any counseling (Kohler, 1975). Thus, childhood oral health not only depends on the child, but also on the child's parents or guardians.

The diet and nutrition of a child is important because it can affect general health, oral health and the presence or absence of caries. During different stages of childhood, the recommendations for nutrition change according to what developmental milestones the child is currently experiencing. It has been found that certain foods are cariogenic while others are anticariogenic (Tinanoff, 2005). Common cariogenic foods are often high in sugars, especially sucrose and include: candy (especially sticky or slowly eaten varieties), cookies, cake, sweetened beverages (i.e. fruit juices), fruit roll-ups, dried fruit, and breakfast bars; other foods that are cariogenic, but to a lesser extent include: fruits (non-dried), chocolate milk, and whole grain products (Tinanoff, 2005). While it is unrealistic to expect parents to completely deprive their children of these cariogenic, but popular, foods, exposure to these foods should be limited to meal times, followed by ingestion of a non-cariogenic substance or mouth cleaning of some variety to reduce synthesis of caries (Tinanoff 2005, McDonald et al, 2010). Non-cariogenic or caries preventing foods are ones that either do not contribute to the formation of caries or have a role in improving the environment of the mouth so that dental caries formation cannot occur

(McDonald, 2010). Non-cariogenic foods include cheeses (especially aged ones), nuts, dried meat sticks, plain milk (bovine or breast), vegetables, popcorn, flavored club soda, and diet sodas (Tinanoff, 2005). Although these materials will not contribute to caries, some of them should be avoided due to their choking hazard potential in children and their generally unhealthy nature (Tinanoff, 2005). A proper understanding of how foods interact with the caries process will help parents minimize oral health risks in their children.

Early in life, tooth eruption begins and so nutrition is extremely important. Most of a child's initial dietary needs are met by breast milk or some form of infant formula. Breast milk has been shown to be anticariogenic and is associated with good general health, but is typically low in fluoride (Tinanoff, 2005). Infant formula, while generally having higher fluoride content when made from water that is fluorinated, often contains sucrose and therefore it can promote caries formation, especially when a child's gums are not cleaned after consumption (Tinanoff 2005, McDonald et al, 2010). In order to make sure the child gets the recommended dose of fluoride, fluoride supplements can start to be given in children over 6 months to strengthen enamel against caries formation (McDonald et al, 2010, Tinanoff 2005). Once the child begins to make the transition from an exclusively milk diet to one that contains other sources of nutrition, it is essential that parents give their children a diet that is low in cariogenic substances (Tinanoff, 2005). It is during this stage that children start to develop their food preferences and eating habits that they will have for the rest of their lives, so establishment of a healthy diet needs to begin as soon as food is introduced to a child (Tinanoff, 2005). Children who have a higher exposure to sugar before the age of three have an elevated rate of caries compared with children who have had less exposure to sugary substances (Tinanoff, 2005). Children who are exposed more to cariogenic foods are more likely to develop preferences for these sugary foods over healthy

options, both in terms of general health and oral health, and are fatter with higher fat diets than children with lesser exposure to these substances (Tinanoff, 2005). Weight is also correlated with general and oral health complications, as well as social ones. It is also extremely important during this stage that parents do not put their children to bed with a bottle or dip the child's pacifier in a sweet substance, because this leads to prolonged exposure of the teeth to a cariogenic environment and because it decreases the body's ability to recover from cycles of demineralization (Tinanoff, 2005). Furthermore, during sleep salivary flow rates are diminished, so the bottle contents are kept on the teeth longer and the anti-cariogenic effects of the saliva and teeth are less effective when the child is asleep (McDonald et al, 2010). When children are given cariogenic foods, it should be limited to meal times and followed by consumption of an anticariogenic substance like milk or cheese, or by a rinsing of the mouth (Tinanoff, 2005). Furthermore, cariogenic treats should not be given to children as rewards, because this only makes cariogenic foods seem more desirable (Tinanoff, 2005). If cariogenic foods are limited during childhood, it seems likely that children are less likely to develop oral illnesses at all subsequent life stages.

In addition to establishing a healthy diet during childhood, it is also important to begin oral hygiene habits early in life. As soon a child begins to get teeth, their teeth should be cleaned after meals by the parents or guardians either with gauze or a soft bristled tooth brush (Fitzsimons et al, 1998). It is important that once children start to be able to brush their teeth on their own that they are monitored and are not swallowing tooth paste (Fitzsimons et al, 1998). If children accidentally swallow fluoride it is possible that they will develop fluorosis, especially if they live in an area where the water is fluorinated (Fitzsimons et al, 1998). Fitzsimons suggested a number of ways to encourage proper brushing habits, such as families brushing teeth together,

and parents praising children for brushing their teeth. The first dental appointment should occur by 1 year of age, and dental visits should occur at regular intervals thereafter; unfortunately in recent years there has been a decline in dental visits among children and an increase in cases of untreated dental decay (McDonald, 2010). If children are complaining about bleeding, mouth pain or refusing to eat or chew, it is a sign that there may be dental illness and that the parents should get their child to the dentist, even if it is not time for a regularly scheduled dental visit (Fitzsimons et al, 1998). Children with special health care needs often have different oral health risks than other children and may need to have increased dental attention in order to remain healthy (McDonald, 2010). One of the best predictors of good tooth-brushing habits in 4-5 year olds is the oral health related self-efficacy of the child's mother (Finlayson et al, 2007). Finlayson et al found that if a mother brushes her teeth at bedtime, her 1-3 year old child is expected to have a 1/3 increase in brushing frequency. The more knowledge a parent or guardian has regarding tooth-brushing and oral health, the more he/she engages in oral health promoting behaviors and the more these behaviors are seen in his/her children (Finlayson et al, 2007).

Looking at a more strictly biological factor, it has been found many times that in girls every permanent tooth erupts earlier than in boys and that tooth eruption happens at different average ages among children of different ethnic backgrounds (Kanagaratnam and Schluter, 2012). It is useful to know about ages of tooth eruption because it allows dentists to assess whether or not a child's mouth is developing at the normal pace and give advice on specific preventative techniques for a given stage of development (Kanagaratnam and Schluter, 2012). Tooth emergence (where the tooth shows up above the gum line) is a single stage in the process of tooth eruption, which is a continuous process that begins in utero (Kanagaratnam and Schluter, 2012). Kanagaratnam and Schluter did a study looking at children aged 5-13, from five



different ethnic backgrounds (European, Māori, Pasifika, Chinese, India) with roughly half girls and half boys. They found that tooth eruption occurred earlier in Pasifika and Māori children than for sex-matched Indian, Chinese and European children (Kanagaratnam and Schluter, 2012). They also discovered that in all groups, girls had their permanent teeth erupt before boys, that teeth emerged in a relatively consistent pattern (mandibular teeth emerge before maxillary ones), and that their results yielded the same conclusions as other similar studies conducted in the past (Kanagaratnam and Schluter, 2012). It is important in terms of girls having a higher rate of caries than boys that girls teeth emerge earlier, and are therefore exposed to cariogenic environments for longer periods of time than boy's permanent teeth (Kanagaratnam and Schluter, 2012).

As soon as a child has teeth, a child has the ability to develop dental caries and it has been estimated that dental caries is the single most common childhood disease (US Department of Health and Human Services, 2000). There are a number of risk factors which contribute to childhood caries development, including: children with special health care needs, especially those that impact motor cooperation, children with impaired saliva (dry mouth, viscous saliva, minimal saliva), children that do not see the dentist regularly, children with decay in the oral cavity, children with oral appliances (including braces), children with family members with decay, children exposed to sugary foods between meals, children from low socioeconomic backgrounds, and children with limited or no exposure to fluoride (McDonald et al, 2010). Once a child develops dental caries, they are increasing likely to develop subsequent oral illness (McDonald et al, 2010). Children of low socioeconomic background, regardless of race, are found to have the highest rates of dental caries when compared with other children, probably due to a number of factors (McDonald, 2010). While there does seem to be a genetic component to

the development of dental caries (mostly because of the positioning and closeness of teeth), caries development during childhood is primarily controlled by the oral environment (McDonald et al, 2010). Boys are found to have higher rates of salivary flow than girls, giving boys greater protection during childhood and at all subsequent stages of development; however, as long as girls have adequate salivary flow rates, their risk of developing dental caries is only somewhat elevated (McDonald et al, 2010). Dental caries begins in childhood, and proper management of oral health during this stage can lead to greater oral health for the rest of an individual's life.

Although there are not many differences between boys and girls that are obvious during childhood, this stage of life sets an individual up for the rest of their life. Habits and eating preferences developed in childhood are good predictors of future oral health and hygiene, and the likelihood an individual will have oral illness.

### **Adolescence:**

Adolescence is a life stage characterized by the onset of puberty, triggered by hormonal changes in an individual, which typically occurs earlier in girls (around age 8-14) than in boys (ages 10-16) and taking about three years to complete, leading to girls being more developmentally mature in this phase of their life (Ranalli and Elderkin, 2006). Since the age ranges of puberty are hard to precisely define, this paper will consider puberty to extend from about age 10 to age 18, after which is the stage of young adulthood. The adolescent phase is a particularly interesting one because it is when an individual is undergoing many psychological, hormonal, physiological changes in addition to learning to be more independent, manage emotions, and handle excess energy (Ranalli and Elderkin, 2006). Since the period of adolescence is accompanied by so many changes, it is also a period where there are a lot of changes in oral health. It is also a period where girls are experiencing events differently than boys, and with different timing, and so it

follows that there is more differentiation in the health of the two sexes, including oral health, during this life stage. Adolescents are particularly at risk for certain oral health concerns, including: a shift in the type of dental caries they develop, high-carbohydrate and high sugar diets, increased independent snacking on sugary foods and drinks, development of periodontal disease (acerbated by hormonal changes, smoking, alcohol consumption and certain sexually transmitted infections), structural/functional/esthetic problems from teeth placement or temporomandibular disorders, third molar emergence issues, oral and systemic manifestations of eating disorders (including anorexia nervosa, bulimia nervosa, and the female athlete triad), and increased potential for accidental dental trauma (Ranalli and Elderkin, 2006). Girls are at an increased risk to develop certain oral health complications (ulcers, swollen salivary glands, gingivitis and increased plaque formation, and oral herpes sores) because starting in adolescence they experience monthly menses (Burakoff, 2003). Some of the topics in oral health that are relevant during the adolescent phase include health beliefs, dental caries formation rates and contributing factors, the effects of athletics, the effects of anorexia, the development of TMD (Temporomandibular Disorder), and the effects on oral health when adolescents become pregnant.

In general girls tend to have more accurate and healthful beliefs when it comes to both oral health and general health (Broadbent et al, 2005). If one considers that health behaviors are often linked to health knowledge, than this implies that girls also have better health behaviors during adolescence. In a study looking at oral health beliefs, it was found that individuals who had better and more stable health beliefs during adolescence through adulthood had fewer missing teeth (due to caries), less periodontal disease, better oral hygiene, more restorations, and better self-rated oral health (Broadbent et al, 2005). Teeth lost to other causes, for instance injury

to the oral cavity, were excluded in analyses of oral health related to oral health beliefs (Broadbent et al, 2005). This finding is important because it implies that if good oral health beliefs and habits are established during adolescence that they are more likely to have better oral health into adulthood, promoting life-long improved oral health. On the other side, unfavorable oral health beliefs are related to worse oral health (Broadbent et al, 2005). Oral health beliefs can be looked at by asking adolescence how much they engage in the following behaviors and how important they think these behaviors are; these behaviors include: avoiding a lot of sweet food, using fluoride tooth paste, visiting the dentist regularly, keeping the teeth and gums very clean, drinking fluoridated water, and using dental floss (Broadbent et al, 2005). Researchers found that adolescent at the age of 15 believed regular dental visits were the most important of these behaviors (93.7% of 741 participants, 364 of which were female) and that they believed water fluoridation was the least important (34.7% of participants reported it to be not important) (Broadbent et al, 2005). By the age of 18, adolescents felt that keeping the teeth and gums clean was more important than regular dental visits and in addition to finding water fluoridation unimportant they also believed that using dental floss was not important (Broadbent et al, 2005). There is a trend in adolescents from age 15 to 18 to find many of the dental practices as less important, although this trend tends to reverse as individuals pass out of adolescence and into adulthood (Broadbent et al, 2005). If good oral health beliefs are taught to the adolescent, it seems reasonable to guess that these beliefs will be put into action and retained during the course of one's life. In order for adolescents to realize how important maintaining oral health is, a five stage plan has been suggested to help adolescents learn and practice more healthful practices. The five stages are awareness (adolescents need to be given information about the dental caries process), self-interest (the information presented to adolescents must be given in such a way that

the information seems personally relevant), involvement ( the adolescent accepts the information and starts to become actively involved in maintaining good oral health), action (the adolescent starts to perform oral health practices that will help him/her improve his/her oral health), and habit (after performing daily activities the oral health improving practices become part of the adolescent's every day routine) (Ricelli and Kelly, 2006). If proper oral hygiene and habits are taught to the adolescent, the adolescent is more likely to correctly realize what practices are essential for oral health. It seems that it is easier to promote these behaviors in women (Broadbent et al, 2005).

Adolescence is a phase of life when many people are engaged in athletic activities, which may have a profound impact on their oral health, for both boys and girls. It is generally found that girls suffer more accidental dental trauma than boys during athletic activity—the male-to-female ratio of traumatic dental injury is about 1.0:1.5 (Ranalli and Elderkin, 2006). It is interesting that girls suffer a higher rate of dental trauma and the current research does not provide an explanation for why this might be the case. The most common dental traumas occur in the front teeth, regardless of the sport or the region of the country that it is played in, but when looking at these statistics one needs to keep in mind that dental injuries are under reported in adolescent athletes, due to the lack of protocol to report such injuries; mouthguards are effective in protecting the teeth, oral soft tissues, and jaws of athletes, and potentially have a role in protecting against concussions (Ranalli and Elderkin, 2006). However, the most effective mouthguards are expensive and need to be custom made, so adolescent athletes are more likely to use the less effective one-size-fits-all models.

Adolescents, athletes or otherwise, are subjected to a number of pressures that can lead them to develop weight and eating problems, either leading to obesity or disordered eating.

Certain sports that emphasize weight, body appearance, and leanness encourage disordered eating, and many of these are sports that are primarily practiced by girls—gymnastics, long-distance running, synchronized swimming, figure skating, dancing, etc. (Ranalli and Elderkin, 2006). Some adolescents may be encouraged to utilize “fad” diets to help them lose weight; these diets often have the consequence of the adolescent developing deficiencies in certain nutrients that may be harmful to both oral and general health (Ranalli and Elderkin, 2006). If the adolescent is eating too high a diet in fats and sugars and not getting enough physical exercise, he or she runs the risk of becoming obese, which is associated with poor oral health, cardiovascular disease and diabetes (Ranalli and Elderkin, 2006). Other adolescents, almost exclusively girls, develop disordered eating.

In girls, one can look at three kinds of disorder eating: anorexia nervosa, bulimia nervosa, and the female athlete triad, all of which are accompanied by unhealthy weight management methods including dieting, fasting, vomiting, use of diet pills, diuretics and laxatives (Ranalli and Elderkin, 2006). Disordered eating has a negative impact on both general and oral health. The general health risks include cardiovascular problems, gastrointestinal problems, blood problems (such as anemia or thrombocytopenia), decreased reproductive health (deficiencies in estrogen and surplus of cortisol), bone loss (osteoporosis or osteopenia, which is more common in adolescent girls), problems in thermoregulation, and death (Ranalli and Elderkin 2006). These general health concerns put the individual in a position where her decreased general health can negatively affect her oral health in the absence of other factors. However, disordered eating also leads to a number of specifically oral health related problems: erosion of the teeth on the side closest to the tongue, decreased tooth height, chipped teeth, erosion of fillings/ release of fillings in treated teeth, traumatized oral mucous membranes and pharynx, dry lips, xerostomia (dry-

mouth), fluid imbalance, burning tongue sensation, decreased salivary flow, and enlarged parotid glands (Ranalli and Elderkin, 2006, Romanos et al, 2012). Dental erosion is described as the dissolution of dental hard tissue (teeth), which can lead to exposure and subsequent erosion of other dental structures and it is extremely common in eating disorder patients, especially those who use vomiting to maintain their weight (Romanos et al, 2012). The amount of dental erosion may be influenced by the number and length of purging events, oral hygiene, especially after purging, and the degree of acid dilution (i.e. rinsing the mouth to remove acid after vomiting) (Romanos et al, 2012). In anorexic patients dental erosion tends to be caused by eating a high citrus diet to limit calorie intake and in bulimic patients most dental erosion is due to purging via vomiting (Romanos et al, 2012). There is evidence that patients who exhibit vomiting behavior have in their saliva bacteria that generally only live in high acid environments, like the stomach, and presence of these organisms may be a marker of disordered eating in a patient (Romanos et al, 2012, Raid et al, 1991). Since caries are formed in part by bacteria who can live in high acid environments, increasing the number of bacteria could potentially have the effect of making the patient more likely to develop caries. Over 90% of the population with anorexia nervosa is women under the age of 25, indicating that knowledge of anorexia nervosa is a serious oral health concern for adolescent girls (Ranalli and Elderkin, 2006). There is also a somewhat questionable link between disordered eating and increased dental caries, periodontal disease, and temporomandibular disorders (Romanos et al, 2012). Anorexia nervosa is characterized by refusal to maintain a body weight that is at least the minimum normal weight, acute fear of weight gain or becoming fat, amenorrhea for at least three menstrual cycles (Ranalli and Elderkin, 2006). Bulimia nervosa is most commonly seen in late adolescents and is characterized by eating in a set amount of time a larger than typical amount of food, consuming large amounts

of food in the absence of particular craving, using inappropriate behaviors after binge eating to prevent weight gain, and being overly conscious of body shape (Ranalli and Elderkin, 2006). The female athlete triad is a condition where women become obsessed with body image and being in the best physical shape and it combines either anorexia nervosa or bulimia nervosa with intensive exercise (Ranalii and Elderkin, 2006). Adolescents with eating disorders show a heightened fear of undergoing dental treatments and general anxiety about dental appointment, exacerbating the harmful effects of the eating disorder on the oral cavity (Romanos et al, 2012). There is not a significant difference in the DMFT values of patients with eating disorders and normal control, but patients with disorder eating often have xerostomia caused by anti-depressant medications (taken for the eating disorder), eat high sugar and acid diets, and have high amounts of aciduric organisms in their impaired saliva, putting them at an increased risk for developing caries (Romanos et al, 2012). These effects may be lesser in bulimic patients who may consume large amounts of fats and dairy products during purging events, which are protective against caries (Romanos et al, 2012). The increased periodontal disease seen in eating disorder patients is most likely to do to poor oral hygiene maintenance coupled with frequent vomiting and deficiencies in certain nutrients, especially vitamin D (Javed et al, 2008). Eating disordered patients may have increased temporomandibular disorders because of the strain on that joint during vomiting episodes and damage caused by inducing vomiting (Romanos et al, 2012). It is difficult to get a full sense of the negative impact eating disorders have on oral health because many patients practice these behaviors in secret, and thus they cannot be studied in a clinical environment (Romanos et al, 2012).

Temporomandibular disorders (TMD) may begin during childhood, but most of them seem to develop during adolescence, and occur much more frequently in women than in men



(Karibe et al, 2012). TMD is generally characterized by pain around the temporomandibular joint that can be associated with pain in the neck and head, tightness in the jaw, face and neck, pain moving the jaw, painful chewing, and pain in the above stated regions during sleep (Karibe et al, 2012). TMD can be looked at on a scale of pain intensity and its degree of interference with daily life; pain associated with TMD is about twice more frequent in women and in men, begins in adolescence and typically increases with age into adulthood (Karibe et al, 2012). Karibe and his fellow researchers conducted an experiment looking at TMD in three groups of children and adolescents from California and Japan, divided according to age (group 1: ages 6-12, group 2: ages 13-15, group 3: ages 16-18) and found the most significant differences in TMD experience accorded in the oldest age group (Karibe et al, 2012). It may be noteworthy that the study was conducted through self-report data on 167 participants, 119 of which were women, and that the participants had a mean age of 14.6 (Karibe et al, 2012). Self-report data is not generally as reliable as clinical data although TMD is diagnosed based on subjective criteria so it may be easier to study through a questionnaire than other oral conditions. However, the fact that most of the participants were women and that the mean age was high given the age range being analyzed, it seems possible that the data might be skewed. In order to make sure that TMD really begins in adolescence and that it is more common in girls, further studies would need to be conducted, looking at more participants. It is found that TMD is more common in adult females than adult males in a ratio of somewhere between 3:1 to 9:1, so the finding that TMD is more common in adolescent girls seems plausible (de Leeuw, 2008). It has also been found that there are not gender differences in instances of TMD or pain associated with TMD in children in the age range of 10-16, indicating that the sex differences in TMD experience start to occur in late adolescence (List et al, 1999). It has been hypothesized that the sex differences in TMD occurs because of

something related to the female hormonal axis and that general pain in women increases with progress through the changes associated with puberty, which would also exacerbate pain related to TMD (Warren and Fried, 2001, and LeResche et al, 2007). While it seems clear that TMD affects women more than men, begins by early adolescence, and pain intensifies with age (more dramatically in women), more work needs to be done to elucidate the mechanism(s) by which TMD acts. With the discovery of the mechanism it might be possible to better alleviate the symptoms of TMD and help young women before their pain intensifies. Furthermore, since TMD is diagnosed subjectively and it requires an individual to admit feeling pain, there may be cultural factors that prevent males from reporting accurately what they are experiencing.

In adolescence, men and women both experience dental caries, but they experience caries at different rates, due to different causes, and in different parts of their teeth than their childhood counterparts (McDonald et al, 2010). Caries rates are increased in adolescents because adolescents' increased independence often leads to poor nutrition, poor oral hygiene, and specialized dental needs (e.g. orthodontics) that make dental care more complicated (Riccelli and Kelly, 2006). The single factor most likely to lead to dental decay in this age group is having low socioeconomic status, which holds true across all ethnic and racial groups in the United States (Riccelli and Kelly, 2006). Poorness is only one factor during adolescence that can contribute to dental caries, other important considerations are the facts that by age 17, 78% of adolescents have had at least one cavity or restoration (as we have already seen, once a person develops caries they are at increased risk for developing more infected teeth), and over one third of adolescents in the United States do not have access to fluoridated water (Riccelli and Kelly, 2006). It is important to identify which adolescents are at the greatest risk in order to be able to combat the dental caries diseases most effectively (Riccelli and Kelly, 2006). Adolescents at low

risks are those who have not had caries in the past year, use proper oral hygiene, drink fluoridated water, have regular dental visits and have ideal tooth morphology; adolescents who fall into this category are recommended to visit the dentist annually, reinforce their education in oral health, continue proper oral hygiene and to continue use of toothpaste containing fluoride (Riccelli and Kelly, 2006). On the other end of the spectrum are adolescents who are at a high risk for developing dental decay because they fall into the following categories: have had two or more caries in the past year, have had caries in the past, have high levels of cariogenic bacteria, have poor oral hygiene, consume a diet rich in cariogenic substances, visit the dentist irregularly, and have reduced salivary flow; more drastic recommendations are given to high risk patients in order to keep their oral health in check (Ricelli and Kelly, 2006). There are a number of ways to prevent caries formation in adolescents or both genders, regardless of whether they are considered high risk, low risk or somewhere in the middle. These prevention strategies are increased fluoride exposure, enhanced diet awareness and improved oral home care routines (McDonald et al, 2010). Adolescents are often made to feel invincible and as though health concerns do not apply to them due to their age; it is imperative that they understand their actions can have direct negative effects on their oral and general health (Riccelli and Kelley).

As indicated previously, adolescents experience different varieties of caries than younger individuals. During adolescence individuals are particularly susceptible to a condition called rampant caries that has been described as sudden, widespread, fast-acting caries that progress more quickly and affect the tooth more deeply than an ordinary cavity (McDonald et al, 2010, Massler, 1945). Rampant caries are particularly alarming because they show up in teeth that have previously appeared to be healthy and stable for any number of years (McDonald et al, 2010). Rampant caries can occur at any age, but they are particularly common during puberty, perhaps

because of changes in hormone concentrations of individuals during this life stage (McDonald et al, 2010). Rampant caries are observed in association with “repressed emotions and fears, dissatisfaction with achievement, rebellion against a home situation, a feeling of inferiority, a traumatic school experience, and continuous general tension and anxiety,” all of which are common feelings in adolescence (McDonald et al, 2010). Other factors contributing to dental caries in association with the negative feelings listed above is that emotional disturbance may lead individuals to seek comfort in high sugar foods, leading to a better environment for caries developments and that salivary deficiency is common in people with increased anxiety (McDonald et al, 2010). While there is plenty of information about adolescent dental caries, more research needs to look at caries incidence specifically in young women.

As has been discussed, there are certain oral health concerns associated with adolescence, and as will be discussed in a later section, there are also oral health concerns associated with pregnancy. Although in the United States and many Western cultures it is not considered ideal to become pregnant during adolescence, it does still occur in some young women; in fact more than 300,000 women between the ages of 15-19 become pregnant each year in the United States, and this number is considered a record low (CDC, 2010). Young women who become pregnant during adolescence are subject to certain concerns that for obvious reasons do not affect their male counterparts. Christina Murphey conducted a study looking at pregnant/parenting, adolescent women who were enrolled in school and literate in English. Since both adolescents and pregnant women are considered high risk populations, Murphey wanted to see what these young women knew about oral health, what oral health practices they engaged in, and how their oral health could be improved (Murphey, 2012). What Murphey discovered was that the women did not receive regular dental care, believed dental care would harm their children, did not

practice adequate oral hygiene, ignored oral pain, felt oral pain was unavoidable, felt oral care would make the baby come early, felt teeth were healthy if they looked “attractive,” and in general did not take steps to care for their oral cavity (Murphey, 2012). However, this study was conducted only looking at 24 young women, 18 of whom were of Hispanic or Latin descent, all of whom lived in the South Western United States, which limits the how useful this study is when looking at all pregnant and adolescent women (Murphey, 2012). The results of this study indicate the pregnant teens need to be given better information about dental care, and perhaps better access to dental care. It also indicates the need for more studies looking at pregnant teens’ oral health in the United States, ideally with a more varied subject pool. This study relied on interviews in the absence of clinical examinations. A better look at oral health in adolescents during pregnancy would include a large subject pool with individuals from many backgrounds in about equal amounts and include a formal evaluation of oral health in study subjects by a dentist.

Adolescence is a time of change in individuals in all parts of their lives, including in their mouths. Special care needs to be taken to insure that during this time of change, adolescents are maintaining their oral health and taking the current steps to avoid development of dental illness in the future. As individuals pass out of adolescence, they enter the stage of early adulthood, which is associated with a different set of special oral concerns.

### **Young Adulthood:**

After adolescence, individuals enter into young adulthood. Young adulthood will be defined as individuals, focusing on women, in between the age of 18 and the period of life when they start to have children, which can happen at any number of ages. During young adulthood, health (general and oral) is relatively stable in both men and women (Rintakoski et al, 2010). All the same sex differences in oral health that started to emerge in adolescence stabilize and hold true in

the young adult phase. During this life stage in particular, there has been research looking into the oral health attitudes of young adults and its impact on oral hygiene and oral health, the impact of orthodontic treatment on young adults and gingivitis in young adults. Gingivitis is seen more in women than men, even though women tend to have been oral hygiene and (in modern times) better oral health (Broadbent et al, 2005, Furata et al, 2011). Much of this research comes from looking at subjects outside of the United States, so one needs to remember that the data may be distorted by cultural norms observed in other parts of the world.

It has been established that there is a genetic component to tooth size, tooth shape/spacing, and caries rates in humans (Boraas et al, 1988, Conry et al, 1993). Some studies have shown that there is also some genetic component to gingivitis, periodontitis and plaque development (Michalowicz et al, 1991, Tatakis and Trombelli, 2004). One study found that the genetic component of gingivitis in adults is 36% in women and 22% in men, with the remaining factors contributing to gingivitis coming from men (Mucci et al, 2005). It is interesting that women have higher rates of gingivitis and a stronger genetic component to their gingivitis. With this data in mind, Rintakoski et al performed a study looking at self-reported oral health in young adult twins to try to establish how the genetic component of oral health may operate. The results of the study found a strong genetic component to the number of filled teeth (49% genetic in males and 68% genetic in females) and a weaker association between heritability and gingival bleeding (about 32% in both males and females) (Rintakoski et al, 2010). This data was compiled looking at a longitudinal study group of twins in Finland, and so the genetic background of those in the study was not very diverse (Rintakowski et al, 2010). Nevertheless, the results reiterate the strong genetic component of dental caries, especially in young adult women. If it is possible to use family backgrounds to tell who might be at an increased risk of

developing caries in young adulthood, those individuals could receive special care in order to reduce their caries incidence. It has been found that men actually have higher rates of periodontitis (an advanced gum disease that can form from untreated gingivitis), perhaps because female sex hormones at certain ages have a protective effect by keeping the bones in the oral cavity strong and reducing the inflammatory response in gums (Burakoff, 2003). It is also interesting that there is such a large sex differences in the observed number of filled teeth in young women compared to young men when focusing on genetic heritable (Rintakowski et al, 2010). It must be kept in mind that this data was complied through self-reporting and that a clinical evaluation is really necessary to look for signs of gingivitis and give the most accurate results regarding caries incidence. In particular, people are bad at assessing gingival bleeding and whether or not its occurrence is due to gingivitis, so it is probable that the data on gingivitis in this study may not be accurate (Rintakowski et al, 2010). Dentists are trained in looking at signs of gingivitis and so an examination would provide more accurate and reliable data. These results do indicate that different risk factors predispose men and women to caries, especially during young adulthood, and that preventative techniques should be modified for the sexes to have the best ability to combat caries development (Rintakowski et al, 2010).

Young men and women have different beliefs regarding oral health, with women tending to have more favorable, accurate and stable beliefs pertaining to dentistry (Broadbent et al, 2006). It has also been found that individuals with more stable and favorable oral health beliefs have fewer missing teeth (due to caries), less periodontal disease, greater oral hygiene, greater self-rated oral health and a greater number of restoration, while those with less favorable oral health beliefs having poorer oral health (Broadbent et al, 2006). People tend to change their minds regarding oral health practices as they age, but women start with more favorable views

and behavior and tend to have less volatile beliefs than men do (Broadbent et al, 2006). The greatest stability of beliefs from adolescence into young adulthood was thinking that it is important to keep the gums and teeth clean and the least stable belief was associated with the importance of drinking fluoridated water (Broadbent et al, 2006). A large number of young adults did not believe that using dental floss, drinking fluoridated water and avoiding consumption of sweet foods were important behaviors, and as they aged they found these behaviors increasing unimportant (Broadbent et al, 2006). As oral health beliefs became less stable, there was a trend toward worse oral health (Broadbent et al, 2006). Of the dental beliefs being tested (importance of avoiding sweet foods, using fluoride toothpaste, regular dental visits, keeping teeth and gums clean, drinking fluoridated water and using dental floss), young adult women found each of these behaviors more important than men (Broadbent et al, 2006). The important take away message of these results is that positive oral health beliefs and stability of beliefs is associated with good oral health, and that because women have better and more stable oral health beliefs, this may be why women have better oral health in modern society. It also implies that if good oral health beliefs are accepted during adolescence, they can take hold during young adulthood and lead to better oral health.

Good oral health attitudes are also associated with better oral hygiene (Ericsson et al, 2012). Once again, in young adults it was noted that better oral hygiene conditions were associated with more positive beliefs regarding oral health and that women tended to have better oral health and hygiene than their male counterparts (Ericsson et al, 2012). Ericsson et al looked at a study of young adults in Sweden who have high levels of plaque and gingivitis and do not regularly visit the dentist, in spite of having free access to dental care. Interestingly, a generally positive self perception and high self esteem have been found to correlated with more frequent



dental visits and more frequent tooth brushing in adolescents (MacGregor et al, 1997). Ericsson et al asked young adults how frequently they performed certain oral hygiene practices and how important they felt various aspects of oral health were. The results showed that most young adults believe that most important factors for their future oral health was their own efforts (and not those of a dentist), that they have quite poor knowledge of oral health, that both men and women flossed almost never (with women flossing more than men), and that many more women felt it was important to have healthy oral conditions and clean teeth than young men (Ericsson et al, 2012). Flossing is a very important part of keeping the teeth clean, so it is alarming that the flossing rate of young people is so low. Most subjects reported that they brushed their teeth twice or more daily, with women brushing twice or more daily being more numerous than men; during a clinical evaluation, it was shown that men had worse poor oral hygiene conditions, more plaque, and more cases of gingivitis (Ericsson et al, 2012). It was also found that most of the young adults felt that their teeth were esthetically pleasing and felt they had good oral health, perhaps explaining why so few of these young adults felt dental visits were important for maintain their oral health (Ericsson et al, 2012). The reason that tooth-brushing is found to be so common in young adults is hypothesized to be either health related (tooth-brushing to avoid oral health complications) or cosmetics related (tooth brushing in order to have teeth look more attractive); it was concluded that the major motivation was cosmetic related (Ericsson et al, 2012). This results implies that young adults can be encouraged to perform better oral hygiene behaviors if they believe it will improve the esthetics of their oral cavity. Other studies have concluded that young adult females have better knowledge of oral health, better attitudes toward oral health, healthier lifestyles and better oral health behaviors than men do (Furata et al, 2011). In particular, women brush their teeth, use additional cleaning devices and visit the dentist more frequently than

their age-matched male counterparts (Furata et al, 2011). Interesting, Furata et al found that knowledge, attitude and lifestyle are (indirectly) responsible for the sex differences observed in gingivitis occurrence in young people. As a result of their knowledge, health and attitude, Furata et al found that girls have lower dental plaque, calculus and gingivitis in the young adult stage. Proposed explanations for these sex differences include the idea that since the social role of women often has them being responsible for the health of their families, women are more likely to be knowledgeable and have a better attitude toward maintaining health (Furata et al, 2011). The other proposed explanation was that females are more interested in health than males and that this interest is related to women's increased knowledge in this field (Furata et al, 2011). It is interesting that men have higher rates of gingivitis than females, because females have a predisposition to gingival infection due to female sex hormones and less intense immune response, indicating how important a good oral environment is to good oral health, regardless of biological predispositions (Furata et al, 2011).

Other research in oral health during young adulthood has found that academic stress is a risk factor for dental caries and that individuals who receive orthodontic treatment during young adulthood feel they have better oral-health related quality of life compared to those who do not seek treatment, perhaps because of the social importance of the smile (Palomares et al, 2012, Mejia-Rubalcava et al, 2012). Both of these studies indicate that social factors during young adulthood have a major contribution to oral health and oral health attitude during young adulthood. As young adult females settle and start becoming pregnant, they experience a change in their oral health compared with the relative stability of young adulthood. More research needs to go into looking at oral health during young adulthood, but the available research demonstrates

that young adults are relatively healthy, and that during this stage females have better oral health, oral health beliefs, attitudes and better oral hygiene.

### **Pregnancy and Early Life:**

During pregnancy, which can occur at a wide range of ages in women—here it will look at the period of life in between young adulthood and middle adulthood—is an extremely important time to maintain good oral health. Pregnancy is a drastic change from the period of relatively stable oral health experienced during young adulthood, and it also sets the stage for the oral health of a new individual. Pregnancy is associated with physiological changes that affect the entire body, mediated by changes in hormones, which can also have an important effect on oral health. In this section, specific oral health concerns during pregnancy, changes in the body associated with pregnancy, pregnant women's knowledge of oral health and oral health related quality of life, and the interaction between fetal health and maternal oral health will be discussed. A major barrier to good oral health during pregnancy is the fact that most dentists are reluctant to treat pregnant women during the course of pregnancy; this is extremely detrimental to both maternal and fetal oral health (Fitzsimons et al, 1998). Numerous studies have found that seeing the dentist during the second trimester of pregnancy actually improves health of both the mother and child, and that many procedures, including receiving dental x-rays and having cavities filled do not harm mother or child (Dellinger and Livingston, 2006). It is unclear why dentists are taught not to treat pregnant women; this practice is a major target for reform in women's health care.

The body changes drastically during pregnancy, including significant changes in the circulatory system, respiratory system, gastrointestinal system, musculoskeletal system, and endocrine system; there are also changes in how substances affect the body, such as alcohol,

tobacco and medications (Dellinger and Livingston, 2006). The most common complications associated with these changes are nausea, vomiting (which was early established to be detrimental to oral health and aid in caries formation), congestion, heartburn, changes in food cravings, shortness of breath, and fatigue (Dellinger and Livingston, 2006). Many of the gastrointestinal changes that occur are also related to the hormone progesterone (Dellinger and Livingston, 2006). Progesterone causes the esophagus to have less peristaltic activity, increases the likelihood of vomiting and has a role in causing constipation during pregnancy (Lee et al, 2000). It is thought that progesterone plays a role in the changes that occur in the gastrointestinal tract, although the mechanism is unknown (Dellinger and Livingston, 2006). As has already been established, increased vomiting and acid around the oral cavity aid in the caries process. Furthermore, the increased acid in the oral cavity leads to increased enamel erosion, which can be hard to reverse and leaves the mouth more vulnerable. During pregnancy there are elevated levels of progesterone, estrogen, cortisol, and chorionic somatomammotropin, which among other things can lead to the development of pregnancy diabetes, which is a danger for both the mother and the child (Dellinger and Livingston, 2006). It is also important to realize that certain substances that are safe for adults to take, such as many medications, can cause serious damage to the fetus; and dosing for pregnant women is different than in normal adults because their blood is more diluted and they are experiencing changes in their metabolisms (Dellinger and Livingston, 2006). Many of the changes in the body associated with pregnancy are not directly related to oral health, but they relate to changes in general health, which does have a direct influence on oral health. These changes set the environment that leads to the large changes in oral health that women experience during pregnancy.

High levels and fluctuations of estrogen and progesterone lead to changes in oral health, with mostly negative consequences (Cottrell-Carson, 2004). Common oral problems for pregnant women include oral lesions, increase in caries formation, pregnancy oral tumors, loose teeth, gingivitis and periodontitis (Cottrell-Carson, 2004). Oral lesions are often caused by increased acid in the oral cavity, such as occurs as a result of “morning sickness” and increased acid reflux during pregnancy (Cottrell-Carson, 2004). Oral lesions can be uncomfortable, unsightly and may become infected; they can be avoided by neutralizing the acidity of the oral cavity with baking soda, rinsing the mouth with a fluoride mouth-wash, and avoiding brushing the teeth immediately after vomiting (so as not to cause further damage to the enamel) (Cottrell-Carson, 2004, Kumar and Samelson, 2007, Lewis and Milgrom, 2003). Pregnant women are at a higher risk for developing dental caries because of the increased acidity of their mouths, cravings for high sugar substances, and avoiding dental visits for fear of harming the fetus; in order to decrease the likelihood of developing caries, women should avoid cariogenic foods, brush their teeth twice a day and use a fluoride mouth-rinse (Cottrell-Carson, 2004). Although the mechanism is unclear, there is evidence that dental caries is vertically transmitted from mother to child, sometime during early life (Guler and Koprulu, 2011). If women undergo treatment during the second trimester of pregnancy to reduce the amount of *Streptococcus mutans* present in their oral cavities, then it has been shown that dental caries are reduced in the children of these mothers (Guler and Koprulu, 2011). Furthermore, it has also been shown that *S. mutans* can colonize the oral cavity even before children’s teeth have emerged, and so cleaning of the oral cavity must occur immediately after birth (Guler and Koprulu, 2011). Pregnancy oral tumors—vascular lesions caused by the increase of progesterone, local irritants and bacterial interactions—develop only rarely, are generally benign and tend to reduce in size after birth

(Cottrell-Carson, 2004). A form of estrogen has a role in the formation of both tumors and gingivitis by creating an environment that allows the bacteria *P. intermedia* to thrive (Dellinger and Livingston, 2006). These tumors are usually left alone during pregnancy unless they bleed, make chewing difficult or do not go away after delivery (Cottrell-Carson, 2004). Increased progesterone and estrogen during pregnancy affects the periodontium (the bone and ligaments supporting the teeth) in such a way that makes the teeth loose, even in the absence of gum disease; these loosened teeth will not necessarily fall out unless some other factors are present as well (Cottrell-Carson, 2002). Gingivitis (inflammation of the gum), is extremely prevalent during pregnancy and is believed to be caused by the fluctuations of progesterone and estrogen, changes in oral bacteria, and decreased immune response during pregnancy (Cottrell-Carson, 2004). Periodontitis (inflammation of the periodontium) is caused by similar factors to those that lead to the development of gingivitis in pregnant women (Cottrell-Carson, 2004). Periodontitis occurs when bacterial toxins create chronic inflammation of the periodontium, which is broken down, destroyed, and infected, eventually loosening the teeth (Cottrell-Carson, 2004). Periodontitis is particularly problematic during pregnancy because it can induce bacteremia, which triggers a hepatic acute response, which results in the production and release of cytokines, prostaglandins, and interleukins, a cascade pathway that can initiate premature labor (Cottrell-Carson, 2004, Bogges and Edelstein, 2006, Dortbudak et al, 2005). Periodontitis also causes the release of substances that can lead to low birth weight by restricting blood flow through the placenta, and causing necrosis of the placenta leading to intrauterine growth restriction (Cottrell-Carson, 2004, Offenbacher et al, 2001). It is well established the premature birth and low birth weight are associated with developmental problems in children, in particular they are the leading cause of morbidity and mortality in United States neonates (Cottrell-Carson, 2004b). Low birth weight

infants are more likely to die, and those that do survive are more likely to face brain and nervous system developmental problems, respiratory problems, and congenital complications (Cottrell-Carson, 2004b, Dasanayake, 1998). Furthermore, mothers with pre-term, low birth weight children have children with increased levels of periodontal pathogens (Cottrell-Carson, 2004b, Mitchell-Lewis et al, 2001). The damaging effects of periodontal disease on mother and child can be mitigated by cleaning the diseased gums and teeth (Jeffcoat et al, 2001).

People's teeth start to develop significantly before birth, with mineralization of primary teeth occurring 3-4 months into pregnancy, demonstrating how oral health begins very early on in an individual's life (Tinanoff, 2005). At birth, many of the teeth are already formed and by a year of life all of the teeth should ideally have emerged; unfortunately during these early stages of development it is possible to do serious and irreversible damage to the teeth and oral cavity (Tinanoff, 2005). Poor nutrition during this early stage of life leads to damaged enamel, which is in turn more susceptible to caries formation and decay (Tinanoff, 2005). Very young children and potentially fetuses are also at risk of receiving cariogenic bacteria from their mothers, increasing their risk for developing this chronic infection (Tinanoff, 2005). In order to ascertain good oral health in these young children, it is recommended that pregnant women focus on eating healthy foods, take vitamins that ensure the health of their children, limit cariogenic food consumption, and once the child is born, it is recommended that mothers do not put their children to sleep with bottles, do not give their children an excessive amount of juice, and do not cover pacifiers in sweet substances (Tinanoff, 2011). It is important to take children to the dentist early in life because once they reach the toddler stage, they may have already developed dental caries, bad eating habits and thumb-sucking behaviors, which can have negative effects on teeth development and positioning (Fitzsimons et al, 1998). Fluoride exposure becomes important in

children after birth, because that is the period when the enamel is calcifying and fluoride will best be able to protect the teeth from caries (Fitzsimons et al, 1998). During the infancy period, it is recommended that children be given fluorinated water, have their gums and erupted teeth cleaned after feedings and before bed, have access to milk at meal times as opposed to constantly, and start eating foods around 6 months (Fitzsimons et al, 1998).

During pregnancy and breastfeeding, mothers have a responsibility to manage their own oral health, as well as that of their child. It is very problematic that many pregnant women are afraid to seek dental care or are turned away from their dentists. This reflects a failure to use clinical evidence into changes in policy. Dentists and pregnant women need to be aware that there are safe ways to give and receive dental care at any stage. Denying women dental care during pregnancy only leads to decreased oral health. Now that studies have shown that most dental procedures are safe during pregnancy, and even beneficial to the mother and fetus, this information needs to be accepted and used.

### **Menopause and Post Reproductive Life:**

The period of life characterized by pregnancy and child rearing generally falls into the category of adulthood. Adulthood represents a period of similar oral health in men and women, and it is a time where oral health is generally high and people have good and stable oral hygiene. After the prime adult phase, women experience menopause which leads to many negative changes in oral health. Like pregnancy and adolescence, menopause is associated with changes in the female sex hormones; adolescence is associated with increases in sex hormones, pregnancy is associated with fluctuations in the female sex hormones, and menopause is associated with a large decline in the female sex hormones, particularly estrogens.



Menopause, which is associated with a decrease in estrogen levels at the end of a woman's reproductive years, may lead to the following oral changes: increased oral pain and discomfort, burning sensation, mucosal atrophy, osteoporosis, reduction in the bone holding the teeth in place, systematic tooth loss, and increased, irreversible periodontitis (Burakoff, 2003). Many of the symptoms can be mitigated by the use of hormone replacement therapy, but this therapy has been associated with breast cancer and therefore its usefulness is controversial (Burakoff, 2003). Pain (both oral and general) associated with menopause is likely partially psychological and partially caused by withdrawal of estrogen (Meurman et al, 2009). Menopause is associated with xerostomia (dry mouth) and reduced salivary flow (Meurman et al, 2009). Since saliva is the principal defense force in the oral cavity, a reduction in saliva and reduced salivary flow induced by menopause leaves the oral cavity more susceptible to attack by infectious agents (Meurman et al, 2009). Menopause also leads to increased inflammation in the oral cavity, which can lead to increased frequency and severity of infections (Buencamino et al, 2009). While gingivitis is reversible, if it is allowed to progress, it can develop into periodontitis, which is irreversible when it occurs in older patients (i.e. those who are experiencing menopause or are post-menopausal) (Buencamino et al, 2009). Advanced periodontitis in junction with systemic bone loss leads to loosened, diminished teeth that are more likely to be lost; as estrogen declines, the likelihood of developing osteoporosis increases, and once osteoporosis has developed, women are much more likely to lose teeth (Buencamino et al, 2009, von Wowern et al, 1994). Risk factors for osteoporosis (and indirectly periodontitis in menopausal and post menopausal women) include being female, being of white (non-Hispanic) or Asian ancestry, being thin, being of advanced age, being post-menopausal, having hyperthyroidism, having a diet low in calcium, having an inactive lifestyle, cigarette smoking, excessive consumption of

alcohol, and having low testosterone (Mulligan and Sobel, 2005). Interestingly, while fluoride is generally associated with good oral health because of its ability to protect teeth against caries, there is also evidence that fluoride contributes to loss of bone mineral density, including in the oral cavity, and this relationship strengthens with age (Mulligan and Sobel, 2005). There is also correlational data that shows that when bone decreases in other bones in the body, as happens in osteoporosis, the bone density of the jaw also decreases (Buencamino et al, 2009). Although there is substantial data showing that the decrease in estrogen and bone density are related to an increase in periodontitis, the largest factor that leads to increased periodontitis in menopausal women is caused by an increase in bacterial plaque (Buencamino et al, 2009). The later menopause occurs in women and the longer women use estrogen replacement therapies, the more teeth they are likely to retain (Muerman et al, 2009).

While menopause is clearly associated with poor oral health, there are not many studies that focus on what happens after menopause and the mechanisms by which menopause causes poor oral health. In fact many of the studies looking at menopause use information on sex hormones effects on the mouth as they related to oral contraception or pregnancy, which may not be relevant to how the sex hormones effect the body after menopause has occurred and once the body has attained a certain age (Meurman et al, 2009).

### **Conclusion:**

Having reviewed the available information, it is clear that there is a need for more research looking at women's oral health as distinct from men's oral health. It is also clear that women's oral health changes drastically as they age. Work needs to go into finding out what mechanisms the sex hormones initiate that leads to men and women having differential experience of oral

health. The specific concentrations and fluctuation in progesterone and particularly estrogen seem to pose different threat to women's oral health depending on the stage of life at which an individual is currently at. A better understanding of how the hormones work, might lead to a better way to manage hormone replacement therapy for menopausal and post-menopausal women, who seem to face the most serious life-stage-specific health risks. Understanding how the hormones interact with oral health would also help inform adolescent, pregnant and oral contraceptive using women of the implications of their life stage on their oral health.

There seems to be a large disconnect between the information that dentists know and expect their patients to know, and what patients actually are aware of when it comes to oral health. For example, many of the subjects in the various papers reviewed were unaware that the first dental visit should happen when the child is younger than two-years old. Since dental caries is such a prevalent problem in the United States, and once carious bacteria enter the oral cavity they remain there in spite of efforts to reduce the bacterial load, it makes sense that children should see the dentist early. The information in the literature focused more on the disease prevention associated with early visits, as opposed to more psychological factors. It would seem reasonable to suggest that if children go to the dentist at an early age, they will be less afraid of the dentist because they are more used to the experience. This in turn might lead to more positive views regarding dentistry, which has been established as correlated with better oral health within the population. Investigating techniques for how to make dentistry seem more positive to more people is a worthwhile endeavor and one that needs to receive more attention. Furthermore, it is a big problem that women are turned away from dentistry during pregnancy. During pregnancy women need to ensure the health of their children, and need to learn the protocol for maintaining oral health in their children during the first few years. If women are turned away from dentistry

during pregnancy, it may be a while after giving birth before they are in any condition to seek dental care, leading to decreased oral health in the mothers. Furthermore, if a dentist sees a patient during the course of her pregnancy, it provides to perfect opportunity to educate the mother on the oral health requirements of her child; something that a parent may not consider on their own until oral damage may have already been done.

This leads to a more general problem that seems to exist in terms of female oral health care. Many women seem unaware that they are prone to certain oral health concerns. It also seems that individuals are unaware how certain behaviors and life stages may directly or indirectly threaten their oral health. Most of the studies pointed to oral health concerns, and did not mention how to warn people of these concerns. An initiative needs to be taken to make people aware, especially women, of what issues specifically pertain to them and their children regarding oral health. Another general problem was that the literature focuses on biological causes of oral health problems, but not on cultural ones. The role that women play in society, the stress associated with being a women etc. are issues that are not really looked at. It is established that biological and environmental factors work together, so both of these things need to be looked at to get a comprehensive view of female oral health.

Major trends identified included that women tend to have a predisposition to poor oral health when compared with men, especially in non-Western cultures and before modern dentistry (Lukacs, 2011). A number of the social pressures applied to women during adolescence lead to their having more oral health problems than men during this stage of their life, such as the prevalence of anorexia and bulimia in young women (Romanos et al, 2012). Pregnancy has a hugely detrimental effect on oral health of women, but both healthcare professionals (including dentists) and pregnant women are unclear as to safe treatment during this stage of life (Boggess

et al, 2012, Dellinger and Livingston, 2006). Menopause is associated with increased risk of oral health complications, especially in women who also develop osteoporosis (Mulligan and Sobel, 2005). Women of all ages are more likely to develop gingivitis, which is associated with a number of more serious oral health concerns, such as periodontitis (Lukacs, 2008). These are not all the trends, but they are some of the most important and help underscore the need for more specialized dental care in the United States and around the world.

It is clear that at different stages of life, women have different oral health statuses and that female oral health is different from male oral health. More research needs to be done to further elucidate these differences and people need to be made aware of them. There is huge potential benefit to oral health of the population if dentists and other health care professionals start providing more sex specific care. The data is available, now it needs to be used to change dental education and practice to better serve individuals.

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