Streptococcus mutans **and Dental Caries in Thailand Populations**

Thesis by:

Christopher Robert Damurjian

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The oral cavity is a complex environment in which many factors influence the colonization of microorganisms. Understanding what influences the colonization of *S. mutans*, will shed light on the development of dental caries. Project taken part in rural and urban communities in Thailand, have evaluated the presences and the impact of early childhood caries. Studies evaluates the relationship between mother - newborn interactions, oral environment, diet, nutrition, and oral hygiene practices to fully understand what these factors have on the relationship of S. mutans and dental caries, to create better preventive care.

Classification of S. mutans

In 1924, J. Kilian Clarke first discover *Streptococcus mutans,* when it was isolate from a human carious lesion leading to further confirmation of the connection between *S. mutans* and the formation of dental caries (3). Part of the genus *Streptococcus,* S. *mutans* is a gram positive facultative anaerobic bacteria, that thrives in the oral environment when there is a high pH along with a temperature of 64 to 104 degrees Fahrenheit (3). Commonly found in the oral cavity, S. *mutans* is the leading cause of dental caries (4). *S. mutans* is one of the twenty-five species of oral streptococci that are found in the oral cavity. This accounts for 20 percent of the total oral bacteria (3). In the oral cavity, *S. mutans*, *S. sanguinis*, *S. salivarius,* and *S. mitis,* are the most colonized streptococci bacterias (7). *S. mutans* has a large impact on tooth decay affecting chewing, nutrition intake, speech, and infections. *S. mutans* metabolize sugars and carbohydrates to produce lactic acid, causing dental caries to form (1).

Kelstrup and Gibbons studied oral streptococci growth on Typticases agar plates from 13 oral streptococci tests. This study showed that strains of streptococci formed zones of inhibition against *S. pyogens* and enterococci along with other streptococci strains when tested on agar plates (3). The relationship between streptococci strains, staphylococci, and lactobacilli along with other unrelated bacterias were observed, indicating that there were no zones against each other formed on agar plates (3). This suggests that there could have not been the presence of a virus that effected the growth of the bacteria. Further evaluation has observed *S. mutans* to obtain a clearer understanding of its characteristics. *S. mutans* were named mutacin after Hamada and Oosshima determined that there were bacteriocins that activate against other species of streptococci (7). This was found by a culture study that demonstrated the ability for *S. mutans* to inhibit growth of actinomyces, mycobacteria and streptomyces, along with other gram-positive bacteria (7). Mutations are understood to be mostly heat stable along with being able to break down proteins and peptides. *S. mutans* strains are characterized by the products that they produce along with their reactivity with mutacin.

S. mutans **Attachment to the Tooth Surface**

S. mutans ability to adhere to the surface of the tooth is an intricate process that involves a range of bacterial and surface components. The anaerobic characteristics of *S. mutans* allow it to live in environments with little to no oxygen, making it ideal for adhering to and colonizing between adjacent teeth or inside the grooves of the occlusal tooth surface (3). Initially the adherence of oral streptococci to epithelial cells is thought to involve several surface attachments. Plaque is composed of a range of bacterial colonizations, including *S. mutans* that forms on the tooth's structure leading to the formation of dental caries (7). Development of plaque on the surface of the tooth occurs when a thin protein film forms on the tooth's enamel allowing for cells to attach without being removed by oral hygienic factors (3). Influencing factors that allow for specific bacterial interactions to occur with a particular thin film coating are imperative to clearly understand the process that allows bacteria to adhere to the tooth surface. Evaluating bacterial species including, *S. mutans, S. sanguinis, and S. salivarius,* were observed on protein and carbohydrate hydroxyapatite film coated tooth surfaces along with uncoated tooth surfaces, in vitro experimentation (7). When *S. mutans, S. sanguinis, and S. salivarius* were observed with protein film coated and uncoated enamel, the findings indicated that the ability to attach decreased from *S. sanguinis,* to *S. salivarius* which attached remarkably better then *S. mutans (3).* Further evaluations concluded that *S. mutans* attaches primarily to carbohydrate hydroxyapatite film remarkably better then the other streptococcal species.

Gunner Rolla, a researcher in the field of oral biology, has proposed a model regarding the attachment of bacterial cells (3). This model explains that *S. mutans* and *S. sanguinis* cells have a particle that is negatively charged when in contact with the surface of hydroxyapatite, causing attachment along with calcium and protamine phosphate. Interactions with phosphate, fluoride, along with the reduction of salivary flow can lead to a lack of bacterial cell attachment (3). The relationship between both *S. mutans* and *S. sanguinis* with the thin layer of salivary protein, is shown to form hydrogen bonds demonstrated by groups of hydroxyl present on exterior growth of sucrose (3). The interaction that the bacterial cell wall and the salivary protein have with surface charges, is that the presence of a calcium ion, a positive charge two ion, is seen to increase the interaction between the negative charges. This demonstrates that the bridge that the calcium ion creates during the interaction is necessary for starting bacterial cell attachment (3). The ability of oral streptococci species to influence one another and their interactions of the varying bonding between the oral cavity environment has had an impact on how bacteria has advanced.

***S. mutans* Production of Acid**

Dental plaque that produces acid causes a lower pH around the tooth's surface, starting the formation of dental caries (1). One of the main bacteria found in dental plaque, considered a pathogen, that causes dental caries is *S. mutans (14).* This occurs by *S. mutans* lowering the pH, by its ability to ferment sugars and carbohydrates quickly(1). *S. mutans* is an anaerobic bacteria, indicated by the lack of the respiratory chain in its cell structure (3). The metabolization of sugar by *S. mutans*, produces energy and acid through the process of glycolysis, which involves cellular respiration and takes place in the cytosol of cell. This is where sugars convert into acid products along with ATP (7). Fermentation of sugar is impacted by the concentration of sugar that is present for the oral bacteria to be converted which in turn has an impact on the secretion of saliva (3). The oral cavity's typical salivary secretion is 5-40 uM, but the intake of food can cause sugar levels to increase in the area surrounding the oral bacteria impacting salivary secretion to increase to 5-40 mM (1). The process of sugar fermentation by *S. mutans,* can produce variations in products of acid mixtures or lactic acid, depending on the shift of the enzyme mechanisms (7).

Lactobocillus lactis is a gram positive anaerobic bacteria that works with *S.mutans* by converting sugar into lactic acid (1). The production of lactic acid, leads to a decrease in the pH level surrounding the tooth's enamel. In turn leading to demineralization, the loss of calcium and other minerals from the tooth's structure. This is the process when sugar is fermented and excretes lactic acid, works to create an environment with a low pH allowing for dental caries to develop (7). *S. mutans* produce ATP during glycolysis, in which an excess of lactate is produced in an environment with glucose (7). *L. lactis* works with *S. mutans* by utilizing the lactate ion to contribute energy to the cycle for the production of lactic acid (1).

Understanding the impact of the *Lactococcus lactis* productivity by fermentation regulation has been examined, through the use of the chemiosmotic model by Mitchell, which lead to the further development of the energy recycling model by Konings (7). Together these models postulated that the lactate ion exits from the cell through a membrane transport with the movement of protons. Energy can be provided to the cell by the movement of the lactate across the membrane, leaving the cell with protons, causing electrical potential across the gradient of the cells membrane (7). Varying conditions involving lactate membrane movement, and the ability to monitor the amount of lactate in glycolysing cells brings about a clearer understanding of the process of energy movement of the cell (7). Lactate's ability to leave the cell as lactic acid, is an energy independent and electroneutral process.

S. mutans Relationship with Dental Caries

The role of *S. mutans* in the development of dental caries is best understood by epidemiological studies, which observe dental plaque obtained from caries cites. Research taken in parts of Northern and Southern Thailand has evaluated populations in urban and rural communities for the presence of *S. mutans* and caries. Several studies have looked at individual factors that influence the presence of caries along with understanding the prevalence of caries in these populations. A study that took part in Northern Thailand evaluated 505 individuals living in Meo, a sub region of Northern Thailand and compared the findings of the presence of caries to other Northern Thailand populations located in hill tribes and rural populations using the DMFT index (13). The DMFT index is the a method in which dental studies can evaluate Decayed, Milling, Filling Teeth (12). Meo is one of several hillside communities that have settled there and like the other communities, have maintained there historical way of life with little to no outside contact (13). Communities like these are ideal models for studying the presence of *S. mutans* and its effect on the formation of caries because of the lack of contact with modern civilization (11). Individuals in these populations have been studied by examining their age, sex and chewing habits to obtain a better understanding of these factors on the presence of caries. One study looked at the chewing habits of betal nuts and miang, and the chewing of fermented tea leaves, which is a popular habit in the Northern Thailand (13). Basic dental examinations were conducted to look at the DMFT of each individual. This data along with a sample of plaque from each individual was studied to evaluate the bacterial composition of the plaque to aid in the understanding of the microflora in the oral cavity.

Data from individuals in the community studied, was collected and organized with the ranging ages put into groups. It was concluded that out of the 505 individuals studied, 246 subjects were males and the remaining 259 subjects were females. From this data involving the age and sex of the subject studies the DMFT index scores were observed, for males in the age group of 31 to 40, 41 to 50 and for women the age group of 41 to 50 had the highest DMFT index, even though caries were observed in all age groups (13). When observing the population as a whole for the presence of *S. mutans,* only 67 subjects were found to have *S. mutans* in their plaque sample. Children from the ages of 1 to 10 years of age have shown to have the highest percentage of the *S. mutans* bacteria in their plaque sample and the percentage of *S. mutans* continued to decrease as individuals became older, up to the age of 30 (13). After 30, there was a very low presence of *S. mutans* indicated.

Results suggest that *S. mutans* is more commonly found in children along with the presence of early signs of caries. When observing the older populations, no conclusive data could be found due to a lower percentage of chewers taking part. Previous studies examining the concentration of fluoride in individuals' urine that chew miang along with evaluating fluoride concentrations in water has been observed but further studies need to be conducted to create a clearer correlation with this data (13). Overall this study suggests that regardless of the living situations and community customs, the presence of caries and *S. mutans* is still present is populations that are disconnected from modern civilizations.

Understanding the link between *S. mutans* and caries present in the Northern Thailand hill side communities has brought further studies to research and evaluate urban and rural school children, which is used in a Southern Thailand study. This research studied children from the school districts of Ratapum, a rural community and comparing them with Songkhla, an urban community to try and find a correlation between *S. mutans* and caries in these demographics (13). School children in these districts were selected to partake in a dmft index exam, which also included a sampling for observing *S. mutans.*(12) Additionally, water samples were taken from the surrounding school district area to analyze for fluoride concentration. These tests were then analyzed to see the correlation between DMFT index scores and the presence of *S.mutans.*

In the rural population, a total of 208 students were examined, 102 boys and 106 girls. In the urban area, a total of 228 students were examined, 102 boys and 126 girls (16). The dmft indexes in both districts were very similar, which was around 3.5. When comparing it with dmft index of Thai urban and rural communities, which was 1.3 for rural and 2.5 for urban, the findings were higher then expected. The difference in the condition of the children's teeth in these districts, was that in the rural population showed a high indication of caries compared to the urban children which had a higher presence of teeth that have had fillings and been extracted (16). The count of *S. mutans* was also observed to be similar for both the rural and urban district. When considering the concentration of *S. mutans* colonies with the dmft index, there was a significant relationship between the increase in DMFT index and the increase in concentration of *S.mutans* colonies. These findings shed light on the direct relationship between the presence of dental caries and *S. mutans* bacteria.

Early Colonization of *S. mutans*

Colonization of early *S. mutans* is the main factor that leads to early childhood cares. It has been found by Caufield et al, that children between the ages of 19 to 31 months are the most susceptible to *S. mutans* infection (2). Early colonization of *S. mutans* were studied in a population of two hundred Thia children from a Police Hospital in Bangkok, Thailand, that ranged from 2 to 36 months old (15). Out of this study population there was 106 girls and 96 boys. Children were put into 3 groups depending on the state of tooth development, group 1 consisted of 84 children with a mean age of 4.5 months with no development of teeth, group 2 consisted of 68 children with a mean age of 10.5 months that has 1 to 8 erupted teeth, and group 3 consisted of 50 children with a mean age of 27.1 months that had 9 to 20 erupted teeth (15).

Parents were asked to answer questions regarding the child's oral health, demographics, and feeding habits. Samples were obtained by swabbing the children's alveolar ridges, buccal mucosa, and tongue for children without teeth, along with children that had erupted teeth were also swabbed buccal/lingual and occlusal surfaces of the teeth.

The results from the study showed that there was *S. mutans* colonization in 26 percent of the children. The mean age of the *S. mutans* colonization was 20.5 months. *S. mutans* was also observed in 12 present of children as young as 2 months old (15). Results showed that as the children increased in age and the teeth began to erupt, so did the increase in colonization of *S. mutans (15).* This study confirms the results of past studies that reported that *S. mutans* becomes present when teeth start to erupt.

Early Transmission of *S. mutans*

Once a child is born, research is trying to evaluate the means in which the transmission of *S.mutans* occurs to decrease the ability for pathogenic microorganism to be transferred. It is hypothesized that the primary caregiver is the one that transmitted the *S. mutans* that colonizes in the child's oral cavity (2). Factors that have been associated with the impact of *S. mutans* transfer to the child from the caregivers include their poor oral health, oral lesions and low economic status, along with the child consuming treats (2). The mode of transfer is not completely understood but possible factors that could play a part in transmission include sharing food or silverware, and close contact.

During the ages of 1 to 4 years, when teeth are erupting, *S. mutans* are able to colonize in two possible ways, vertical and horizontal transmission. Vertical transmission is the direct transfer, normally seen in a mother to child transmission that allows for bacteria to be transferred from the mother to the newborn through direct saliva, exchange(6). This transfer of caries forming bacteria is the main means of *S. mutans* entering the oral cavity during the early period of a newborn's life. This reason is because of the close contact the mother has while taking care of the child(7). Other vertical transmissions have been evaluated and looked at the interaction with the father along with other family members (ref). Looking at the inherent questions regarding mother/ father relationships, the results comparing studies is mixed. Saying that 4 indicatives out of 9 studies found that 50 percent of the children had at least 1 type of *S. mutans* that was similar to the mother but not to the father. Another 4 studies showed that there was a similarity between children receiving *S. mutans* from both the mother and father. Overall mother-child relationship is assumed to be the main transmission because of difference in personal contact.

An additional mode of transmission is horizontal transmission, where the newborn is interacting with another individual and is not aided by direct parental interaction but from the surrounding environment (ref). This transmission through saliva from an individual can be accomplished through silverware, bottles, licking, and coughing. Understanding both processes of the vertical and horizontal transmission of bacteria, along with the relationship of both individuals involved, early disruption of *S. mutans* colonization can be accomplished and in turn, reduce the formation of dental caries(7).

Understanding Dental Caries

The high incidence rates of dental caries is not far off from that of the common cold, this is true for both children and adults (14). This multifactorial disease is influenced by a combination of factors continuously being formed, involving bacteria that produces acid, along with fermentable carbohydrates, saliva and tooth surface, which have an impact on the health of the oral cavity (4). Dental caries are characterized as either pit or smooth caries that develop in either the crown or root of the tooth along with primary and secondary teeth. Build up of plaque on the tooth surface impacts the tooth's hard tissue by bacteria carbohydrate fermentation that produces acid (7). This is the most common cause of oral pain and tooth loss and is connected to the indication of dental caries and if not treated will continue to decompose the tooth. This preventable disease is common amongst children and is present throughout adulthood unless treated (14). The early stages of dental caries start when there is a microbiological change in the composition of the biofilm which can be influenced by diet, oral hygiene habits, fluoride, formation and saliva (8). Even though dental caries are considered a chronic disease that occurs in most individuals at a slow rate, it is able to be interrupted at any stage with proper dental treatment.

The association between nutrition and its impact of dental caries in primary school aged children has been evaluated in recent studies. One study consisted of 862 school children, age 12 - 14 years old from 5 different regions of Thailand including rural and urban areas. There were 30 - 40 children from each area (9). The children all filled out a questionnaire regarding their basic background information including, age, sex, region along with other oral hygiene questions including brushing habits, use of fluoride toothpaste, check up frequency, and nutrition habits.

Oral health exams were taken using techniques recommended by the DMFT, these exams were done in the classroom with natural light. Weight and height was measured to determine the nutritional states of each child, which was taken the same day as the oral exam. From the nutritional data, children were grouped into one of 4 groups including thin, normal, overweight, and obese (9).

It was observed that the population of students was 48.5% urban and 51.5% present rural, gender of children was 47.7% males and 52.3% female, age range of children 12 to 14 years old and a mean age of 12.75 years (9). When nutrition was observed, 10.1% thin, 78.3% normal, 5.3% overweight, and 6.3% obese. Out of the total population 37.9% of children were free of caries and when observed the overweight and obese 56.0% of children were caries free (9). There was a significant negative correlation between nutritional status and DMFT. The mean DMFT value for the study population was 1.93 per person, 2.19 per thin person, 2.03 per normal person, 1.23 per overweight person, and 0.89 for obese person in the population (9). From these DMFT results it was concluded that there was a significant difference. Further work needs to explore the impact of an overweight status and its decreased risk of dental caries. This study helped to demonstrate the relationship between nutrition and dental caries. By eating a healthy low sugar diet along with less frequent snacking a person can decrease the impact on caries formation.

Oral environment

The oral cavity environment contains a complex range of microorganisms that are specific for that desired habitat, which maintain a balanced overall oral environment. When bacteria is present in another habitat and reproduce, they are considered pathogenic because they are not indigenous to a particular habitat (4). This new interaction with a different habitat by reproduction and produces unfavorable products causing a pathogen to become present (6). The imbalances of the original habitat with the presence of a pathogen allows for a change in the initial environment commonly seen where the pathogen is at a high concentration. Maintaining a balance of the varying species of microorganisms in the oral cavity takes into play the structure of the teeth, oral hygiene and diet (8). Many of these variables play a part in the impact that dental caries have. Not all components of the species that comprise plaque can cause the formation of dental caries but do aid in the ability to withhold a balanced oral habitat (7). The bacteria responsible for dental caries being able to form, is *Streptococcus Mutans* and *Streptococcus sobrinus (6)*. S. mutans, the main oral bacteria that causes dental caries is an anaerobic bacteria and is able to metabolize carbohydrates. Further infections involving lactic acid producing bacteria like Lactobacillus sp. and the acid tolerant Streptococcus sanguinis bacteria impacts the ability for dental caries to develop (14). Additionally, it has been observed that patients' that have active dental caries are observed to have Candida albicans, a yeast present in the saliva.

Birth Method Influence on Microbial Flora

The relationship between the mode of transmission of dental caries from the mother to child is being further explored. When a child is born, the microbial flora of the oral cavity is developed by the interaction between the individuals the newborn interacts with (5). During the beginning stages of the newborn's life, research has showed that the difference in birth methods, either vaginal birth or cesarean section can lead to a difference in the child's microbial composition (9). Even at one year of age, children delivered by cesarean section are thought to have a reduced microbial diversity when compared to individuals that were delivered vaginally(9). Additionally, research has shown that children that are born by vaginal delivery obtain *S.mutans* at least one year later than cesarean section deliveries (9). Comparing vaginal and cesarean section delivery methods has been further evaluated for other health factors including the influence on developing allergies and diseases(9). The difference in delivery methods has an impact on the immune system which leads to a variation in the microbial composition. It has been proposed that immune variations are caused by the lack of pressure during a cesarean section delivery. This pressure during delivery has an impact on the leucocyte function that involves the production of white blood cells from the immune system to protect the body (9). Not only is it important for the impact of delivery method on the oral microbial composition to be better understood but the connection of the mode of transmission of the dental caries forming bacteria into the oral cavity needs to be further evaluated.

Affect of Tooth Development on Microflora

Once teeth begin to erupt, the concentration of bacteria forming colonies increases; by 4 years of age, a child has a diverse and developed oral microflora (5). During this time, caries forming bacteria become more prevalent in the oral cavity because of the tooth's increasing surface area. (14) The tooth's surface structure involves the crown, which is covered with saliva, located above the gingival tissue and is connected to the bottom half of the tooth called the root. The upper region of the tooth, the crown, is composed of five surfaces including the buccal (cheek side), lingual (tongue side), mesial (front side), distal (back side), and occlusal (biting surface). Varying surfaces of the tooth are all prone to plaque build up, which is influenced by the structural components. The lingual and buccal side surfaces, are smooth but less common for the presence of tooth decay. Periodontal disease is commonly found on the mesial and distal surfaces, while the occlusal surface that aids in chewing has more crevasses where bacteria becomes trapped. This leads to the formation of caries. A plaque called supragingival builds up around the surrounding surface of the crown (7). The development of the tooth structures allows for *Streptococcus mutans* to be able to colonize because of the structural components of the tooth. *S. mutans* is a gram positive facultative anaerobic bacteria, which is the leading factor for developing dental caries because of its ability to produce acid that erodes the tooth's enamel (14). *S.mutans* are able to thrive in the oral cavity when there is high pH and a nutritionally rich surrounding, full of refined carbohydrates.

Classification of Dental Caries

Dental caries can be classified as smooth surface caries, pit and fisures caries. Classifying dental caries are imperative because it illustrates the impact it has on the actual tooth. This classification is achieved by evaluating the individual characteristics of the caries. Characteristics of types of caries vary by their location, impact on the hard tissue, state of decay, and causes of infection (7). These characteristics are all important when evaluating the impact of tooth decay to determine the severity of the disease. Smooth surface caries develop from the root surfaces of the tooth or on the smooth surface between neighboring teeth. The point at which caries are formed between two teeth, when the surfaces of the root of both teeth are in contact with one another is considered interproximal caries (7). The cite of caries formation on the smooth surface makes it difficult to detect with instrumentation like visual and film from x-rays. In patients with unhealthy gum tissues, gingival recession can occur which is when the root of the tooth becomes exposed because of the loss of gum tissue (7). Gingival recession is a common indicator that root caries are able to form. However, when there is healthy gum tissue, root caries fail to form because of the gum tissue covering the root surface.

Compared to the tooth's enamel, the root surface is more perceptible to demineralization and thus, the reduction of the tooth enamel, because of the structure of the root of the tooth (7). This structure consists of a thin layer of calcified bone-like material which is weaker and can be broken down more easily in a lower pH environment compared to the enamel which is harder to break down and needs a higher pH to occur (14). It is imperative to have healthy gum tissue so that it can protect the root of the tooth (7). An additional way to characterize caries is when they form in a small pit located at the cross section or end of the grooves where there is a specific spot of decay. Similar to pits caries, fissure caries are present where the tooth is not fully flush creating grooves, allowing dental caries to develop (7). Fissure caries are found on the enamel of the tooth, mainly on the chewing surfaces of the tooth because of the structural nature of the grooves and ruts. A common cause of caries in both the pit and fissures is the difficulty of proper oral hygiene practices to get into the grooves, along with it being difficult, at times, to detect by professionals (14). Indication of early caries formation in children is commonly seen in the pit and fissures areas.

Fluoride Impact on Dental Caries

When trying to prevent or control the bacterial infection caused by dental caries, the use of fluoride, baking soda, toothpaste and flossing will aid in controlling the concentration of the *S.mutans* bacteria (18). A common strategy populations have used to control the presence of dental caries is by introducing fluoride into the drinking water. (11) Children are the most prone to dental caries, especially during the early years of their lives. Weak and discolored teeth, is an indication of the presence of dental caries and can lead to a decrease in chewing, overall impaired nutrition, and can impact the individual's overall health, which prevents one from thriving (18). The relationship of fluoride and dental caries was linked to the presence of naturally high fluoride in groundwater compared to those without naturally fluorinated water. Research developed by the drinking water information, shows that the presence of fluoride consumption with a concentration of 0.7 to 1.2 ppm in the water supply would lead to prevention of dental caries. (11) People who do not receive the desired amount of fluoride through drinking water are able to receive fluoride though dental hygiene products, to reduce the development of dental caries (4). Toothpastes are the most common product for adding fluoride into the diet with a concentration of 0.24% NaF, 0.76% MFP, and 0.45% stannous fluoride which is encouraged for protecting adult teeth. Fluoride rinses have been introduced as a similar idea but secondary to the ideas of fluorinated water (4). Dentists can also perform an in office fluoride treatment normally during the development stages. A gel with a concentration of 1.23% acidulated phosphate fluoride is used by placing the gel into a tray and introduced to the tooth surface for a determined time.(11) Similar procedures have led to the addition of fluoride supplements into drinking water along with dental education of the importance of the introduction fluoride in the proper concentration to prevent caries. These common uses have been developed to aid in the prevention of caries, leading to the improvement of oral hygiene. (18)

Current Research

Current research continues to dive deeper into the multifactorial disease of dental caries. The development of caries involves interacting variables to allow for its development which mainly include the presence of bacteria, the oral environment, nutrition, and time (4). To learn more about this multifactorial disease, studies are looking into the risk factors of childhood dental caries. The project was a community based study that took place in the Thepa district, Thailand, a rural area where a majority of the population consumes rice, vegetables, fish and spicy rice. The population studied started off as 599 infants but dropped to 495 infants because 406 infants completed 3 oral exams at age 9,12 and 18 months and 89 infants only completed 2 oral exams (17). During the oral exam, the dentist would label the tooth surface as one of the following, unerupted tooth, normal enamel surface, initial caries, caries in dentin or caries involving pulp (17). These exams were done at 3, 9 and 12 months. The mother of the infants were interviewed during the second trimester of pregnancy, where she was asked questions about income, education, use of calcium supplements, and milk intake. A second interview was preformed when the infant was 3 months old, involving questions about the infants' calcium supplement use, intake of milk, use of vitamin supplements, sugar snacks or food taken, what food the infant was eating and other habits (17). They were interviewed again at 9 and 12 months.

Once all data was collect, results that ECC amount 9 to 18 month old children in this study population was high. All factors were documented and analyzed by negative binomial models. Overall the high incidence of ECC was from age 9 to 18 months and was affected by the quality of care given by the mother, from the time it was a fetus to the first year of birth (17).

During the time of pregnancy, the factors of main importance were calcium intake by milk or supplements. After the birth, the main factors of importance were the intake of supplements, amount of milk consumed, diet, snacks, and oral hygiene (17). These findings show the lack of research that has been done on children this young in the population regarding dental caries. This project allows for a clearer understanding of the risk factors involved in ECC starting at a very young age along with early childhood habits that influence ECC.

Conclusion

Dental caries are one of the most common widespread disease affecting children and adults throughout their lives. The impact that *S. mutans* has on the development of dental caries involves many factors, which play a part in the ability for the bacteria to transition and colonize. Several different project have evaluated children populations in Thailand and the impact on S. mutans and dental caries. Research has shown that birthing method and interaction with a newborns' and its mother is the key link to the development of the oral cavity flora and its impact on obtaining *S. mutans* into the oral cavity. The influence of feeding habits, diet, nutrition, and oral hygiene have all been evaluated in deterring the effect they have on colonization of *S. mutans.* Continues studies need to take in part a further correlation between all the varying factors that influence the relationship between caries and *S. mutans.* In time researchers hope to better understand how *S. mutans* can be reduced by preventive methods, including physical practices and interaction, oral hygiene habits and treatment procedure. All in the hope to create better oral health.

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