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LITERATURE REVIEW

My study attempts to determine if the transition from a hunter-gatherer subsistence mode to an agricultural subsistence mode led to an increase in the dental caries rate of the female population of the late-woodlands site in question.

Subsistence Modes

Subsistence Modes and Health.

Subsistence Modes and Gender.

Transitioning From One Subsistence Mode to Another.

Dental Caries

To understand how transitioning from one subsistence mode to another could have affected dental caries rates, one first must understand the pathology of dental caries and what influences their formation.

Disease Process. Dental caries is a disease process that involves the demineralization of tooth enamel and dentin matrix by bacterial organic acids (Hillson, 1986; Featherstone,

2004). Acidogenic plaque bacteria, like lactobacillus and staphylococcus mutans, ingest fermentable carbohydrates that enter the mouth. Lactic acids and other organic acids are produced as a byproduct of the bacteria's digestion. These acids work their way into the enamel, and sometimes the dentin or cementum, of the tooth. There they proceed to break down the inorganic matrix. They also lower the overall pH of the dental cavity, making the environment more hospitable to the acidogenic bacteria that produced them.

The acids begin to dissolve the mineral crystals that make up the inorganic matrix components (Featherstone, 2004). These broken down crystals can then diffuse out of the tooth, leaving it structurally weaker. At first the absence of matrix is not visible macroscopically. Over time, a white/brown spot will form, making the carious lesion visible to the naked eye. As the disease progresses, the discoloration is replaced by a small pit. This pit can grow along the tooth's surface, developing into a large shallow depression. It can also go deeper and deeper into the tooth, passing through the enamel and dentin, making its way to the periapical area (Dias & Tayles, 1997).

The body has ways of compensating for this demineralization process. The body produces saliva, which acts as a lubricant, an antimicrobial agent, and a matrix transporter. Saliva flushes out some of the fermentable carbohydrates that the bacteria ingest, restricting their food supply (Lenander-Lumikari & Loimaranta, 2000; Featherstone, 2004). It also provides a medium for the acids to diffuse into, weakening them.

Saliva also contains proteins that keep the pH in the oral cavity from dropping too low, thereby making the environment less hospitable to the microbes (Lenander-Lumikari & Loimaranta, 2000). It contains antimicrobial agents which kill some of the bacteria. Inorganic compounds like calcium and phosphate are also found in saliva. These compounds can be utilized by the body to reform the dissolved dental matrix and repair the carious lesions, actually making the tooth stronger than it was before.

It is possible for this remineralization process to cancel out damage done by the demineralizing organic acids (Featherstone, 2004). Carious lesions can only form if more material is demineralized than is remineralized.

Genetic Factors That Contribute to Caries Development. Scientists have found that some individuals seem to be more likely to develop dental caries than others, all other things aside (Horowitz, Osborne & DeGeorge, 1958; Rosen, Hunt & Hoppert, 1961; Boraas, Messer, & Till, 1988; Bretz, Corby, Schork, Robinson, Coelho, Costa, Melo Filho, Weyant & Hart, 2005). Anthropologists have recognized this as well, noting that sometimes groups in the same geographic area who utilize the same resources will still have very different caries rates (Costa, 1980; Cucina & Tiesler, 2003). Studies have been conducted on both human and animals which suggest that a person's chances of developing dental caries can be greatly reduced or increased depending on their genes.

Caries susceptible rats that have been placed at birth with caries resistant rats will develop carious lesions at a much faster rate than caries resistant rats placed anywhere,

even when both groups are on the same diet high in fermentable carbohydrates (Rosen, Hunt & Hoppert, 1961). Human beings also seem to develop caries at a rate influenced by their genetics (Horowitz, Osborne & DeGeorge, 1958; Boraas, Messer, & Till, 1988; Bretz, Corby, Schork, Robinson, Coelho, Costa, Melo Filho, Weyant & Hart, 2005).

Numerous studies have been done on both monozygotic and dizygotic twins, looking at their caries rates. Pairs of monozygotic twins seem to develop caries at the same rate, while pairs of dizygotic twins develop caries at a different rate (Boraas, Messer, & Till, 1988; Bretz, Corby, Schork, Robinson, Coelho, Costa, Melo Filho, Weyant & Hart, 2005). This is true whether the twins are reared together or apart.

If there were no genetic factors influencing caries development, we would expect monozygotic and dizygotic twins to have similar rates (Boraas, Messer, & Till, 1988). Instead, we find that twins with the same genes (monozygotic) tend to develop caries similarly. Those with different genes develop caries at a different rate. Because this happens in twins that share the same environment (reared together) and that grow up in different environments (reared apart), it shows that there is some unknown genetic component involved in the development of dental caries.

Genes influence a number of things, including tooth development and salivary gland function (Bretz, Corby, Schork, Robinson, Coelho, Costa, Melo Filho, Weyant & Hart, 2005). Genes determine how soon teeth erupt, which is important because teeth seem to be most susceptible to caries right after eruption. Their form also influences the severity of dental caries. Fermentable carbohydrates get stuck in deep fissures on the tooth's

surface. This is where caries are most likely to form (Hillson, 1986; Featherstone, 2004). Genes determining the final form of teeth means that they can help determine the final location of carious lesions.

The influence of genes of salivation is well known (Lenander-Lumikari & Loimaranta, 2000). Individuals born with xerostomia and other hyposalivary conditions have a much higher rate of caries than those born with normal saliva levels. If a person's genes make them produce too little saliva, the remineralization process can be retarded and the carious lesion development process accelerated.

Microbial Factors That Contribute to Caries Development. It is not only the genes of the host that determine how dental caries develops. There are also several different microbes involved in the development of dental caries. The two types of bacteria that are recognized as being the main cause of carious lesions are lactobacillus and Mutans streptococci (Loesche, 1986). There are four generalized types of mutans streptococci: *S. mutans*, *S. rattus*, *S. cricetus* and *S. sobrinus*. While some or all of these species of MS can be found in the human mouth, it is *S. mutans* which is most common in humans. *S. mutans* is also thought to be the bacteria mainly responsible for the initial formation of carious lesions.

Each tooth selectively absorbs certain glycoproteins from the saliva that then stick to its surface, forming a thin membrane called the acquired enamel pellicle (Loesche, 1986). It is on the surface of this pellicle that bacteria in the mouth make their home. Initially

the pellicle and the microbes in the oral cavity both have a negative charge, and so repulse each other. Certain proteins on the pellicle end up attracting specific microbes, which then begin to group together and form dental calculus (plaque) (Lenander-Lumikari & Loimaranta, 2000). Once plaque forms, microbes like *S. mutans* and lactobacillus can take up residence on the pellicle and the dental caries process can really begin in earnest.

S. mutans is thought to be the bacterium that is most destructive during the initial stages of lesion development (Loesche, 1986). It ferments the sugar alcohols mannitol and sorbitol, producing extracellular glucans. Lactobacilli are thought to take over at a later stage, causing the lesions to grow larger and increase in number. The role of other microbes, like *S. sobrinus*, is still being investigated.

Dental Caries in Hunter-Gatherer Populations. Hunter-gatherer populations tend to have diets high in grit, leading to lots of occlusal wear (White, 2003). This has been noted in a number of studies conducted by anthropologists on hunter-gatherer populations, though it is noted that not all groups experience equal levels of wear (Costa, 1980). The high level of occlusal wear seen in hunter-gatherer populations is thought by some to lead to a high rate of caries (Hillson, 2001; Dias & Tayles, 1997). It is certainly possible that the chipping and cracking of weakened teeth could enable caries formation (Larmas, 2003).

Caries are most likely to form in the crevices of the teeth, especially those on the occlusal surface (Hillson, 2001; Featherstone, 2004). When teeth crack and chip a new

crevice is formed, providing another place for fermentable carbohydrates to become lodged. These carbohydrates can then be digested by odontopathogenic microbes, which release acid, break down the tooth further and form caries.

Some hold the opposite viewpoint that the high level of dental wear experienced by hunter-gatherers actually leads to a lower caries rate (Hillson, 2001). It is contended that the teeth of these populations wear down faster than carious lesions can form, thereby leading to an overly rosy picture of dental health.

Dental Caries in Agricultural Populations. Anthropologists have proposed a link between the development of agriculture in a population and higher rates of dental caries (Hillson, 2001). Many anthropologists have noted that changes in diet (moving from traditional diets low in carbohydrates to modern diets high refined carbohydrates like sugar) leads to a major decrease in dental health as evidenced by a much higher rate of dental caries (Costa, 1980; Keene, 1986). Evidence exists in pre-contact New World populations as well as post-contact groups (Cucina & Tiesler, 2003).

Dental Caries and Gender. Anthropologists and dental researchers alike have recognized that there seems to be some link between an individual's gender and their susceptibility to dental caries (Costa, 1980; Hillson, 2001; Bretz, Corby, Schork, Robinson, Coelho, Costa, Melo Filho, Weyant & Hart, 2005). It is believed that women have a higher caries rate than men, though the reasons behind this are not understood. Some have proposed

that it could be genetic, while others believe it has to do with differential access to fermentable carbohydrates. Though *S. mutans* is thought to be initially acquired in infancy from the mother, it is found in both men and women, making a bacterial reason unlikely.

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