ANALYZING SOCIAL INTEGRATION IN A PROTOHISTORIC PUEBLO SITE THROUGH DENTAL CARIES

A thesis submitted to the faculty of
San Francisco State University
In partial fulfillment of
The Requirements for
The Degree

Master of Arts
In
Anthropology

by

Heather May Bradford

San Francisco, California

May 2013

CERTIFICATION OF APPROVAL

I certify that I have read *Analyzing Social Integration in a Protohistoric Pueblo Site through Dental Caries* by Heather May Bradford, and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requests for the degree: Master of Arts in Anthropology at San Francisco State University.

Mark Griffin
Associate Professor of Anthropology

Cynthia Wilczak
Associate Professor of Anthropology

ANALYZING SOCIAL INTEGRATION IN AN PROTOHISTORIC PUEBLO SITE THROUGH DENTAL CARIES

Heather May Bradford
San Francisco, California
2013

This study examines carious lesions in the diverse community of Pottery Mound, a Pueblo IV site. Six hypotheses were tested for differences in the observed caries rates between males and females; young and older adults; individuals from different sectors; individuals with and without unusual grave goods. The correlation between the observed caries rate and the number of grave goods found, and the rate of males and females affected was also examined.

Individuals from the Pottery Mound population were examined macroscopically for carious lesions. The data collected was then statistically analyzed. A significant correlation was found between lesion rates and age, burial location, and grave goods type or quantity, though not sex.

I certify that the Abstract is a correct representation of the content of this thesis.

Mark Griffin
Chair, Thesis Committee

5-15-13
Date

ACKNOWLEDGEMENTS

This project would not have been possible without the support of numerous individuals. I would like to offer my deepest thanks to Dr. Mark Griffin and Dr. Cynthia Wilczak for giving me the tools I needed to do this research, and for their patience and assistance in what has been a lengthy writing process. Thanks also go to Dr. Heather Edgar and Dr. Bruce Huckell for generously allowing me access to their collections and archives.

I would like to thank Dr. Jeffrey Fentress for helping me hone my osteological skills and mentoring me during the most challenging period in this process. Many thanks go to Jennifer Blake, Andrea Guidara, Monica Nolte, Hoss Richardson, Jorge Vega, and Christina Alonso for learning with me and keeping me going. The support of my peers was invaluable. I would like to thank my family for their tireless support. Kathleen Ross-Bradford, Donovan Bradford, and Alexis Brown have always believed in me, even when I didn't. Finally, I would like to thank my darling husband, Andrew Podolsky, who made all this possible.

I would like to dedicate this work to my late father, Ricky Eugene Bradford, who I gained a better understanding of through my time researching this project in New Mexico. Plaid shirts and Panama hats.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

Bioarchaeologists have used the dentition of long deceased individuals to ascertain a great deal about past civilizations (Cucina and Tiesler 2003; Lukacs 1996; Turner 1979; Watson 2008). One of the most frequently analyzed dental conditions studied by bioarchaeologists is dental caries, a disease process that can provide insight into both foodways and social stratification.

Dental caries is a disease process that takes place in the mouth. Acidogenic bacteria consume particulate carbohydrates in the human mouth and excrete acid as a waste product (Costa 1980; Cucina and Tiesler 2003; Featherstone 2004; Hillson 2001; Turner 1979; Watson 2008). That acid breaks down the calcium matrix of the teeth, destroying tissue and forming lesions. These lesions can grow over time, affecting enamel, dentine, the pulp chamber, and eventually causing the tooth to die.

Bioarchaeologists have looked at dental caries rates to estimate the level of carbohydrates past populations consumed (Costa 1980; Hodges 1989; Keene 1986; Turner 1979; Walker and Erlandson 1986). They have also used carious lesion rates to look at the foodways of past populations, paying special attention to differential access to foodstuffs (Cucina and Tiesler 2003; Lanfranco and Eggers 2010 Watson 2008). This study will focus on the latter.

Carious Lesions at Pottery Mound.

The site under examination is known today as Pottery Mound (29-LA-416). It is an ancestral Puebloan site in the Eastern Pueblo culture area, near the border of the Eastern/Western Pueblo Culture areas. Pottery Mound was occupied from 1370-1450/1475 CE, during the period known as Pueblo IV (Schaafsma 2007). It was first recorded as an archaeological site in 1930 by the Laboratory of Archaeology in Santa Fe, after being described briefly in a 1928 article by Thor Warner (R. Gwinn Vivian 2007). Pottery Mound was later excavated in 1954 by Frank C. Hibben and the University of New Mexico Archaeological Field Session (Hibben 1955). Excavations and recordation continued through 1961, with Hibben taking the helm. Work began again in 1975 and continued sporadically until 1986.

Pottery Mound has been studied extensively by archaeologists and physical anthropologists (R. Vivian 2007). A great deal of work has been done on the murals found in the 17 kivas excavated by Hibben and his crews, as well as on the numerous pottery sherds that gave the site its moniker (Schaafsma 2007). Studies have also been conducted on the layout of the community and the design of the familial and community spaces within it (Adler 2007; Wills 2001). The diet of the Pottery Mound population has been looked at in some ways. Emslie (1981) studied the bird bones found at Pottery Mound, and determined that a mixed-subsistence economy was in place during the habitation period. People consumed crops, domesticated animals, and wild game (Clark 2007).

Statement of the Problem. Emslie's (1981) study details what was consumed at Pottery Mound, but not who consumed it. This is an important question to address at Pottery Mound. The ancestral Puebloan world was a complex place, especially during the Pueblo IV period. People came together from all over the prehistoric Southwest to form large cities in the desert. Families from different villages united, sometimes with people from other cultural traditions and what we would today consider tribes, to create densely populated urban centers in a difficult climate. How well those disparate groups meshed has been debated (Kantner 2001; Kidder 1924).

This study will compare the observed caries rate between a variety of different subgroups, including males and females, juveniles and adults, individuals in different part of the site, and individuals buried with different amounts and types of grave goods. Differences in observed caries rates speak to overall patterns of dental health. These patterns can then provide a foundation for further study into different resource utilization strategies. This study will provide insight into important questions about who had access to dietary resources in this harsh climate, and what that access says about the overall organization of this thriving metropolis.

Background and Need. A number of studies have been conducted that examine the prevalence of carious lesions in pre-historic populations (Costa 1980; Cucina and

Tiesler 2003; Lanfranco and Eggers 2010; Lukacs 1996; Turner 1979; Watson 2008). This information is often used to reconstruct past life-ways and subsistence patterns. It can also be used to analyze more abstract things like social status and group affiliation (Cucina and Tiesler 2003; Lanfranco and Eggers 2010). This study, like those before it, will examine carious lesion frequencies and observed caries rates of people within the site, looking for intragroup variability in caries rates that correlates with potential markers of social differentiation, such as grave good types and quantity.

For over thirty years, anthropologists have been positing a link between a population's subsistence modes and their rate of carious lesions. In 1982 a conference was held at State University of New York College at Pittsburgh. At this conference, a number of landmark papers were presented, which were later compiled in the book Paleopathology at the Origins of Agriculture (Cohen 1984). These papers discussed an apparent drop in health that seemed to coincide with the rise of agriculture, hypothesizing that the development of agriculture leads to a drop in overall population health. Recently, studies have begun to discredit this hypothesis, suggesting instead that what individuals eat before and after the transition to agriculture is what determines caries rates (Tayles et al. 2000; Watson 2008).

One variable that has been looked at in a number of studies is sex. Numerous studies have found that females often have a higher caries rate than males. Tayles and colleagues (2000) suggest that this is because of their role in food preparation. Carious lesions are formed when bacteria in the mouth excrete organic acid, which then dissolves the calcium matrix of the tooth. Consuming food throughout the day can lead to the pH in the mouth being acidic for longer periods. This is because every time a person eats, the acidogenic bacteria of the mouth consume fermentable carbohydrates and produce acid, driving the pH levels lower (Loesche 1986).

After the initial drop, it takes several hours for the pH to return to normal. Continual eating, even if the amounts of food are small, prevents the mouth from ever returning to its neutral pH, leading to a higher rate of caries. Tayles and colleagues (2000) suggest that this process contributed to women having rates of caries as high as 21% in their Khok Phanom Di sample. They posit that an increase in the amount of protein consumed, as well as the adoption of agriculture, which put women in the field rather than in the kitchen, led to a decrease in the frequency of carbohydrate consumption and was therefore one of the factors in women's later lower rates of caries.

This is especially pertinent to Puebloan groups. According to Ogilvie and Hilton (2011), the people of Pottery Mound lived in a society where women were expected to contribute in a significant, physical way to the subsistence economy of the community. Their 2011 study lends credence to this theory of a sexual division of labor at Pottery Mound, showing that men and women engaged in different tasks, resulting in different levels of muscle and bone development. The kiva paintings show this as well (Hibben

1975). This study will attempt to determine if men and women's different roles in dietary resource processing led to differences in diet as shown by observed caries rates.

Numerous studies have looked at dental caries in prehistoric populations in much the same fashion that this study will. Watson (2008) looked at caries rates in a Zapotec population from the Sonoran desert. Watson's sample consisted of 135 individuals from the Early Agricultural Period (1600 BC – 200 AD). Sex and age were estimated for these individuals, and their dental health was assessed. Carious lesions were found in 13.5% of the population, and 17.6% had ante-mortem tooth loss. There were no statistically significant differences between the males and females in this sample, leading Watson to conclude that sex had little to no impact on access to dietary resources. Watson concluded that these high rates of dental caries were caused by the sticky carbohydrates being gathered, rather than the grains being cultivated.

Costa (1980) looked at caries rates in males and females in pre-contact populations from Kodiak Island, Alaska and Point Hope, Alaska. There were so few caries in the sample that Costa could not run statistical analyses. Rather, he had to use the raw data to look for general trends. He found some differences between sex and age groups, though whether these differences are statistically significant or not remains to be seen. According to Costa, the caries rates are a product of cultural and environmental factors.

Cucina and Tiesler (2003) looked at dental caries in a Classic Maya sample. They found statistically significant differences in caries rates between upper class males and the rest of the population, which they attributed to differential access to protein. Sex and social class determined dietary resource access in this society, and was reflected in the caries rates.

Lanfranco and Eggers (2010) looked at four different Pre-Columbian groups in Peru, three from the Formative Period and one from the Late Intermediate Period. They found that all four of these groups overall had low rates of carious lesions, despite being agricultural and, in the case of the Late Intermediate Period sample, highly socially stratified societies. Antemortem tooth loss was also fairly low, and only one Formative period group had high lesion rates. When these samples were broken down by age and gender, a whole new pattern emerged. Adults were found to have higher rates of caries overall as time, and reliance on grain agriculture, intensified. Young men in the highly stratified Late Formative Period were found to have significantly higher caries rates than their female counterparts. Lanfranco and Eggers point out that their study was hindered by the small size of their populations, and the unevenness of sex and age ratios within it. A large sample, like that of Pottery Mound, should not suffer from these problems.

These studies show that the subsistence mode itself has nothing to do with caries rates. Rather, what people eat determines whether or not they have good oral health (Tayles et al. 2000). This study will be looking at a population that had a mixed subsistence economy, with some agriculture being practiced, along with some hunting/gathering (Magaha 2008). A number of kiva paintings depict the women of Pottery Mound as having participated in the planting, harvesting and processing of things like corn, beans and squash. The layout of the community and evidence of irrigated fields confirms that agriculture provided a great deal of the dietary resources used at Pottery Mound.

Despite having access to agricultural goods, hunting was also an important source of dietary resources. Archaeologists at Pottery Mound have excavated the remains of both large (deer, wolves) and small (rabbits, rodents) mammals, along with over 50 different bird species (Emslie 1981; Magaha 2008). Emslie (1981) suggests that the diversity of bird species in the Pottery Mound diet is due in part to their tradition of agriculture. He suggests their crops attracted hungry birds to the community, which were then hunted and consumed.

Studies of Pottery Mound have also looked at culturally created subgroups, specifically what are thought of today as ethnic groups. Of special note are the studies done by Eckert (2007) and Adler (2007) which discuss the integration and segregation of ethnic groups at the Pottery Mound Pueblo. Eckert (2007) identified several different pottery styles, based on both the kind of temper and the type of glazing, and charted them through time, finding that Zuni and Hopi-style pottery began appearing early in the occupation period and continued throughout. She contended that this reflects two waves of migration, one Hopi and one Zuni. These introduced pottery types never eclipsed the original varieties, though they were found in great number. This suggests that the people who made them were numerous and retained their own ethnic identity even after living at the site for some time.

Adler (2007) found a similar pattern in the architecture of the pueblo itself. He noted that single-story, single family dwellings were the first to be built. These were then followed by multi-story multi-family units which appeared in the early occupation period, around the time the Hopi and Zuni wares began to appear. Changes in the religious iconography found in the kiva murals occur around the same time, with a distinctly Western-Pueblo influence, specifically the Sikyatki style designs characteristic of the Pueblo IV Hopi (Crotty 2007; Gilpin and LeBlanc 2007). The design of the kivas was also unusual, with most of the kivas having the rhombus shape that is characteristic of Western Pueblo kivas, rather the circular shape one would expect from an Eastern Pueblo site like Pottery Mound (Adler 2007)

Both Eckert (2007) and Adler (2007) noted that in pueblos across the region, there have been ethnographically documented instances of the communities “splintering”. A large pueblo would split into several small groups for political, religious or financial reasons, and often one or more of these groups would leave the area. The small groups would then often go join other, established pueblo communities. Pottery Mound was in an interesting geographic area, close to both the Eastern and Western Puebloan communities, making it the perfect place for people on the move. It is suggested that the changes in architecture, religious iconography and material culture over time suggest a wave of immigration in the early occupation period (Adler 2007; Eckert 2007; Schaafsma 2007).

Rationale. A great deal of research has been done on the material culture of Pottery Mound, though much research still needs to be done. Some studies that use individual remains from Pottery Mound use them as a reference sample for the region as a whole rather than looking to them as a source of data on the site itself. Others look to the skeletal remains of the individuals in the community to learn more about the people of Pottery Mound.

Ogilvie and Hilton (2011) looked at the role women played in the economy of Pottery Mound through an examination of their humeral dimensions, finding that women played an important role in food acquisition and preparation process. Women were found to have more humeral strength overall. This brings to mind the kiva murals which show women carrying burden baskets, making pottery, raising children and preparing food (Ogilvie and Hilton 2011). Knowing that women played such an important role in the subsistence economy of Pottery Mound, it begs the question: Did all this hard physical work grant them equal access to dietary resources?

Another study that looked at the remains of individuals from Pottery Mound with an eye towards gathering information about the people and culture of the site was a 2008 Master's thesis by S.M. Magaha. She looked at a variety of skeletal pathologies present in the Pottery Mound sample, including dental caries, and compared the overall lesion counts to those found in the Mimbres sites housed at the Maxwell Museum of Anthropology. Overall comparisons of health were made between the Pottery Mound and the Mimbres samples, but no analysis of groups within Pottery Mound was done. Different pathology rates by sex, age, and other variables were not discussed.

Purpose of the Project. Previous research indicates that there was a great deal of diversity at Pottery Mound (Adler 2007; Eckert 2007; Ogilvie and Hilton 2011). How much of an impact did this diversity have on the daily lives of individuals at Pottery Mound? Though it appears to have been reflected in their material culture, were these differences only skin deep? Or did they cut to the bone? This study will examine the dental health of the Pottery Mound population, and will hopefully shed some light on this.

This study will provide further information relating to these questions about integration at Pottery Mound. Differences in lesion rates could indicate different foodways being practiced at Pottery Mound by certain subgroups, opening up a new line of inquiry. This would suggest a lack of integration as discussed by Adler (2007) and Eckert (2007). If lesion rates did not vary, then the lack of integration discussed previously was likely superficial.

Research Questions/Hypotheses. Because lesions are more likely to form on rugged surfaces, teeth must be studied by tooth type, mouth position, or dental arcade, to see if different types of teeth are affected differently in different groups. This can be done by using a ratio of the number of carious teeth to the number of teeth in that tooth type found. This is called the observed caries rate (Lukacs 1996).

The observed caries rate will be used to answer a number of questions about the Pottery Mound population. Were people affected by carious lesions at different rates? And did the location and number of lesions vary significantly between groups? These questions will be answered by testing a number of hypotheses to determine if there were differences in the observed caries rate between 1) males and females, 2) individuals found with unusual grave goods and those without, 3) individuals in different age cohorts, 4) individuals from different sectors of the site, and 5) by looking for a correlation between the number of grave goods an individual was found with and their carious lesion rate.

Methods. To examine these hypotheses, provenience and grave goods information was collected for all the individuals in the study, along with any specifics on the manner in which they were buried. Each individual first had age and sex estimated, then was macroscopically examined for carious lesions. Lesions were identified using a jeweler's loupe and fluorescent light source, and measured using metric calipers. Once collected, the data on lesion frequency was input into the SPSS statistical suite and examined using appropriate statistical analyses. Statistically significant differences between subgroups within the pueblo were then examined.

To estimate age and sex for each individual, each individual was first placed in either the juvenile or adult categories using Ubelaker's (1989) diagram outlining the "sequence of formation and eruption of teeth among American Indians", as found in Buikstra and Ubelaker (1994). All individuals in the adult group were further aged using the Scott (1979) methods for scoring surface wear, as described in Buikstra and Ubelaker (1994).

Sex was then estimated for all adults using Buikstra and Ubelaker's (1994) innominate analysis and their cranial method, taken from Acsádi and Nemeskéri (1970). Each individual was placed in either the male, female, or indeterminate category. Burials that contained both a skull and pelvis had sex estimated using innominate and cranial sex estimation methods. Any burials lacking a pelvis had sex estimated using Buikstra and Ubelaker's (1994) cranial method only.

Once an individual's remains had age and sex estimated, a dental inventory of each element was taken, using the attached Lesion Recording Form (Appendix B). Once a lesion was detected, it was measured using metric calipers. Its dimensions and depth in millimeters were recorded, along with the tooth and surface it was located on. Missing teeth were noted, with an eye to distinguishing ante-mortem from post-mortem loss. Analysis of lesions size and AMTL was found to be beyond the scope of this study, and may be looked at separately in the future.

This data was recorded using a data recording form devised for this study. Once collected, the data was entered into SPSS, a statistics program, and appropriate analyses were run, including chi-square, and Spearman's rho correlation.

Limitations. Pottery Mound was excavated by Frank Hibben and his field crews, off and on, for over 30 years. For much of that time there was no overarching research design, or standardization of methods. Mapping was inconsistent, as was data recordation. The amount of data lost can never be known. Attempts have been made to ensure this did not affect the results of this study, as is discussed in chapter 4. Despite these attempts, the lack of data for many individuals in the population required that they be excluded from this analysis. Fortunately, much of Pottery Mound has not been excavated yet. Some of the hypotheses in this study could be further investigated if the pueblo currently in possession of the land ever decides to allow further excavations.

Pottery Mound was a unique settlement. It was located at a cultural crossroads, in an area bordering two distinct culture areas. It was made up of immigrants from a variety of areas, and is thought to have been a major center of trade. This makes Pottery Mound an excellent site to study, though it also means that this settlement is likely not a typical ancestral Puebloan settlement. Comparisons between Pottery Mound and other large, diverse settlements like Grasshopper Pueblo and Kuaua are more appropriate than those that might be made with smaller sites.

Though unique, Pottery Mound was not unlike other large Pueblo IV period settlements. Comparisons between it and its neighbors can be made, though the population dynamics going on make it a poor comparative model for settlements in earlier periods. Large Pueblo III settlements could be readily compared with Pottery Mound, as could some large Pueblo II settlements. Any settlements from Pueblo I or earlier would have a very different type of population, with different customs and origins, making comparisons tenuous at best.

2. LITERATURE REVIEW

The purpose of this study is to examine dental caries in a pre-contact population from the protohistoric Pueblo site of Pottery Mound (29-LA-416) in New Mexico. Scholars have used dental caries analysis to reconstruct past foodways in various places and eras (Costa 1980; Cucina and Tiesler 2003; Lanfranco and Eggers 2010; Lukacs 1992; Turner 1979; Walker and Erlandson 1986; Watson 2008). Not only does this provide information about who ate what in any given place and time, it can speak to larger issues such as social structure, resource distribution, and changing subsistence and economic modes.

Dental caries

To understand how dental caries rates could vary within a population depending on social influences, such as resource distribution and technological innovation, one first must understand the pathology of dental caries and how social factors could influence their formation.

Human Dentition. Human teeth begin forming in utero (Hillson 1986, 2005; White 2000). The tooth buds, also known as germs, form in small pockets in the maxilla and mandible called crypts. They begin to erupt in the first months of life. Human beings have two sets of teeth, the deciduous (baby) teeth, and the permanent teeth. Deciduous teeth begin forming in-utero, and fully erupt within the first two years of life. There are only 20 deciduous teeth in the human mouth. These teeth consist of four incisors, two canines, and four molars in the maxillary and mandibular arcades. Modern humans have 32 permanent, also known as secondary, teeth. These permanent teeth consist of four incisors, two canines, four premolars, and six molars in the maxillary and mandibular arcades.

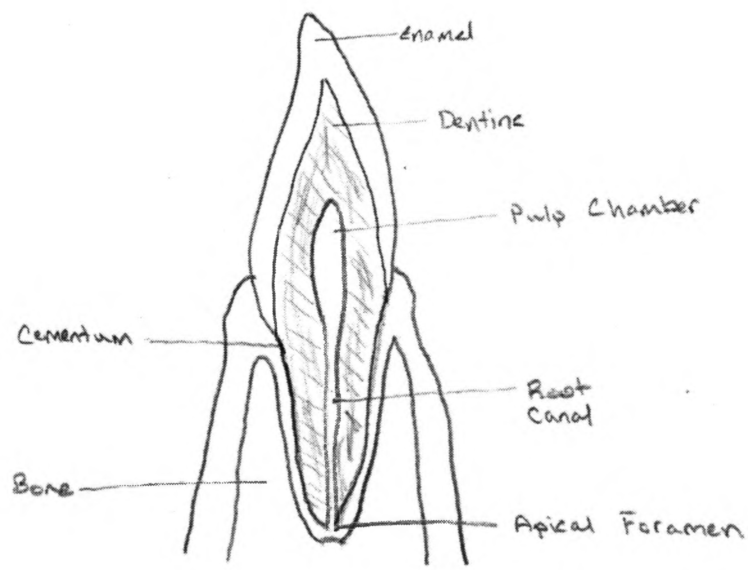


Figure 2.1: Human tooth. White 2000.

The pulp chamber contains the tooth's blood and nerve supply (White 2000). It is protected by a thick layer of dentin, and a thinner, but very strong, layer of enamel (Figure 2.1). Cementum, a bonelike tissue, covers and protects the root. The tooth's nerve and blood vessels trail down the root canal, passing through the apical foramen and connecting the tooth to the body's nervous and circulatory systems.

Disease process. Dental caries is a disease process that involves the demineralization of tooth enamel and dentin matrix by bacterial organic acids produced by bacteria that inhabit the mouth (Featherstone 2004; Hillson 1986; Larsen et al. 2001). The demineralization forms focal lesions, known colloquially as "cavities" (Larsen et al. 2001). The human mouth is colonized in infancy by a large number of bacteria, including *Lactobacillus* and *Staphylococcus* mutans. These bacteria inhabit the mouth, attaching themselves to the pellicle on the surface of the tooth (Bowen 2002).

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 come into contact with the surface tissue, whether enamel, dentin, or cementum, of the tooth. There they proceed to break down the inorganic matrix. They also lower the overall pH of the oral cavity, making the environment more hospitable to the acidogenic bacteria that produced them. Over time, this causes acidogenic species to far outnumber species which are less acid tolerant (Bowen 2002).

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 and Tayles 1997; Larsen et al. 2001).

The body has ways of compensating for this demineralization process. The salivary glands produce 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 (Featherstone 2004; Lenander-Lumikari and Loimaranta 2000). It also provides a medium for the acids to diffuse into, weakening them.

Saliva 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 and 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. When remineralization cannot compensate for the destabilization caused by these organic acids, carious lesions form (Figure 2.2). Over time, they can destroy the entire crown of the tooth, as seen in some individuals in the Pottery Mound sample.

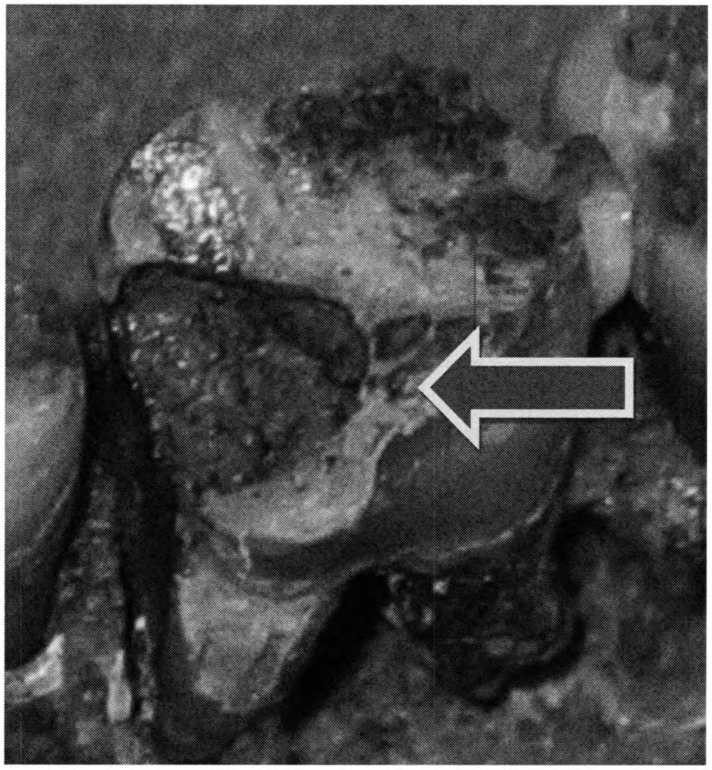


Figure 2.2: Specimen 80.14.2, with carious lesion indicated.

Carious lesions can also expose the pulp chamber, giving the native bacteria access to the interior of the tooth, and access to the rest of the body through the tooth's blood supply (Figure 2.3). The bacteria travel down the root canal, forming an infection site near the apical foramen (Dias and Tayles 1997). If the infection is not resolved, a periapical granuloma or an apical periodontal cyst can form. These conditions can be observed archaeologically (Figure 2.4).

Figure 2.3: Specimen 73.103.77, with exposed pulp chamber and bone loss.

Figure 2.4: Specimen 79.29.1, with a cloacae likely caused by a periapical granuloma.

Genetic factors that contribute to caries development. Diet, namely the ingestion of fermentable carbohydrates, is only one factor in caries development. Scientists have found that some individuals seem to be more likely to develop dental caries than others, all other things aside (Boraas et al. 1988; Bretz et al. 2005; Horowitz et al. 1958; Rosen et al. 1961). Studies have been conducted on both humans and animals which suggest that a person's chances of developing dental caries is greatly impacted by their genes.

Numerous studies have been performed on laboratory rats. Rosen and colleagues (1961) found that 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. This suggests that, in animals, there is a genetic component to caries development.

How human beings develop caries is also influenced by their genetics (Boraas et al. 1988; Bretz et al. 2005; Horowitz et al. 1958). Numerous studies have been done on both monozygotic and dizygotic twins, looking at their caries rates. Boraas and colleagues (1988) looked at twins that had been reared apart and compared their caries rates. They found that twins who shared the exact same DNA (monozygotic) had caries at the same rates, while twins who did not (dizygotic) had more divergent caries rates, despite having lived in different environments. The same pattern has been found in twins reared together (Bretz et al. 2005). Pairs of monozygotic twins had the same caries rates, while pairs of dizygotic twins had variable rates (Boraas et al. 1988; Bretz et al. 2005).

If there were no genetic factors influencing caries development, researchers could expect monozygotic and dizygotic twins to have similar rates (Boraas et al. 1988). Instead, they find that twins with the same genes tend to develop caries similarly. Those with different genes develop caries at a more divergent rate. Because this happens in regardless of environemnt, 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 et al. 2005). Genes determine how soon teeth erupt, which is important because teeth seem to be most susceptible to caries right after eruption. Teeth that erupt earlier would also be exposed to cariogenic bacteria for a longer amount of time, potentially allowing them to incur more damage (Lukacs and Largaespada 2006). 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 (Featherstone 2004; Hillson 1986). Genes determine the final form of teeth, thereby determining the final location of carious lesions.

The influence of genes in salivation is well known (Lenander-Lumikari and 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.

The genes that determine sex have a recognized influence on the rate of salivation (Lukacs and Largaespada 2006). Women have been found, both in the archaeological record and in the modern day, to have a higher rate of dental caries than their male counterparts. Cucina and Tiesler (2003) found that high status women in the Mayan world had the highest rate of caries. Watson (2008) found the same thing in the Sonoran desert. This could in part be because women have smaller salivary glands than men, giving them less saliva overall (Lukacs and Largaespada 2006). More likely is the estrogen link. Lukacs and Largaespada (2006) explain that high amounts of estrogen have been shown to cause low levels of saliva production. This explains why historically people have observed a direct correlation between number of pregnancies and rate of dental disease.

Archaeologists have long recognized the non-environmental factors in dental caries rates, noting that sometimes groups in the same geographic area who utilize the same resources will still have very different caries rates (Costa 1980; Cucina and Tiesler 2003). Costa (1980) looked at three Eskimo groups: two from Point Hope, Alaska and one from Kodiak Island, Alaska. The two Point Hope groups lived in the same area and utilized most of the same resources, but they ended up with very different caries rates. He suggests that in addition to utilizing some resources at different rates than others, genetic differences could account for much of the variation (Costa 1980).

Microbial factors that contribute to caries development. The types of microbes present in the oral cavity are another critical factor in caries development, since it is the microbial activity that forms the lesions in question. There are 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 *Streptococci mutans* (MS) (Cucina and Tiesler 2003; Loesche 1986; Lukacs and Largaespada 2006). There are four generalized types of *Streptococci mutans* : *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 plaque, which when hardened forms dental calculus (Lenander-Lumikari and Loimaranta 2000). The plaque protects the bacterium from environmental assaults and provides them with a more hospitable living environment (Marsh, 1994).

S. mutans is thought to be the bacterium that is most destructive during the initial stages of lesion development (Loesche 1986, Lukacs and Largaespada 2006). 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.

These bacteria live in a state dubbed "microbial homeostasis" (Marsh 1994). The numbers of each species tend to remain constant over time, unless acted upon by some outside force. The outside force most associated the disruption of microbial homeostasis and caries development is sucrose (Staat et al 1975). Sucrose enters the oral cavity where it is fermented by microflora of the mouth. Lactic acid is produced, lowering the pH of the mouth. This makes it easier for acidogenic species to reproduce and kills off acid-sensitive species like *S. sanguis* that promote oral health. The surviving acidogenic species go on to produce more acid and continue to outnumber the acid-sensitive species.

This is a vicious cycle that can lead to some individuals having a lower baseline pH in their oral cavity (Bowen 2002). The low pH provides an ideal environment for these destructive microbes, which continue to consume carbohydrates and excrete acid, forming more lesions and destroying dental tissues.

Structural factors that contribute to caries development. The acidogenic bacteria that cause dental caries tend to be most prevalent, and do the most damage to the tooth, on surfaces that contain an abundance of their food source (Hillson 2001; Lieverse 1999). Because these bacteria digest particulate carbohydrates, any location where those particles congregate is more susceptible to lesion development. The occlusal surface of molars and premolars are lined with grooves in which carbohydrate particulates can accumulate. As a result, these more rugged surfaces are often more likely to develop lesions (Fejerskov 1997, Hillson 2001). Dental calculus also provides a hospitable surface for carbohydrate particulates, and the microbes that consume them, making the supregingival and subgingival regions of a tooth more susceptible to lesion formation (Lieverse 1999).

The role of occlusal wear has also been noted, especially when studying hunter-gatherer populations. Some scholars think that the high level of occlusal wear seen in hunter-gatherer populations may lead to a high rate of caries (Dias and 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 odontopathic microbes, which release acid, break down the tooth further and form caries.

Others have suggested that the heavy occlusal wear seen in archaeological hunter-gatherer populations would have the opposite effect, wearing down and obliterating tissue on which carious lesions had been forming (Lillie 1996). This is a common problem, and is difficult to address in studies as absent lesions cannot be counted (Costa 1980). Examining the rate of carious lesions by age can help give insight, as older individuals would be more likely to have obliterated dental tissues through wear and tear, and through AMTL. If young people have higher rates than old people, the possibility of lesion obliteration can be discussed.

It has long been theorized that an increase in dietary carbohydrates leads to an increase of carbohydrate particulate accumulation throughout the mouth, leading to lesions on both rugged and smooth surfaces (Hillson 2001). Archaeological studies have demonstrated that this is often the case, as carbohydrate preparation can influence the oral environment (Tayles et al. 2000). When examining dental caries, noting the surface on which a lesion is present can give some insight into how the lesion was formed, and perhaps speak to the overall etiology of caries formation within the population in question. It can also give hints as to their diet, foodways, and lifeways of the society in question.

Behavioral factors that contribute to caries development. Because culture has an impact on the utilization of available dietary resources, it is thought to have an effect on caries development. Martin and colleagues (1991) talk about Bumstead's (1984) theory that each geographic area contains dietary resources which are then distributed based on cultural and individual tastes. They explain that each population has a menu of foods to choose from, consisting of all the available dietary resources in their area. From that menu, certain foods are selected to form a meal, which is what individuals actually consume. Choosing which foods make up a meal is based on both immediate practical concerns, such as seasonality and quantity, as well as cultural concerns.

This model is incredibly useful when discussing caries rates because it points out that, even within a population, not all individuals will be consuming the same things. Technology can limit what resources are available to individuals, namely the knowledge of agriculture and animal husbandry. What people eat can also be influenced by the attitudes of their particular culture towards certain items, or towards certain groups within the culture. This model used by Martin and colleagues (1991) and Bumstead (1984) discusses the obvious fact that just because a group of people lived near a dietary resource does not necessarily mean they utilized it, or that all members utilized it in the same way or to the same extent.

The idea that membership in a subgroup influences one's access to resources has been discussed by a number of scholars. One of the most frequently studied types of subgroup membership is of sex-based subgroups, typically posited as a binary of male and female. Numerous anthropologists have recognized that there seems to be some link between an individual's sex and their susceptibility to dental caries (Costa 1980; Bretz et al. 2005; Cucina and Tiesler 2003; Hillson 2001).

As discussed earlier, genetics is definitely a factor in one's susceptibility to carious lesions, especially as it relates to sex. Behavior is also thought to be a factor, whether it involves a female's role in food preparation, or some larger cultural idea about the importance and worth of females relative to males (Cucina and Tiesler 2003; Tayles et al 2000).

Social status is another often studied subgroup, with societies being divided into a binary of elite and common (Cucina and Tiesler 2003; Lanfranco and Eggers 2010). This type of analysis is especially popular in studies of Mesoamerica and South America, as historical texts document a clear social hierarchy. Because the archaeological record indicates that the ancestral Puebloans had a similarly stratified society, social status is also a viable area of inquiry.

Population Studies

Carious lesion rates have been examined in archaeological populations across the world. Variables such as sex, subsistence mode, social class, and age have all been looked at both in and out of the American Southwest.

Subsistence Mode and Dental Caries. For over twenty years, anthropologists have been positing a link between a population's subsistence modes and their rate of dental caries. In 1982 a conference was held at State University of New York College at Pittsburgh. At this conference, a number of landmark papers were presented, which were later compiled in the book Paleopathology at the Origins of Agriculture. These papers discussed an apparent drop in health that seemed to coincide with the rise of agriculture.

This relationship between poor health and agriculture would become something of a theme in paleopathology. Watson (2008) explains that it became an accepted fact that the transition from a hunter-gatherer subsistence mode to an agricultural one led to an increase in population, sedentism and a decrease in overall health. This pattern could be demonstrated by skeletal stress markers such as Harris lines, enamel hypoplasias, periosteal reactions, and dental caries (Cohen 1984). Hillson (2001) posits that an increase in the amounts of starches in the diet leads to a subsequent increase in the amount of caries in a population. Martin and colleagues (1991) suggested a similar pattern, as did Hodges (1989).

More recently, it has become clear that the relationship between subsistence mode and caries rate is not as simple as was once thought (Tayles et al. 2000; Watson 2008). Transitioning from a life of hunting and gathering noncariogenic foods to farming cariogenic foods can lead to an increase in caries rates. But that is not the only type of transition that can, and has, been documented in the archaeological record. Several studies have shown that people who gather cariogenic foods can see improved dental health when they transition to the less cariogenic foods that they have grown. Not all pre-agricultural diets are low in cariogenic carbohydrates. Scientists now state that the most important factor in the caries rate of any given hunter-gatherer population is actually the type of food being eaten.

Studying different groups is critical, as each population across both space and time is different. Lukacs (1992) explains that "As each region of the world has its own distinctive biological, geological, and chemical attributes, each human population is characterized by unique cultural patterns and genetic composition" (134). This necessitates independent study of many different populations to ensure a good understanding of local conditions at the time in question.

Landmark Population Studies. A number of landmark studies have contributed a great deal to scholar's understanding of how ancient civilizations were sustained and organized by examining dental caries in bioarchaeological samples.

One of the most frequently cited studies was conducted in 1979 by Christy Turner. In his study, Turner looked at the dental health of the Jomon people of central Japan. He recorded caries rates for individuals from the Middle to Late Jomon Period (3600-300 B.C). The Jomon of this period were thought to practice agriculture, but no solid evidence had yet been found at the time of publishing. Turner compared the rates of dental caries in the Jomon to rates in several other groups: modern Hokkaido Ainu, an indigenous group in Japan; northern Chinese individuals from the Shang Dynasty (1400-1100 B.C); modern Taiwan Atayal, an indigenous group in Taiwan; individuals from the eastern Thailand site of Ban Chiang, and numerous Inuit and Aleut individuals from North America.

Each of these groups was used for comparative purposes at least in part because their method of subsistence was known at the time of study. Looking at these groups, Turner found that those who practiced agriculture had higher rates of caries than those who did not. The Jomon rates were close to those of the agricultural groups, indicating that the Jomon of central Japan were practicing agriculture during the Middle to Late Jomon Period.

Turner (1979) was not the only scientist to reach this conclusion. Many other studies have suggested that the adoption of agriculture led to many populations leading sedentary lives filled with abundant cariogenic carbohydrates (Lukacs 1981). The evidence in the archaeological record does not unequivocally support this conclusion.

Hunter-gatherer populations also 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).

In his study of Eskimo groups from Point Hope, Alaska and Kodiak Island, Alaska, Costa (1980) found that all three hunter-gatherer groups had high levels of occlusal wear, though two had a higher rate than the third. He determined that this high level of wear was due to their diet, which was heavy in grit, along with their cultural practice of eating large amounts of food, and doing so often. He said this occlusal wear led to exposure of the pulp chamber and likely led to a larger than expected number of abscesses. This may be why so many teeth were lost antemortem. The tooth loss may also have led to an artificial drop in the caries rate, with carious teeth falling out. Hillson echoes Costa, contending that the teeth of hunter-gatherer populations may wear down faster than carious lesions can form, thereby leading to a lower carious lesion count (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). Keene (1986) looked at the remains of 1,338 Hawaiian individuals believed to have lived and died in the prehistoric period. He found that regardless of sex, all age groups had a very low caries rate before contact. Those under age 15 had no caries, and those over 40 had the most as a percentage. He contrasted this with the post-contact populations, which have "catastrophic" caries rates (Keene 1986: 937).

Tayles and colleagues (2000) looked at caries rates from three sites in Thailand. They studied how the rate of dental caries changed over time for the populations as a whole, for each site, for men and women, and for different age groups. They found that in the period before rice agriculture, women had higher caries rates than men. As rice agriculture became more intensely exploited, the caries rates of both sexes dropped. The later groups had almost identical rates of dental caries, which since women had a much higher rate of caries initially means they dropped much further in absolute terms.

Tayles and colleagues (2000) suggest that women may have had a much higher caries rate initially because of their role in food preparation. Consuming food throughout the day can lead to the pH in the mouth being acidic for longer periods. This is because every time a person eats, the acidogenic bacteria of the mouth consume fermentable carbohydrates and produce acid, sending the pH lower (Loesche 1986). After the initial drop, it takes several hours for the pH to return to normal. Continual eating, even if the amounts of food are small, prevents the mouth from ever returning to its neutral pH, leading to a higher rate of caries. Tayles and colleagues (2000) suggest that this process led to women having rates of caries as high as 21% in their Khok

Phanom Di sample. They posit that the adoption of agriculture, which put women in the field rather than in the kitchen, led to less frequent carbohydrate consumption and was therefore one of the factors in women's later lower rates of caries.

Larsen and colleagues (2001) looked at Native Americans from coastal Georgia and northern Florida spanning a vast period, from 400 BCE – 1450 CE in Georgia and 0 CE -1700 CE in Florida. They looked at disease patterns and biomechanical changes as shown in the skeletal remains. When discussing dental caries, Larsen and colleagues wanted to study how diet changed over time, and the impact that had on the population as shown through carious lesion rates. They found that when native groups transitioned from a varied hunter-gatherer diet low in cariogenic foods to a diet that relied heavily on maize, caries rates went up. Women were found to have higher caries rates before contact than men. Larsen and colleagues suggest that this is due to the sexual division of labor in the pre-contact period, which had women preparing the cariogenic food and thereby consuming more of it. As in the study by Tayles and colleagues (2000), Larsen and colleagues suggest that the sexual division of labor may have led to differences in caries rates.

Phillip Walker and Jon Erlandson (1986) reached a similar conclusion in their study of the prehistoric inhabitants of Santa Rosa Island off the coast of Santa Barbara, California. Walker and Erlandson looked at 155 individuals from three different burial sites: Canada Verde, Skull Gulch A, and Skull Gulch B. Canada Verde was an early period site, Skull Gulch A was a middle period site, and Skull Gulch B was a late period site. They looked at both the caries prevalence and the number of caries by dental arcade and by tooth type. Comparisons were made between males and females in each period, and between the total number of individuals in each period. Age specific comparisons were also made to ensure that any differences found between sexes and periods were not simply a result of age related sampling bias.

Walker and Erlandson (1986) found that the early period individuals had a significantly higher rate of caries than individuals of the middle and late periods. Both the caries prevalence overall, and the percentage of carious lesions by tooth type, decreased over time. Further, the early period inhabitants showed significant differences in caries rates between males and females, while later periods did not.

This result was puzzling in light of archaeological evidence from Santa Rosa Island. It had been assumed that high protein resources, such as shellfish and sea mammals, were the main source of nutrition throughout the occupation period. Midden deposits had lots of shells, dating back from the early period. The fact that stone "donuts", which ethnographic accounts suggest were used with digging sticks to gather tubers, were found in higher numbers there than anywhere on the mainland, and were found throughout the occupation period, was usually ignored.

Walker and Erlandson's (1986) study suggests that they should not be ignored. The heavy dental wear seen in early period individuals is consistent with a diet high in gathered carbohydrates, as is the presence of these stone “donuts” and of milling stones at higher elevations. Over 80% of early period individuals had one or more carious lesion, while less than 50% had one or more in the later periods. Marine resources are high in fat and protein, not carbohydrates, making them less cariogenic. They are also high in fluoride, which is known to inhibit carious lesion development. This study suggests that, over time, the residents of Santa Rosa Island became more dependent on marine resources, and as their reliance on carbohydrates diminished, they suffered fewer carious lesions.

The difference in caries rates between the sexes, seen in the early period, disappears during the later periods. Walker and Erlandson (1986) suggest that this reflects gender roles and the division of labor in place on Santa Rosa Island. They point out that females on the mainland were in charge of procuring and preparing the wild plants, including the carbohydrates, while males were in charge of acquiring animal proteins. That protein was then often shared, though not always.

The results of their analysis suggest that the inhabitants of Santa Rosa Island, like their contemporaries on the mainland, had a similar division of labor. As females acquired and prepared carbohydrates, they may have developed more carious lesions either through the sampling of food as they prepared it, or by being denied an equal share of the hunt, as their mainland counterparts were. The equal caries rates seen between males and females in later periods could suggest that females were, over time, given equal access to protein, though Walker and Erlandson (1986) think it more likely that the entire population simply began consuming more marine resources and fewer carbohydrates, making it impossible to use carious lesion rates as an indicator of social standing or production roles.

Lukacs (1992) studied the Bronze Age settlement of Harappa, looking at the relationship between agricultural intensification and dental caries, much as Hodges (1989) did. Harappa is a mound site on the Indian sub-continent, near the Ravi River. Lukacs studied the frequency and distribution of a number of dental pathologies in this population, including dental caries. Carious lesions were found in 43.6% of the population. Chi-square tests were performed to look for differences in the rate of males and females affected, though none was found ($p > .05$).

In addition to frequencies, teeth were examined by tooth type, by jaw, lesion location, and lesion size. Only 6.8% of teeth had 1+ lesion, though maxillary elements were more likely to be affected than mandibular elements (9.1% vs. 4.8%). Lukacs thought this number might be a bit low, as carious lesions can eventually cause tooth death and AMTL, making 6.8% the minimum number of teeth affected. Nearly half of the observed caries (49%) penetrated the pulp chamber, which suggests that the lesion rates may be vastly under reported due to AMTL.

Males and females had similar patterns of lesions, with one exception. Females at Harappa had a higher rate of maxillary anterior lesions than males. Lukacs said that females in this population must have been using their anterior maxillary teeth differently than males for this pattern to exist. Females overall had a higher number of carious teeth than males, and of carious maxillary teeth than males. The difference was not statistically significant, but is interesting when noting the anterior maxillary lesion differences. Caries overall tended to be larger when found on the maxilla, though the difference was not statistically significant.

Females tended to have a higher rate of pulp chamber exposure due to caries, more AMTL, higher caries rates, and more enamel hypoplasias than their male counterparts. Lukacs suggested that female consumption of carbohydrates during food preparation and male consumption of protein during the hunt combined synergistically to give females more dental pathologies than their male counterparts. Differential access to food sources is also indicated by the enamel hypoplasia rates, which show that females received less nutrition growing up than males. This shows that females may have been valued less in Harappan society. Though Harappa may not have had rigid social classes, it is clear that not all individuals were treated equally. Sex roles seem to have impacted both one's role in food acquisition and preparation, as well as access to foodstuffs.

Southwest and Mesoamerican Populations Studies. A number of studies have looked at carious lesion rates in populations across the prehistoric Southwest, Mesoamerica, and South America. The populations examined include early agriculturalists from the

Sonoran desert and the Valley of Oaxaca, ancestral Puebloans from the Colorado Plateau, and individuals from the Classic Mayan world.

Watson (2008) looked at 135 individuals from the La Playa site in Sonora, Mexico. These individuals were from two different phases: the San Pedro phase and the Cienega phase. The people of both phases were early agriculturalists. The San Pedro phase predates the Cienega phase, and is characterized by less complex material culture and architecture. Despite the agricultural intensification demonstrated by the presence of irrigation canals, the people of the San Pedro phase relied on agriculture and foraging equally. The people of the Cienega phase had more complex architecture and material culture, lived in bigger settlements, and relied less on foraging than their ancestors. Like other Southwest and Mesoamerican sites, including Pottery Mound, the people of La Playa were maize agriculturalists.

Watson (2008) compared the proportion of individuals between sexes and phases with at least one carious lesion or who showed signs of AMTL using chi-square tests. The frequencies of carious lesions and AMTL were compared across sex and phase using t-tests. The chi-square tests found the proportion of males and females to have at least one carious lesion were comparable, as was the proportion of males and females experiencing AMTL. There was an increase in the proportion of individuals with one or more carious lesion between the two phases, but the difference was not statistically significant. The proportion of individuals in the two phases with signs of AMTL was not statistically significant either. This shows that males and females were affected in equal numbers by carious lesions and AMTL, as were the populations of both phases.

The frequency of caries between the two phases did not increase, suggesting that as agriculture became more important in the La Playa diet, the number of caries did not increase. Watson (2008) points out that the local wild flora, such as cacti, were themselves incredibly cariogenic. Since the La Playa people were gradually replacing cariogenic cacti with cariogenic maize, the caries rate stayed the same. This illustrates the importance of considering available local resources when analyzing carious lesions in an archaeological population. What people eat is more important than how they get their food.

There was a difference in caries frequency between males and females, but it was not statistically significant. This suggests that males and females utilized similar types of dietary resources and likely had the same menu. Any socially constructed ideas about the roles and worth of males and females does not appear to have translated into differing access to dietary resources.

Hodges (1989) looked at individuals from the Valley of Oaxaca, where maize agriculture first began. Her study is unlike the others, in that the Valley of Oaxaca is a region of primary agriculture development, while most other populations found in the literature are from regions of secondary agricultural development. Hodges looked at three different periods in the Valley: the Formative (1400-200 BCE), the Classic (200

BCE-1000 CE), and the Postclassic (1000-1400 CE). She wanted to look at whether the health status of the people of the Valley of Oaxaca changed over time. Did agriculture make them more or less healthy?

Hodges (1989) looked at the remains of 549 individuals, who were from 14 sites in the Valley of Oaxaca. Several types of paleopathology were examined, though only the information on caries will be discussed. Chi-square analyses of frequency between periods, between sexes, and between sexes in different periods, were all performed.

Though the Valley of Oaxaca experienced great dietary change in the centuries under study, the results were quite consistent. Hodges (1989) first looked at the frequencies of individuals affected by caries. Males and females were affected equally during the three periods. Sexes were then pooled and looked at across the three periods. Individuals during the Formative were more frequently affected by caries than those of the Postclassic. The individuals of the Classic period showed no significant difference in caries rates. The frequency of caries rises during the Formative period, levels off during the Classic period, and decreases during the Postclassic period.

In addition to looking at the overall caries frequency, tooth type was also examined in a way. Hodges (1989), like many others, explained that because the posterior teeth have more fissures for carbohydrates to become trapped in, they tend to have higher rates of carious lesions. Rather than examining each tooth type, anterior and posterior teeth were examined and analyzed separately.

During the Formative period, males had a higher rate of caries than females when looking at posterior, though not anterior, teeth. During the Classic and Postclassic periods, there was no significant difference between the rates of lesions seen in males and females, either anteriorly or posteriorly. There was no significant difference between the caries rates of males over time, either in posterior or anterior teeth. Females had no difference in posterior teeth, though their anterior teeth could not be examined over time because of the condition of the sample used. The severity of caries did not change over time, and was not significantly different among males and females.

The overall rise and drop in caries rates suggests that, as agriculture intensified, the use of these sticky carbohydrates caused caries rates to rise. The rise seems to have been small though, and virtually insignificant, since the only significant difference was in the posterior teeth of males and females during the Formative period. This paints a picture, much like that of prehistoric Sonora, of a population with uniform dental health.

The same cannot be said for the Classic Maya. Cucina and Tiesler (2003) looked at three Classic Maya sites from the northern Mayan region: Calakmul, Dzibanché, and Kohunlich. Forty-nine individuals from these sites were examined. Nineteen were high status, or elite, individuals. Thirty were low status, or common, individuals. The Mayan social hierarchy has been studied extensively, so much so that standards have been established for placing an individual in either the elite or common category. This makes analysis of the relationship between social status and other variables much more straightforward than it is in the ancestral Puebloan world, where social standing must be estimated by the individual researcher.

Cucina and Tiesler (2003) recorded both AMTL and carious lesions, with a carious lesion being defined as a surface lesion measuring at least 2mm depth. This is an unusually rigorous standard. The number of teeth affected by caries, the number of teeth unaffected by caries, and the percentage rate of teeth affected were examined both by dental arcade and separately by tooth type. Chi-square analyses were performed looking at these caries prevalence data between elite males and females, common males and females, elite and common males, elite and common females, and elite and common individuals regardless of sex.

The common individuals had a fairly uniform rate of caries prevalence, with no significant difference between males and females. The elite group showed a significant difference between males and females, with females having a significantly higher rate of caries than their elite male counterparts. There was a significant difference between common males and elite males, with elite males having the lowest rates of caries in the sample. Elite and common females had comparable rates, suggesting that elite males had very different caries prevalence than any other group in the population. The elites also had a significantly higher rate of AMTL than the common individuals, who had an overall higher rate of caries than their elite counterparts.

These results suggest many things. It is clear that, with a higher rate of AMTL and higher caries prevalence in males, elite social status did not guarantee better oral health. There was no correlation between age at death and either caries prevalence or AMTL, suggesting that culture, not time, was responsible for these differences.

Common individuals had higher caries prevalence, while elite individuals had higher rates of AMTL. The AMTL could lead to an under-representing of elite caries rates, since caries can often lead to tooth loss if left unchecked. Cucina and Tiesler (2003) point out that meat, a noncariogenic food, was consumed at different rates between the elite and common people of these sites. If elite males got more meat than anyone else, that would explain their lower rate of caries prevalence. Favoring elite males over elite females, and over all common individuals, is not unique to the Classic Maya, and makes sense in the overall cultural context of the warfare driven, Classic Mayan world. The numbers suggest that elite females may have had a diet similar to that of the common individuals, suggesting that they perhaps were not valued in the same way elite males were (Cucina and Tiesler 2003). In this case, caries prevalence not only illuminates past foodways, it illuminates past social structure and values as well.

Anthropologists have proposed a link between the development of agriculture in a population and higher rates of dental caries (Martin et al. 1991; Hillson 2001). Martin and colleagues looked at rates of dental caries in the Anasazi population at Black Mesa. They found that roughly one quarter of the individuals in the population had visible dental caries. They were surprised that the caries rates seemed to peak around the fourth decade of life, but posited that dental attrition might have worn away some of the lesions. They found that females had a higher rate of caries than males, and suggested that it may have been due to males and females utilizing different dietary resources.

Ann Stodder (1996) discussed caries rates at a number of prehistoric and contact era sites in both the Eastern and Western Pueblo culture areas. She looked at the number of adults in each population who had one or more carious lesion. In terms of absolute numbers, neighboring Hawikku had a caries rate of 53% between 1300-1680 CE, when the site was abandoned after the Pueblo revolt. San Cristobal, which was also abandoned after the revolt, had a caries rate of 57% over the same period. Pecos Pueblo had a caries rate of 48% between 1300-1550 CE, 61% between 1550-1600 CE, and 43% between 1600 and 1800 CE. Gran Quivira, abandoned shortly before the revolt, had a caries rate of 69% between 1315-1550 CE, 85% between 1550-1672 CE, and an overall rate of 81% between 1315-1672 CE. The difference in pre-contact and post-contact caries rates suggests to Stodder a change in diet from one high in meat to one high in carbohydrates.

Another bioarchaeological study of ancestral Puebloans was conducted in 1986 by Nancy Akins. She looked at burials from Chaco Canyon, New Mexico. Using specimens from the Maxwell Museum of Anthropology in Albuquerque, New Mexico, along with materials from the National Parks Service, Akins (1986) analyzed the remains from a number of sites in Chaco Canyon, including but not limited to Pueblo Bonito, Kin Kletso, Casa Rinconada, Turkey House, Leyit Kin, and Shabik'eschee Village.

Her sample was made up of 27 individuals from these collections whose teeth were present (Akins 1986). Of those individuals studied, four had no carious lesions and 23 individuals had at least one carious lesion. There were 21 adults and two juveniles with at least one carious lesion. The adults in her sample who had at least one carious lesion ranged in age from 20-55 years old. These adults had between 1-8 lesions each. She found that a 4 year old child in her sample, who appears to have had tuberculosis, had circular caries. Another child, age 5-7, had a single lesion.

Akins did not conduct any statistical analyses of these lesion rates, leaving it unclear whether age, sex, or any other factor may have influenced the development of caries in her sample group. She notes that tooth loss and abscessing were common, and that her caries rates might have been influenced by the lack of dental preservation found in her sample. Like the Pottery Mound sample, several of these Chaco Canyon burials were missing their maxillary or mandibular elements.

Conclusions. Carious lesion rates and severity have been studied by both biologists and archaeologists. Acidogenic bacteria consume carbohydrates and excrete acids, which demineralize the surfaces of an individual's teeth. Over time, the entire tooth can be destroyed. The disease process is fairly well understood, making it an excellent object of archaeological study.

The material culture of Pottery Mound has been studied, with special attention paid to the pottery and kiva murals. Little has been done with the teeth. As other studies have shown, carious lesions can provide a great deal of insight into how a culture was organized by indicating who ate what. This study will address these issues with the Pottery Mound population.

3. MATERIALS

Pottery Mound is an ancestral Puebloan settlement near the Rio Grande drainage. To understand who the people who lived there were, and why they decided to come together in such a hostile climate, one must have a good understanding of the ancestral Puebloan world.

The Study of Puebloan History and Culture

To discuss the pre-history of the Puebloan people, a brief discussion of nomenclature is essential.

Naming Conventions. What were the people who lived at Pottery Mound and culturally affiliated sites called? Since they do not appear to have had a written language, any name they used for themselves has been lost (Hibben 1975; Kantner 2001; Schwartz 2000). As a result, the only names we currently have access to have been bestowed by outsiders.

The group being studied here has been given many such names, including Anasazi, ancestral Puebloan, Hisatsinom, and Se'da (Hibben 1975; Kantner 2004; Michel 2006).

Each name refers to the group of people who from roughly 1000 BCE-1600 CE occupied Pottery Mound, Chaco Canyon, Mesa Verde, and a host of other sites in what is now the Southwestern United States and the northernmost portion of the state of Chihuahua, Mexico (Kantner 2001). Different stakeholders have used different names to refer to these people through time.

The term most commonly associated with these people is Anasazi, a Navajo word, which has been variously translated as "ancient ones"; "ancient enemy"; or "ancestor" (Hibben 1975; Kantner 2001; Michel 2006; Schwartz 2000). This name was bestowed by Alfred Kidder, one of the most influential early Southwestern archaeologists, in 1936 (Schwartz 2000). The name Anasazi was accepted by historians and archaeologists for several decades, appearing in books, journal articles, and museum placards.

Because these early people have been recognized from the days of the Spanish as having been the direct ancestors of the modern Puebloan people, some have asked why a Navajo, rather than Pueblo, word was first chosen. That a Navajo word was adopted made sense to many anthropologists, and some Navajo, as continuity was seen between the Navajo and the ancestral Puebloans (Hibben 1975; Kantner 2004).

In the introduction to his 1975 book, Kiva Art of the Anasazi at Pottery Mound, Hibben explains that the Navajo now occupy some of the land the ancestral Puebloans called home, and share certain artistic styles and textile designs with them. He contended that the Navajo "by proximity and contact, acquired much from their [Anasazi] culture (8)".

In the last 40 years, many modern Puebloans have taken issue with the use of the word Anasazi. Some of these individuals translate the word differently than Hibben and other archaeologists did, stating that it means "Ancestral Enemy" rather than "Ancient One" or "Ancestors" (Kantner 2004; Michel 2006). Others contend that the modern Puebloan people have a better claim of kinship with these people, and so a Pueblo word should be used, rather than a Navajo word (Kantner 2004; Michel 2006; Schwartz 2000).

The discussion is ongoing (Michel 2006; Schwartz 2000). At this point, scholarly books and articles refer to these people as ancestral Puebloans out of respect for the contemporary Pueblo peoples. In keeping with the current naming conventions, and out of respect for contemporary descendants of these groups, this study will be using the term ancestral Puebloan instead of Anasazi. When discussing the work of other researchers, the terminology chosen by those researcher will be used, whether it be ancestral Puebloan or Anasazi.

The Organization of Puebloan Prehistory. The ancestral Puebloans have been formally studied by archaeologists for almost a century (Schwartz 2000). Pot hunters and avocational archaeologists have been examining the material culture even longer, going all the way back to the pot hunting of Spanish conquistadores in the 16^{th} century

(Kantner 2001). One of the first, and certainly most significant, scholars to study the American Southwest archaeologically was Alfred Kidder. Building off the work done by early greats Adolph Bandelier, Nels C. Nelson, Alfred Kroeber, and Leslie Spier, Kidder began working under famed archaeologist Edgar Lee Hewett in the Southwest in 1907. His thesis and research were firmly rooted in the Southwest, specifically in the regions once occupied by the ancestral Puebloans.

After doing a great deal of research using ethnographic and historic accounts of Pecos Pueblo, Kidder began excavations at Pecos in June, 1915 (Schwartz 2000). Excavations continued annually until 1929, with a break from 1917-1919 which allowed Kidder to fight in World War I. Kidder's first published work on the site was titled Introduction to the Study of Southwestern Archaeology. Originally published in 1924, it became the first of seven volumes dedicated to his work on Pecos Pueblo, and is still in print as of this writing.

Combining both archival data and material culture specimens collected in the field, Kidder ordered major developments at Pecos Pueblo and used them to construct a system that could be used all across the Southwest to place different sites along a single cultural timeline (Schwartz 2000). Called The Pecos Classification, Kidder's system named and described eight stages of cultural development observed at Pecos Pueblo (Table 3.1).

Table 3.1. Pecos classification

Period	Description
Basketmaker I	Pre-agricultural. Also called Early Basketmaker, Archaic.
Basketmaker II	Also called Basketmaker. Sites lack pottery, bow and arrow technology. Earliest evidence of agriculture.
Basketmaker III	Also called Post-Basketmaker. Earliest pottery, with cooking vessels typically undecorated. Lived in pit houses.
Pueblo I	Also called Proto-Pueblo. Houses above ground, rectangular, grouped together, made of stone. Cooking vessels begin to show decoration, usually unsmoothed coils.
Pueblo II	Villages made up of very few people, tended to be spread out. Cooking vessels now typically show decoration, with unsmoothed coils covering whole surfaces.
Pueblo III	Also called The Great Pueblo Period. Arts and crafts present, specialized. Houses grouped together in large, often multi-story compounds.
Pueblo IV	Also called Proto-historic. Many villages abandoned. Depopulation of vast areas. Pottery style changes, with unsmoothed coil pottery replaced by plainware.
Pueblo V	Also called Historic. Begins in 1600. Contact Era.

When archaeologists like Hibben tried to use Kidder's system to study other parts of the Southwest, they encountered a host of problems (Schwartz 2000). The Pecos Classification uses the presence or absence of certain types of material culture to determine an overall chronology of the region, but the diversity present in the Southwest precludes its use in many places. Schwartz (2000: 28) explains "By the mid 1930s it was apparent that the Basketmaker-Pueblo sequence was an aspect only of the Northern Southwest". Other parts of the Southwest, in essence, did things differently, and at different times, than those in the Pecos region. As a result, the Pecos Classification became relegated to use by those studying ancestral Puebloans.

Even when looking at ancestral Puebloan sites like Pottery Mound, Kidder's Pecos Classification system is still of limited use (Schwartz 2000). Kidder himself had no means of absolutely dating artifacts, so when he proposed the system, there were no firm dates assigned to any of the periods he described (Kidder 1924). Tree rings dates were beginning to come into use, and carbon dating had not yet been discovered. Additionally, different villages entered each period at different times. This makes it impossible to say with certainty what the start and end dates of each period are, though ranges have been postulated (Kantner 2001). Each site should be examined through comparisons with contemporary sites, within the context of the region and culture's history, and of course as its own individual entity.

Because this study looks at the ancestral Puebloans of Pottery Mound, Kidder's Pecos Classification can be applied. Pottery Mound is a Pueblo IV, or Proto-Historic, site (Schaafsma 2007). Pottery Mound was formed during this Pueblo IV period, and so was not contemporary with the famed Pueblo sites of Chaco Canyon, Mesa Verde, and

Aztec. However, the patterns seen at Pottery Mound were clearly influenced by the rise and fall of these communities, and the larger patterns seen in the early ancestral Puebloan world. Therefore, an understanding of ancestral Puebloan history is essential. This discussion will focus on the more commonly accepted distinctions of Paleoindian, Archaic, Basketmaker, and Pueblo Eras.

The Origins of the Ancestral Puebloan People: Clovis to Chaco Canyon

The history of the ancestral Puebloan people spans almost 15,000 years. This is an incredible span of time, and it can, as mentioned above, be conceptualized in many different ways. This study will begin with a brief overview of the Paleoindian and Archaic eras, discussing the Clovis culture. Because the southwest has some of the earliest evidence of material culture ever found in North America, and that material culture led directly to the material culture being discussed at Pottery Mound, these early centuries must be examined. The Pecos classification will then be used, with a discussion of the Basketmaker period, and an in depth discussion of the Pueblo period.

Paleoindian and Archaic. Archaeological evidence suggests that Puebloan peoples have inhabited the region known today as the American Southwest since the end of the last Ice Age, in what scientists call the Pleistocene era (Kantner 2001).

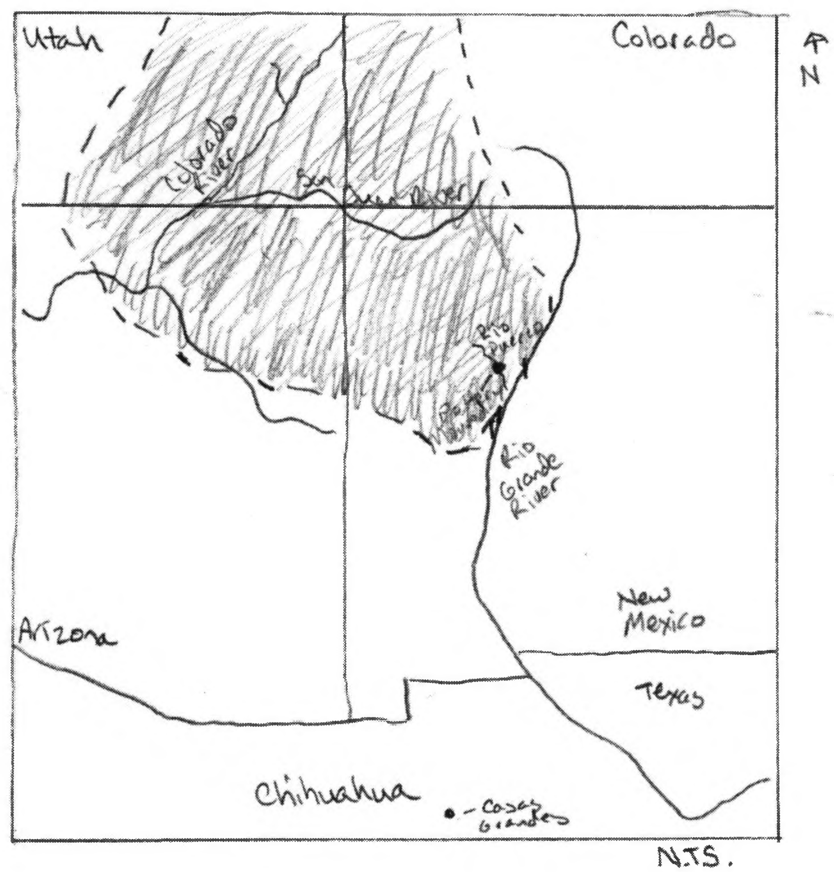


Figure 3.1: Map of the Southwest, with the Colorado Plateau shaded

Archaeologists refer to this period of early human habitation as the Paleoindian period. Several Paleoindian sites have yielded stone tools dating back over 13,000 years, which make up a material culture dubbed the Clovis culture.

Though they inhabited many of the same regions that Ancestral and Modern Puebloans settled, Clovis peoples lived in a very different kind of environment. During the Pleistocene era, the climate of the Colorado Plateau and its environs was moister, and more stable. What are today deserts were grasslands during the Pleistocene, with woodlands covering the lower elevations and permanent ice and snow at higher elevations. The abundance of accessible surface water and large game animals, including megafauna, sustained the nomadic hunter-gatherers of the late Pleistocene.

There are still a number of important questions being asked about the Paleoindian period, and the Clovis culture that seems to have started it. Were these Clovis people the earliest inhabitants of the region? Where did they come from? How and when did they get to North America? While some archaeologists and scientists are attempting to find evidence of earlier inhabitation, most archaeologists accept the premise (for now) that the Clovis culture is what we have left of the earliest inhabitants of North America, and of the American Southwest in particular. The earliest widely accepted dates for the Clovis culture in this region are roughly 11,000 BCE. Any earlier dates for this region will have to be addressed in later studies.

What led to the end of the Clovis culture is unclear (Kantner 2001). As the climate grew drier and the Megafauna went extinct, the Clovis culture seems to have faded away. Some suggest that the Younger Dryas stadial, a massive cold snap that took place 12,800-11,500 BP, caused by a comet impact, may have killed off the megafauna and ended the Clovis culture (Holliday and Meltzer 2010). Holliday and Meltzer themselves (2010) disagree. They think Clovis may have simply changed over time, producing the Archaic and eventually Basketmaker period material cultures. Their study has found evidence of culture change rather than abandonment or some kind of natural cataclysm.

That culture change produced the Archaic culture of the Southwest, which like the Clovis culture appears to have been fairly uniform throughout the region. During the Holocene period, the southwest climate changed, growing drier (Kantner 2001). The material culture and diet of the people changed with the climate, though it is impossible to say at this time if that was the only force driving change in the region.

Due to the fragile nature of many of the materials used by Archaic peoples, and the lack of large scale landscape change brought about by their nomadic lifestyle, the archaeological record has little to tell us about the Archaic period. Archaeologists know that Archaic peoples were hunter-gatherers who used tools made of wood, bone, cordage, hides, and stone. Grinding stones, bone tools, atlatls, and baskets have all been found at various archaeological sites throughout the region. The material culture seems to have varied little across the region. Pottery had not yet been introduced.

By 550 BCE the region was occupied "widely, though thinly" (Kantner 2001: 57). Agriculture and animal husbandry seem to have their roots in the Archaic period. The earliest form of maize reached the Southwest around 2000 BCE, though it is not thought to have become an important source of calories until 1000 BCE. Evidence for the introduction of domesticated turkeys has been found dating as far back as 500 CE.

During the Archaic period, people began transitioning from living in a series of open air brush shelters, called ramadas, across the landscape to building more permanent, though simple, structures and returning to them each year. Over time these structures, called pithouses (Figure 3.2), became more complex and plentiful, turning into what we today would consider villages (Kantner 2001; Kidder 1924; Schwartz 2000).

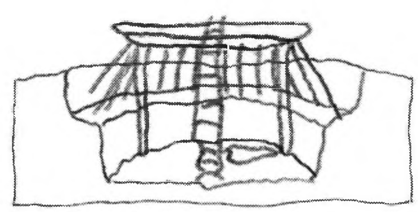


Figure 3.2: Pithouse.

Pithouses consisted of a single semi-subterranean room, with beams rising up several feet above the ground surface. Those beams would then be covered by brush, or wattle and daub. Eventually these shelters became more complex, replacing brush coverings with basic masonry. Stone and mortar pithouses appeared, along with adobe, and gradually transitioned to stone and mortar pueblos during the Basketmaker and Pueblo periods.

Ancestral Puebloan History: Basketmaker. During the Paleoindian and Archaic periods, there appears to have been little diversity across the Southwest (Kantner 2001). People lived in small, nomadic groups that were widely spaced across the landscape and culturally indistinct. This began to change during the Basketmaker period, with a series of massive technological innovations, regional distinction, and cultural diversity which have lasted to the present day (Kantner 2001; Schwartz 2000). Much of this change appears to have been brought about by the increasingly large role of agriculture in the Southwest.

It was during the Basketmaker I period that the transition from nomadic hunter-gatherers to semi-settled agriculturalists began (Hibben 1975; Kantner 2001; Kidder 1924; Schwartz 2000). Kidder (1924) first postulated the arrival of maize in the Southwest as occurring between 2000-15000 BCE. The advent of modern dating techniques, such as radiocarbon dating, allows scientists to say with a great deal of certainty that in fact maize became popular 1000-1500 BCE, sometime during the late Basketmaker I – early Basketmaker II period (Kantner 2001; Schwartz 2000). Beans followed in 400 BCE (Schwartz 2000).

Initially agriculture was not especially important to the people of the Southwest (Kantner 2001; Kidder 1924; Schwartz 2000). Crops were grown in small batches and used to supplement the foods gathered through traditional hunter/gatherer methods. By 1000 BCE irrigated fields began appearing in certain areas (Kantner 2001).

The increased importance of agriculture led to a dramatic change in lifestyle for the ancestral Puebloans (Kantner 2001; Kidder 1924; Schwartz 2000). One major transition occurred in the realm of housing. The earliest inhabitants of pithouses in the southwest ate a variety of foods and were still very mobile, spending at least part of the year living away from their pithouse villages (Gilman 1987). This changed when maize entered the region (Kantner 2001; Kidder 1924; Schwartz 2000). Crops had to be planted, fields had to be weeded, and animals, birds, and other people had to be kept out of the fields. This led to a shift from constantly mobile hunter-gatherers to more sedentary semi-agriculturalists. Pithouses became larger, as they were now used for much longer periods as storage and habitation spaces. Kivas, the underground religious chambers of the Puebloans, started appearing in these settlements. These proto-kivas were located in open areas and appear to have been mixed-use spaces. They share traits with both Pueblo period kivas, and with storage chambers.

Being in a single place for long periods meant that, during those periods, the only available resources were those within walking distance. Hunting and gathering could, and did, still go on, but now people could only engage in these activities close to their fields. Ancestral gathering grounds several days journey away could not be reached when the people could not leave their fields for days at a time. Being unable to practice their traditional gathering routines made people more reliant on crops, forcing them to become more settled. This created what Kantner (2001:61) describes as "a feed-back loop". Being settled made people more dependent on agriculture, which required that they be more settled.

Their dependence on what scholars refer to as "the holy trinity", maize, beans, and squash, specifically led to a population boom (Kantner 2001). Through agriculture people were able to produce more food than ever before, which allowed each village to feed more people. Additionally, maize could be used for weaning infants, allowing children to be weaned sooner. By ceasing nursing earlier, women were able to become pregnant sooner than before, contributing to the population boom.

The feedback loop Kantner (2001) discusses led to a much more sedentary society. Temporary structures and seasonal pithouses gradually turned into small room blocks, then big room blocks. Permanent villages began to appear. As these villages became more established, cultural distinction began to occur. Regional differences began to appear in everything from architecture to arts and crafts. The single culture of the southwest Archaic period transformed into a dynamic landscape inhabited by four distinct cultures.

These four distinct culture groups or areas emerged at the beginning of the Basketmaker period. Schwartz (2000) identifies them as the ancestral Puebloan, Hohokam, Mogollon, and the Patayan cultures. Each group occupied a different area in the southwest. The ancestral Puebloans occupied the areas on and around the Colorado Plateau, located in the northern Southwest. The Hohokam lived in the deserts and river basin areas in southern Arizona. The Mogollan lived in the mountainous areas of southern Arizona and New Mexico. The Patayan lived along the western edge of the Colorado Plateau and the southern edge of the Colorado River.

Though these groups were culturally distinct and geographically distant, they were not isolated from one another (Kantner 2001). In addition to the type of contact brought about by their extensive trade networks, there is an archaeologically recorded history of individuals and groups leaving one area and moving to live and integrate to some degree with another group, a pattern that continued well into the Pueblo IV period and is seen at Pottery Mound.

Ancestral Puebloan History: The Pueblo Period.

The Pueblo Period heralded a number of important developments for the ancestral Puebloans. The much acclaimed Chacoan Culture rose and fell during the Pueblo I and

Pueblo II periods (Kantner 2001; Kidder 1924; Schwartz 2000). Pottery became more complex, and became tied to ethnic and religious identity (Adler 2007; Eckert 2007, 2009). Large scale migrations occurred and, as people moved around, settlements became more diverse and multiethnic (Kantner 2001). Kiva design became increasingly variable, then standardized. Religious practice seems to have followed a similar pattern, first with the Chacoan religion, then the Southwest cult, and the Katchina cult, which swept the region during the Pueblo IV period. Public and private architecture underwent a great deal of change (Adler 2007; Kantner 2001). Agriculture continued to grow in importance, leading to changes in health and resource distribution. Both violent and non-violent conflict appears to have played a major role in a number of these changes.

No discussion of the ancestral Puebloan world is complete without some discussion of Chaco Canyon. The people of Chaco Canyon were ancestral Puebloans, though their culture is often looked at separately. This is because Chaco Canyon had a major impact on the entire ancestral Puebloan world, changing its characteristics and setting the stage for community development and interactions for centuries to come. Therefore the word Chacoan appears in much of the literature about ancestral Puebloans, to distinguish the specific set of practices they introduced that radiated out across the ancestral Puebloan world from earlier and later practices. That convention is appropriate, and will be used here. Additionally, despite the amount of study done by archaeologists, there are still a number of unanswered questions about the Chacoan world. This discussion will attempt to illustrate the research done, and will make explicit several questions that remain unanswered.

Pueblo I and Pueblo II: Chaco Canyon and the Chacoan Culture. It is difficult to say when Chaco Canyon was first inhabited, as many early pithouse structures were destroyed to make way for the large scale architecture which Chaco Canyon continues to be famous for (Kantner 2001). Around 800 CE, during the Pueblo I period, clusters of pithouses and small pueblos were built around the Chaco wash drainages, which provided the people with a reliable source of clean drinking water. There is no evidence to suggest that these early settlements were politically affiliated at this time.

The first Great House, Pueblo Bonito, was built around 860 CE by one of these settlements. Great Houses were characteristic of the Chacoan culture (Kantner 2001). A Great House is a large building, often several stories high, containing hundreds of rooms. Chaco Canyon held several dozen. The Great Houses of Una Vida and Peñasco Blanco, each built by a different settlement, quickly followed. Between 860-900 CE the people of these settlements added wings to their Great Houses.

Why these structures were built remains a mystery, in large part because little is known about how the Great Houses of Chaco Canyon and its environs were used. Archaeologists have made the case for Great Houses being residential complexes, storage facilities, community recreational or religious spaces, and monuments to the greatness and superiority of the Chacoan people and way of life (Kantner 2001). It is possible that they may have served any one or more of these purposes through time. Regardless, this was the beginning of large scale Puebloan structures which, over time, would morph into the enormous pueblos seen at Pottery Mound and contemporary sites.

The Great Houses of Chaco Canyon were built during a period of environmental stability, with rainfall allowing large crop yields. This climate stability was important, as agriculture had become one of, if not the, most important source of nutrition for the ancestral Puebloans. The beginning of the Pueblo period had been an unusually dry period, lasting for almost 150 years. As the northern reaches of the ancestral Puebloan world, including Chaco Canyon, began to get more rainfall, Great Houses began to appear. Around 900 CE Great Houses began to be built outside of Chaco Canyon, appearing in the nearby San Juan Basin and Red Mesa Valley regions. By the end of the 1000s, Great Houses had spread out in all directions, appearing in what are now New Mexico, Arizona, Colorado, and Utah.

Archaeologists have long wondered why Great Houses were built outside of Chaco Canyon in the Chacoan style. Some suggested that Chaco Canyon sent out emissaries to spread their culture and influence. Others suggested that Chaco Canyon was the capital of a military power, which conquered the communities around it and absorbed them into itself. Kantner (2001) hypothesizes that as Chaco Canyon became more prosperous, its neighbors began emulating it in hopes of sharing some of its success.

Though the reason for Chaco's growing influence remains unclear, the Chacoization, as Kantner characterizes it, of the ancestral Puebloan world was complete by the late 1000s CE.

Chaco Canyon's influence was just that: influence. Kantner (2001) and other modern archaeologists do not believe that Chaco Canyon directly controlled these outlying settlements. Though the settlements produced Chacoan style pottery, buildings, and kivas, there is no evidence of any kind of formal political ties, or ties of patronage. These Chacoan settlements traded with their immediate neighbors and retained some of their earlier material culture. They appear to have been small autonomous communities that interacted with, and mimicked, Chaco Canyon. They were not colonies or members of a larger commonwealth. This is demonstrated by the fact that the influence of Chaco Canyon on their social structure was variable, and overall influence appears to diminish the further one looks from Chaco Canyon itself.

One characteristic of the Chacoan culture that appears to have spread is the presence of an elite socio-economic class. There has been a great deal of debate about how this stratification spread, and whether a strong social hierarchy was present in later periods, including the Pueblo IV period. There is no agreed upon method of determining the social status of individuals from the ancestral Puebloan world. Further study is warranted, and would likely add greater richness and depth to studies of ancestral Puebloan social dynamics, including those of Pottery Mound.

Because there is no single agreed upon system of establishing socio-economic level, a number of different variables have been used as indicators. One of the more obvious signs of a person's social status in the Chacoan world was the amount and type of grave goods they had, along with their burial location. Numerous burials have been associated with the Great Houses of Chaco Canyon (Akins 1986; Kantner 2001). Archaeologists have asked if those individuals buried in these monumental structures were members of the social elite, drawing comparisons to Ancient Egypt, the Mayan world, and the modern western world.

Akins (1986) looked at burials in Chaco Canyon, examining and comparing the remains of individuals found buried in Pueblo Bonito and in domestic areas. Those buried in the Great House had more grave goods, and those grave goods were of a higher quality and contained more luxury items. These individuals were, on average, 4.6 cm taller than those buried beneath their homes. Their skeletons also exhibited fewer pathologies. This suggests that, not only were these socio-economic classes real, membership in one or the other had a measurable impact on one's overall health. Whether this is a result of elite access to the best lands and foods, or a hereditary system whereby status and resource access was passed down along a line of descent as Akins suggests, is still being debated.

How these elites got their luxury items is not in question. Both luxury items, such as shells and turquoise, and everyday items like pottery, were imported to Chaco Canyon

(Kantner 2001). Material wealth poured into the canyon, and excavations at Chacoan settlements suggest that it did not flow back out. The people of Chaco appear to have been consumers, not producers. Though people moved to Chaco Canyon and its environs from other places, this flow of people cannot fully explain the amount of goods being brought in. Was it tribute? Were people in the Chacoan settlements outside the canyon trying to curry favor with the canyon's elites? And if so, why? These questions are still being debated, and no satisfactory answer exists at this time.

Elite or common, how did the people of Chaco Canyon and other Chacoan settlements live? And, more specifically, where did they live? During the Pueblo period, the pithouses of the Basketmaker Period began to creep up out of the ground, becoming adobe room blocks, or pueblos (Kantner 2001; Kidder 1924; Schwartz 2000). It is this new type of architecture, which the people of Pecos Pueblo continue to inhabit annually today, for which this period was named.

During the Pueblo I and Pueblo II periods, the room blocks became more closely joined, forming an L or U shape around a plaza. In Chaco Canyon these rooms were bigger than ever, as were the pueblos themselves. Multistory dwellings became more prevalent, with some room blocks at Chaco Canyon having 3-4 stories. This pattern of larger and larger pueblos holding more and more people would continue into the historic era.

At Chaco Canyon, the public plazas, ramadas, and kivas were gradually surrounded by private family spaces and spaces for the elite. Privacy became a feature of living in these large pueblos, with each family having their own clearly defined space.

The people living in these pueblos derived most of their nutrition from the crops they grew. Crops were the only source of nutrition that the ancestral Puebloans could control, which was important in an increasingly marginal climate like that of the Colorado Plateau. Crops could be grown and surpluses stored, to be distributed during the next dry year. This made access to arable land essential, and gradually became a source of conflict.

Towards the end of the Pueblo II period, the hold Chaco Canyon and its culture had on people of the ancestral Puebloan world gradually began to wane (Kantner 2001). The tools of modern archaeology make it difficult to say with precision when things end. People do not typically abandon a place outright, leaving everything behind and starting anew elsewhere. This is certainly the case at Chaco Canyon.

In the early 1100s CE, building at Chaco Canyon quickly tapered off. Remodeling became much more common, and remaining communal spaces began to get converted into private spaces. Some small Great Houses with internal kivas, dubbed McElmo structures by archaeologists, were built. These buildings were much cheaper to build and required less manpower. By the mid-1100s CE even this construction ceased.

This drop in construction coincides with a drop in the amount of trade goods being brought into the canyon (Kantner 2001). The midden layers grew thinner, and new types of shell began appearing. This could suggest old trade routes being closed off and replaced by new ones. Population consolidation began, and the number of people immigrating dropped. It is unclear if this was caused by a loss of prestige, though there is little doubt that this constriction of resources and people would have led to further loss of prestige, which may have started a cycle of depletion. The climate also began to change, with rainfall becoming more unpredictable. Though more places than ever had Chacoan Great Houses, Great Kivas, and architecture, Chacoan culture was waning.

Small communities began to spring up in the shadow of some Great Houses, while other Great Houses were remodeled, splitting the large building into two or more smaller structures that shared a common wall. Other Great Houses were burned down, sometimes with people still in them. Kantner (2001) suggests this may have been caused by a rise in factionalism, perhaps induced by the increasing scarcity of resources. The increase in violent deaths and cannibalism during this period lend credence to this theory.

Pueblo III: The Great Pueblo Period. When Chaco Canyon lost prominence and was abandoned during the mid 1100s CE, the people did not simply disappear (Kantner 2001; Kidder 1924; Schwartz 2000). Rather, a period of migration began that would continue into the modern day. Some moved to established villages like Mesa Verde, while others founded new settlements like Aztec (Schaafsma 2007a). These large pueblos give rise to the term "Great Pueblo period", which archaeologists use to characterize the Pueblo III period.

These pueblos were not only larger than those of the Chacoan culture, they were also organized differently (Schwartz 2000; Kantner 2001). This may be due to the great deal of population growth which, region-wide, was roughly 1% annually. During the Great Pueblo period, ancestral Puebloans began living in close quarters. The locations of settlements also began to change. Instead of having large settlements spread out across the open landscape of a plain or a mesa top, new settlements were constructed in more defensible locations, such as canyon shelves and cliffs midway up mesas and in canyons.

These villages may have been more defensible, but they presented some new problems to the ancestral Puebloans. People lost the privacy they had become used to during the Pueblo I and II periods, which almost certainly was difficult to adjust to (Kantner 2001). Interpersonal violence against women became much more prominent, with females showing significantly more nutritional stress and signs of healed injuries than males. This has led Kantner and others to suggest a shift to patrifocality, and perhaps even the taking of slave wives or concubines rather than a more traditional exchange of marriage partners. Fortunately for ancestral Puebloan women, this pattern was likely temporary, lasting only during the Pueblo III period. Living in close quarters also created sanitation issues, making waste disposal and microbe exchange more of an issue than it had previously been. These problems would continue to crop up in larger Pueblo IV settlements, like Pottery Mound.

Scholars have long discussed why Chaco Canyon and the Chacoan system were abandoned in the first place. According to Kantner (2001) there are a number of possible reasons why people might have abandoned their old settlements for new ones. Proximity may have helped keep kin ties strong, allowing land rights to be more easily and clearly passed down along family lines. This would have been important in the Southwest, where environmental degradation and climate change was taking a toll on the landscape. Productive land would have been increasingly rare and important over time, making issues of transference important. Also, the close social bonds would have given people a wider safety net if their own crops were to fail during a particularly hard year.

These migrations spiked during the late 1200s, during what archaeologists have dubbed "The Great Abandonment" (Kantner 2001: 199). Large portions of the Colorado Plateau were abandoned. People continued to move south and east, forming new settlements and expanding existing ones. This large scale migration coincides with an exceptionally dry period on the Colorado Plateau. The rains became unpredictable, with flash flooding causing the formation of arroyos, a problem that continued into the modern era. The arroyos consumed both settlements and precious farmland. What farmland remained became less productive as the soil was exhausted. Increased population density further stressed ever dwindling resources.

The large scale migrations of the Early Pueblo III period made the large, multi-ethnic towns of late Pueblo III and early Pueblo IV period unavoidable. The settlements, now more town than village, were larger than ever before. Variation began to appear in all aspects of the archaeological records. Though each town was made up of room blocks surrounding large plazas, different room blocks were organized in different ways. Kiva design ceased to be uniform, with round, square, and t-shaped kivas all appearing in the same town. The cliff dwellings were abandoned, and towns were once again built out in the open. Their sheer size may have been enough to ward off potential attack. The Rio Grande drainage, where Pottery Mound was built during the Pueblo IV period, shows this pattern continued into the mid 1400s CE.

These large, multi-ethnic towns were not especially egalitarian, as places like Grasshopper Pueblo show (Kantner 2001). In these large towns, newly arrived immigrants often ended up inhabiting the outlying parts of town, providing a buffer between the town founders and the potentially hostile outside world. They were allotted those most marginal farmlands, on what appears to have been a first come, first served basis.

There was some melding of traditions however, as shown by the pottery found at places like Grasshopper Pueblo and Pottery Mound. There were a variety of temper types, glazes, designs, and design locations (inner rim, outer rim, etc). Potters at these multi-ethnic towns like Pottery Mound combined various elements from different regions to produce unique pottery never before seen in the southwest.

Pueblo IV: The Proto-Historic Period. Archaeologists have been unable to study a number of important Pueblo IV period sites, such as the Zuni and Acoma Pueblos, because they are still inhabited by the descendants of the ancestral Puebloans, here called contemporary Puebloans (Kantner 2001). The Taos Pueblo, a UNESCO world heritage site, has been continuously inhabited for over 1,000 years, and therefore cannot be excavated in the same way a site like Chaco Canyon or Pottery Mound can. Though this limits the amount of certain types of information scholars can gather about the Pueblo IV period, a great deal has been uncovered because of excavations at sites such as Pottery Mound.

The Proto-historic Pueblo world was divided into two main categories: Eastern and Western Pueblos (Hibben 1975; Kantner 2001). Western Pueblos, such as the Hopi and Zuni pueblos, were located west of the Rio Grande River. Eastern Pueblos were found along the Rio Grande and slightly to the east, extending to what is now El Paso, Texas, along a river centered North-South line. Pottery Mound was technically an Eastern Pueblo town, though it has features characteristic of both Eastern and Western Pueblos.

The people who founded these settlements were part of the previously discussed migratory period, which was ongoing (Adler 2007; Kantner 2001). Warfare and the wholesale burning of entire pueblos once again became prevalent, forming large no-man's lands around the enormous pueblos.

During the Pueblo IV period, kiva shape began to vary by region, with Eastern Pueblos building traditional, round kivas, and Western Pueblos building square kivas. Pottery Mound, which was near the border of the Eastern and Western Pueblo culture areas, had both types. 17 kivas have been excavated to date at Pottery Mound, and only one, dubbed Kiva 10, was round. Though the ratio of kivas to living quarters dropped, the role of religion and ceremony did not diminish.

These Pueblo IV towns, like those that came before them, are not thought to have been especially egalitarian (Kantner 2001). The women of Hawikku enjoyed higher status than the supposed slave wives of the Pueblo III period, and may have existed in a newly matrifocal society. Whether this shift from patrifocal to matrifocal kin organization was region wide is unclear. Regardless of how kinship was organized, a social hierarchy was definitely in place.

Individuals who had been in a town the longest tended to have higher social standing than those newly arrived (Kantner 2001). Some have dubbed this the founder effect, not to be confused with the well studied type of genetic drift. The Katchina Cult, a Pueblo IV faith that swept the region, appears to have been used to give the people of these towns common ground, while allowing elites to cement their authority, and ambitious individuals to gain local, though not regional, power.

Ethnic identity also appears to have been important in the Pueblo IV world (Adler 2007; Eckhart 2007; Kantner 2001). One extensively studied tool of expressing membership in a sub-culture was through pottery. By the early 1400s CE specialist potters appeared in ancestral Puebloan towns. Some towns made only enough for themselves, while others mass produced vessels and traded them up to 120 km away. Pottery grew in size and intricacy over time. These vessels were difficult to make, and certain types of glaze could only be made using rare minerals. This may have been one of the reasons why certain towns, especially those with access to rare minerals, became pottery export centers. The symbols painted on them, and the location of those symbols, is thought to have been one of the ways people indicated membership in certain sub-groups, particularly ethnic sub-groups.

The burial patterns seen at many of these sites, including Pottery Mound, also suggest that ethnic identity was retained by the inhabitants of these large pueblos. At Pottery Mound, some individuals had numerous luxury items in their burials, while others had only a simple woven mat. The treatment of the individual also varied. Most individuals were buried, which was the common ancestral Puebloan practice. Others were cremated, which is not consistent with the ancestral Puebloan burial customs (Kantner 2001). This is one of the many lines of evidence for Pottery Mound being one of the many Pueblo IV period multi-ethnic towns.

Migration was not the only means of cultural flow between Pueblo IV towns. Trade was also important. According to Kantner (2001), the ancestral Puebloans of this era maintained social and trade ties with their neighbors, but gradually let many of the more far flung trade routes and social ties disappear.

That is not to say that all far flung trade routes went into disuse, though they did become more uncommon. Tribes from other regions did trade with each other, though not at the levels seen during the Pueblo I and II periods (Stodder 1996). According to Stodder (1996), a trade route existed between central Mexico and the people of Zuni and Pecos pueblos. Goods were carried back and forth between these groups. This included trade in luxury items, as evidenced by the Macaw skeleton found at Pottery Mound (Frank Hibben, Unpublished Data, Maxwell Archives), along with staples like food and pottery. Far flung settlements such as Pecos Pueblo and Gran Quivira received a significant amount of their meat through trade with Plains tribes (Spielmann 1989).

Some settlements, like Pecos Pueblo and Taos Pueblo, remained inhabited all through the Pueblo IV period. Others, like Pottery Mound and Casas Grandes, did not. Why were these places abandoned? Casas Grandes and many towns like it were abandoned and burned to the ground. Was this a result of warfare? Was it a type of ritualized burning? Archaeologists do not know. Pottery Mound, like many other towns of its time, was not burned down. It was simply abandoned. Did it have anything to do with the massive drought that swept the region, and coincided with Pottery Mound and many other town's abandonment? It may well have. Theories on why Pottery Mound specifically was abandoned will be addressed in the next section.

Archaeology is not always good at unraveling the reasons for rapid change: "Unfortunately, the decades leading up to Spanish entry into the Southwest and the pre- to post-contact connections are not well understood by archaeologists" (Kantner 2001: 255). Analyses of morphological skeletal and dental traits verify that people in the region migrated a great deal in the Pueblo period. Historical documents from the ethnographic present and beyond show that these migrations continued for centuries after contact, though the reasons behind these moves varied. The amount of gene flow has been so great that it precludes conclusively linking any modern or contact era population to any specific pre-contact populations. Scholars have also tried using the evolution of the language families in the Southwest to reconstruct population movements, but all those studies really tell us is where the language went, not who was speaking it or where they came from.

Another factor which has been difficult to study is the effect of Spanish arrival before contact. The effects of the Spanish arrival, namely disease, are thought by many to have spread across the region and reached pueblos long before the Spanish themselves did. The existing trade networks of the time likely played a role in that. The types of diseases the Spanish brought, such as smallpox and other acute infections, usually kill the infected individual before any changes to the skeleton can occur. That makes it hard to tell what role, if any, newly introduced infections had on these Proto-historic towns.

The End of an Era: The Contact Period. The first Europeans to enter Mesoamerica and what is now the American Southwest were Spanish Conquistadors. Hernán Cortés de Monroy y Pizarro landed in Mexico in 1512, introducing things like horses, guns, and a number of infectious diseases (Kantner 2001; Stodder 1996). The first documented contact between Europeans and Puebloans occurred in 1539, when Marcos de Niza delved deeper in North America and made contact with people of the Zuni Pueblo. He was followed in 1540 by Francisco Vásquez de Coronado, who entered the area with his army (Hibben 1975; Stodder 1996). The first Spanish colony in New Mexico was founded in 1598 in the Upper Rio Grande. In 1680 the Puebloan people united and drove the Spanish out of the region, but their departure was only temporary. By 1700, the Spanish had retaken the area. Non-Puebloans have lived in the region ever since.

Pottery Mound

The site known today as Pottery Mound (29-LA-416) is a Puebloan site in the Rio Grande Region, near the western edge of the Eastern Pueblo culture area (Schaafsma

2007a). Ceramic dating of pottery sherds found at the site suggests that Pottery Mound was occupied from 1370-1450/1475 CE, during the period known as Pueblo IV, or the Proto-historic period (Schaafsma 2007a, R. Vivian 2007). This date range been verified by archaeomagnetic data and non-cutting tree ring dates (Schaafsma 2007a). Ceramic analyses suggest it may have been occupied as late as 1500 CE (Adler 2007).

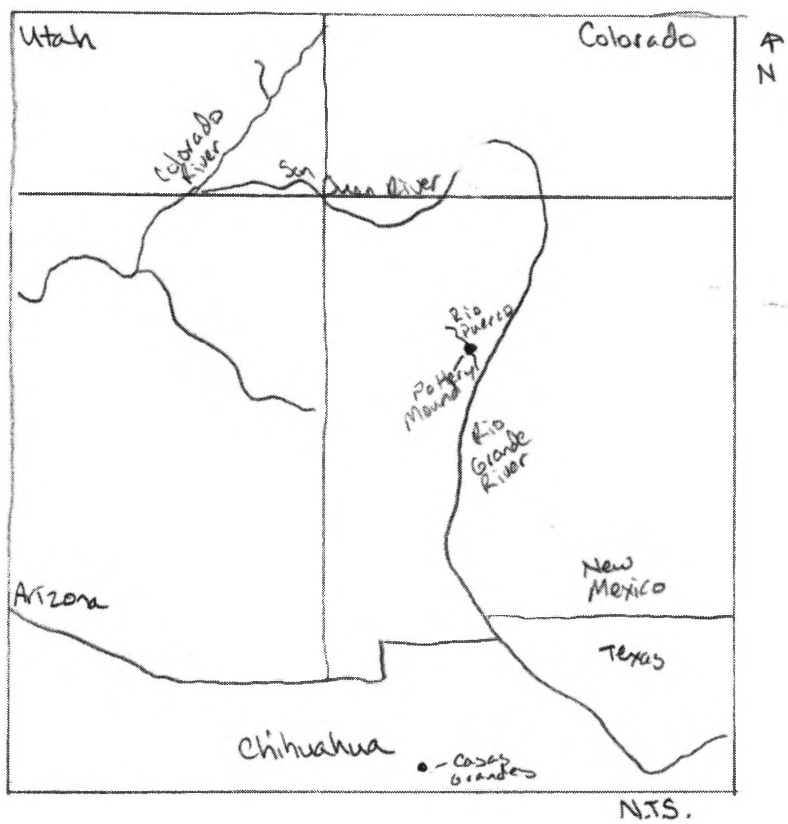


Figure 3.3: Ancestral Puebloan world, Pueblo IV period.

The Site: Pottery Mound. Pottery Mound is located roughly 25 miles southwest of present day Albuquerque, New Mexico, on the west bank of the Rio Puerco (Figure 3.3) (Schaafsma 2007a). The site lies in the rather flat Rio Puerco Valley, at an elevation of approximately 5,000 feet above sea level (R. Vivian 2007). The northern slopes of the Sierra Ladrones lie along the southern edge of the valley, while Mesa Carrizo and the Hidden Mountains rise to the west. The western uplands of the Rio Grande valley skirt its eastern edge.

Archaeologists think the site sits at what was once the high point of the Rio Puerco valley, perhaps on a natural terrace above the floodplain (Hibben 1975; R. Vivian 2007). Estimates put the mound at 20 feet above the plain's surface. The site itself has been estimated at 15 acres in 1926, and 7 acres in the 1950s (Figure 3.4).

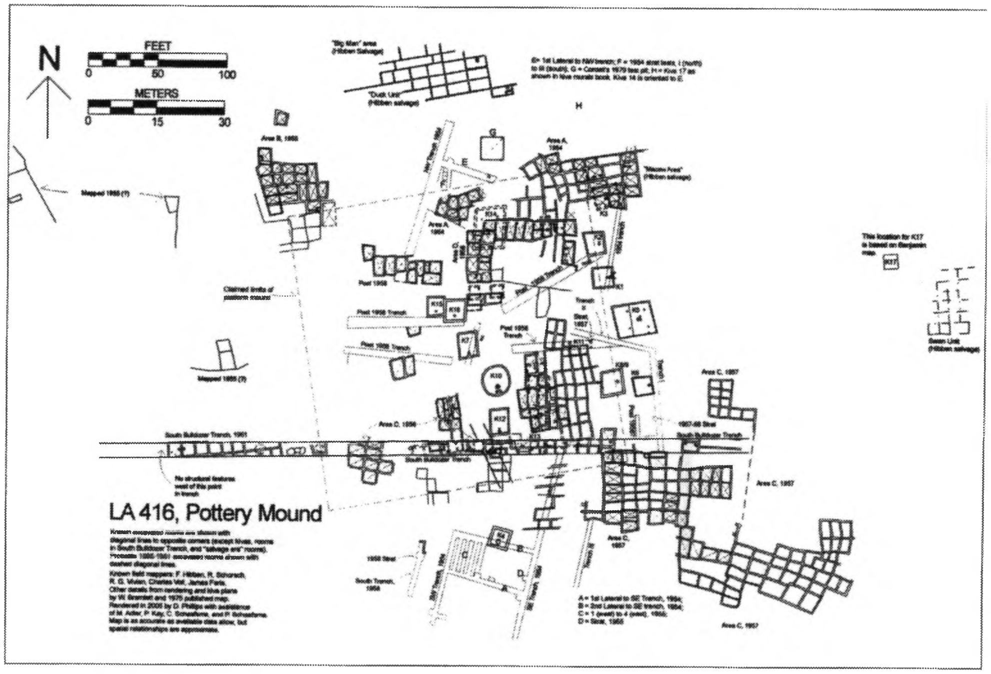


Figure 3.4: Pottery Mound.

Even in the 1920s the Rio Puerco was beginning to erode what was left of the site, making it impossible to say with certainty how big the site might have been during its inhabitation period. This natural erosion has been largely halted by a dam built by the Army Corps of Engineers and the New Mexico National Guard in 1977.

The Huning Land Trust owned the property on which Pottery Mound sits until 1979, when it was deeded to the University of New Mexico (R. Vivian 2007). The site is now fenced, and access is controlled by the Pueblo of Isleta. When human remains erode out of the mound, the University of New Mexico, Albuquerque Maxwell Museum of Anthropology documents any visible remains and reburies them at a designated area on the property.

The reasons for Pottery Mound's abandonment during the fifteenth century are not clear (Schaafsma 2007a). After the fall of Chaco Canyon during the Pueblo III period, migration became one of the defining features of Puebloan peoples (Adler 2007; Kantner 2001). Numerous settlements, including the large towns of Mesa Verde and Aztec, were abandoned. Typically the migrant flow would start small, gradually getting larger until the entire settlement had been abandoned.

In many cases, such as Mesa Verde, the settlement was then completely burned to the ground. The practice of burning abandoned settlements may have been ceremonial, or it may have been a consequence of some natural events, or the result of a major attack. There is no way to say with certainty, though the practice was widespread. It was so very widespread that there may not be a single answer. Some settlements may have been burned ceremonially, while others were caught in wildfires, or destroyed by raiders. Fortunately for archaeologists, Pottery Mound was not burned down after abandonment, though it is unclear why it escaped the fate of so many other contemporary sites.

Why was Pottery Mound abandoned? One possible explanation is environmental degradation. Schaafsma (2007a: 6) explains that salinity has often been an issue for farmers in New Mexico: "Unless precautionary measures are taken, irrigation on flat, arid plains such as that in the vicinity of Pottery Mound will result in salinization of the soil within a hundred years or so" . Palkovich (1996: 185) says "The history of occupation in the Southwest can be read as a series of strategies designed to adapt to specific conditions. Each strategy, however, provided only a temporarily successful, and usually still marginal, existence for human groups". She suggests that changing environmental conditions were often responsible for changing settlement patterns, "particularly during the Basketmaker and Pueblo periods". Kantner (2001) discusses a number of sites that suffered as a result of environmental degradation, including Chaco Canyon itself.

It is impossible to discount another major source of community-wide conflict in the Pueblo IV period: interpersonal discord. Kantner (2001) explains that some people left their communities because of interpersonal discord. During the Pueblo IV period, many communities were made up of different families, from different regions, in different moieties, who suddenly had to live together in close quarters. This is thought to have caused to a great deal of conflict within settlements. The Katchina cult may have helped mitigate some of these conflicts, but the evidence of individuals retaining their ethnic identities is clear. Variations in burial treatment, pottery, and architectural style are seen throughout the ancestral Puebloan world during Pueblo IV. Pottery Mound was no exception.

During the habitation period, Pottery Mound existed near the border of the Eastern and Western Puebloan culture areas. The presence of Hopi Yellow Ware, the Sikyatki style found in the kiva murals, and the shape of the kivas suggest that the Western Puebloan culture area heavily influenced life at Pottery Mound.

The number of kivas found at Pottery Mound is unusually high (Adler 2007). Seventeen kivas have been excavated to date, each layered with elaborate murals. Three of the excavated kivas show signs of having been built over during the habitation period. Though they were not all in use at once, the number of kivas is still unusually high. The variation in kiva design found at Pottery Mound is also unusual. Some of the kivas found at Pottery Mound were round, while others were square (Hibben 1975). This is typically thought to be a regional difference, with Eastern Puebloan groups using round kivas and Western groups using square kivas (Schwartz 2000).

The fact that Pottery Mound contains both types of kivas suggests that the population was made up of both Eastern and Western Puebloans, or at least was culturally influenced by both. The number of murals in these kivas is also unusual, numbering more than 800 (Hibben 1975). Over one hundred of these murals were reproduced in

Hibben's 1975 book Kiva Art of the Anasazi. These murals show a society that had firm gender lines, with certain tasks being performed by women, and others by men (Hibben 1975).

It is thought to have been a diverse settlement, and likely was a trading center (Adler 2007; R. Vivian 2007). Pottery styles from several different Southwest culture groups have been recovered from Pottery Mound midden deposits and burials (Eckert 2007). Luxury goods from Mesoamerica, such as greenstone carvings, have also been excavated. In addition to material culture items, animals were also brought up from Mesoamerica, as is evidenced by the complete Macaw skeleton found by Hibben. The presence of a flat-topped pyramid and a ball court also suggest a strong Mesoamerican influence, though the nature of these structures, and their characterization as a pyramid and a ball court, are still being debated (Hibben 1975; Schaafsma 2007a).

Excavation History. Pottery Mound was known to modern scholars as far back as 1926 (R. Vivian 2007). Geologist Thor Wagner examined Pottery Mound in 1926, describing the layout of the site and digging a test unit from which he pulled pottery sherds, human remains, grave goods, and midden material. He published his findings from Pottery Mound and other sites in his 1928 publication.

Pottery Mound was first recorded by archaeologists in 1930. H.P. Mera visited the site in 1930, dubbing it LA-416. According to R. Gwinn Vivian (2007), Mera may have gone again in 1932 and 1939 to study the site further, and may have been accompanied by Stanley Stubbs. Luhrs (1937) also examined the site briefly, noting that pot hunting was destroying the site, and seemed to be a problem across the whole surface of the site. F. Fenenga also studied the site with T. Cummings, taking sherd samples.

The bulk of the excavations were done by Frank Hibben and his crews from the University of New Mexico, Albuquerque. Hibben's first excavation of Pottery Mound took place as a field school though the University of New Mexico, Albuquerque in 1954 (Hibben 1955). Excavations and recordation continued through 1961, with Hibben taking the helm. Work began again in 1975 and continued sporadically until 1986.

The manner in which the excavation was conducted has been looked at with a critical eye in recent years. According to R. Gwinn Vivian (2007), who participated in those early field schools, Hibben was not on-site every day. Any notes he kept have not been donated to the University of New Mexico's Hibben Center. The notes of his field students are located in the Hibben Center, and many were examined for this study. These notes seemed to focus on the pottery of the site, with pages and pages of typologies and sherd counts. It was surprising how little attention was paid to the burials and grave goods. This may simply be an artifact of the era, a time pre-NAGPRA when burials were studied in a different way. It might also be related to the lack of a formal research design R. Vivian (2007) noted.

According to Vivian, Hibben did not have a larger, overall research design in place. Instead, he had students dig where there were exposed ruins, and where he and his graduate students thought the most interesting areas were. The fact that these supervisory team members were not informed about a research design, and were not told to keep written field notes, is not in keeping with modern excavation research standards and techniques. A great deal of usable data was gathered despite this.

Further, there were site destruction issues due to natural and man-made forces. Part of the northern edge of the site has been destroyed by the encroachment of the Rio Puerco, as was discussed earlier (Schaafsma 2007a). In addition to erosion caused by the Rio Puerco, further damage was done to the site by the salvage excavations Hibben led in the 1980s. Paul Schaafsma, New Mexico State Archaeologist, wrote up a report on Hibben's salvage work in 1987. According to Schaafsma (1987), Hibben led volunteer crews in what he termed "salvage excavations" of the northern portion of the site. When these areas, dubbed Duck Unit, Big Man Area, Macaw Area, and Swan Unit, were excavated the units were not backfilled. When the annual monsoons came, these units filled with water, causing the sidewalls to become saturated and collapse in on themselves.

Schaafsma (1987: 7) said "the excavations since 1980 along the bank have actually led to the deterioration of the site". He suggested that "present activities are leading to the deterioration of the site, and must be stopped". He also addressed Hibben's long-term problem with research designs, or lack thereof: "adequate documentation of the work at the site has not been submitted".

Based on Schaafsma's recommendation, Hibben's permit was not renewed by the state. Excavation was halted, and has not yet resumed. The cessation of work helped the site retain what was left of its integrity. Some erosion still occurs due to heavy sheet rains. However, today this causes relatively little damage.

Studies of Pottery Mound. Pottery Mound has been studied extensively by archaeologists and physical anthropologists (R. Vivian 2007). The majority of the published material relates to the murals found in the 17 kivas excavated by Hibben and his crews, as well as on the numerous pottery sherds that gave the site its moniker (Hibben, 1975; Schaafsma 2007). Studies have also been conducted on the layout of the community and the design of the familial and community spaces within it (Adler 2007; Wills 2001). Of special note are the studies done by Eckert (2007) and Adler (2007), which discuss the integration and segregation of ethnic groups at the Pottery Mound Pueblo.

Eckert (2007) discussed the different type of pottery found at the site. She identified several different styles, based on both the kind of temper and the type of glazing. These were charted through time, demonstrating that Zuni and Hopi-style pottery began appearing early in the occupation period and continued throughout. She contended that this reflected two waves of migration, one Hopi and one Zuni. These introduced pottery types never eclipsed the original varieties, though they were found in great number. This suggests that the people who made them were numerous and retained their own ethnic identity even after living at the site for some time.

Adler (2007) found a similar pattern in the architecture of the pueblo itself. Architectural variation has been used in numerous studies to distinguish between the constructed space of settlement founders and migrants, including that of Adler (2007) at Pottery Mound. He noted that single-story, single family dwellings were the first to be built (Adler 2007; Hibben 1975). These were then followed by multi-story multi-family units, which appeared in the early occupation period, around the time the Hopi and Zuni wares began to appear. Changes in the religious iconography found in the kiva murals occurred around the same time, with a distinctly Western-Pueblo influence, specifically the Sikyatki style designs characteristic of the Pueblo IV Hopi (Crotty 2007; Gilpin and LeBlanc 2007). The design of the kivas was also unusual, with most of the kivas having the rhombus shape that is characteristic of Western Pueblo kivas, rather the circular shape one would expect from an Eastern Pueblo site like Pottery Mound (Adler 2007).

Kantner (2001), Eckert (2007) and Adler (2007) all noted that in pueblos across the region, there have been ethnographically documented instances of the communities “splintering”. A large pueblo would split into several small groups for political, religious or financial reasons, among others, and often one or more of these groups would leave the pueblo. The small groups would then often go join other, established pueblo communities. Pottery Mound was in an interesting geographic area, close to both the Eastern and Western Puebloan communities, making it the perfect place for people on the move. It is suggested that the changes in architecture, religious iconography and material culture over time suggest a wave of immigration in the early occupation period (Adler 2007; Eckert 2007; Schaafsma 2007).

A great deal of research has been done on the material culture of Pottery Mound, though much bioarchaeological research still needs to be done. Some studies that use individual remains from Pottery Mound use them as a reference sample for the region as a whole rather than looking to them as a source of data on the site itself. Others look to the skeletal remains of the individuals in the community to learn more about the people of Pottery Mound.

Ogilvie and Hilton (2011) looked at the role of women in the economy of Pottery Mound through an examination of their humeral dimensions, finding that women played an important role in food acquisition and preparation process. Women were found to have more humeral strength overall. This reinforces the themes of the kiva murals which show women carrying burden baskets, making pottery, raising children and preparing food (Ogilvie and Hilton 2011). Knowing that women played such an important role in the subsistence economy of Pottery Mound, it begs the question: Did all this hard physical work grant them equal access to dietary resources?

Another study that looked at the remains of individuals from Pottery Mound with an eye towards gathering information about the people and culture of the site was a 2008 Master's thesis by S.M. Magaha. She looked at a variety of skeletal pathologies present in the Pottery Mound sample, including dental caries, and compared the overall rates to those found in select Mimbres sites. Unfortunately the data gathered was only used to shed light on the overall health of the population and did not provide any information about groups within Pottery Mound. Overall comparisons of health were made between the Pottery Mound and Mimbres samples, but no analysis of groups within Pottery Mound was done. Different pathology rates by sex, age and possible ethnic affiliation were not discussed.

The Pottery Mound Collection

The Pottery Mound Collection is housed at the Maxwell Museum of Anthropology, at the University of New Mexico in Albuquerque, New Mexico. It contains 79 boxes, which hold the remains of a number of individuals. The entire collection was examined and all relevant specimens used in this study.

Materials. In the collection, 154 individual burials have been identified by Maxwell Museum researchers and assigned accession numbers. In addition to the 77 boxes of individually sorted remains, there were two boxes of comingled remains. These boxes only contained a few cranial elements, which were so degraded as to be useless in this study.

Some burials contained only a few fragmentary elements, while others were virtually complete. Because this study looks at differences in lesion rates between groups, only those individuals with erupted teeth that still had some enamel present were used. Individuals who did not have teeth present, or whose teeth were too damaged to be diagnostically useful, were excluded.

Of the 154 individuals in the population, 82 were excluded. Thirty-three neonates and infants whose teeth had not yet erupted, or who were missing their all of their cranial elements, were excluded from the study. Forty-nine adults and juveniles were also excluded. Some of these individuals were missing all their cranial elements. Others had some cranial elements, but had no teeth, or had teeth which were broken and missing all their enamel. Eight individuals had no provenience data, no post-cranial remains, and were missing over 50% of their teeth. Because these individuals could not be placed in any of the groups being compared in this study, such as sex or burial location, they too were excluded. After these individuals were all removed, this led to a sample group of 72 individuals, all of whom were examined carefully for this study.

The 72 individuals in this sample had a total of 1,340 teeth present. There were 1,756 alveoli present, suggesting that 416 teeth were missing. This averages to roughly

24 alveoli per individual, with 18 teeth. How many of these teeth were lost antemortem, perimortem, and postmortem, is unclear.

All 72 individuals in the sample were placed in one of three age categories, spaced at 20 years increments: Juveniles (0-19 years old), Young Adults (20-39 years old), and Older Adults (40+ years old). Of the 72 individuals in the population, 59 were 19 years old or older, making them adults for the purpose of this study (Table 3.2).

Table 3.2. Pottery Mound sample by age.

Age Groups	**Frequency**	**Percentage of Population**
Juveniles: 0-19 years	15	20.8
Young Adults: 20-39 years	44	61.1
Older Adults: 40+	13	18.1
Total	72	100.0

Of the 59 adults in the sample, 31 were found to be male, 21 to be female, and 7 were indeterminate. Sex could not be estimated for juveniles under age 15. The sex and age information for each individual can be found in Appendix A.

Table 3.3. Pottery Mound adult sample by sex.

Sex	**Frequency**	**Percentage**
Male	31	52.5
Female	21	35.6
Indeterminate	7	11.9
Total	59	100.0

As Table 3.3 shows, just over half of the adults in this sample were male. Because Pottery Mound has not been fully excavated, and likely will not be at any point in the near future, it is impossible to say at this time why males are over represented in this sample. It could involve burial practices, collection bias, or taphonomic processes, to name a few.

There was a great deal of variation in the burial styles of individuals excavated at Pottery Mound. The position of the body and directional orientation of the head varied considerably burial by burial. Many of the individuals in this sample did not have some of their basic burial information recorded. In a number of instances, no information on burial position, head orientation, or burial location could be found. This, coupled with the lack of agreed upon interpretations of ancestral Puebloan burial customs, meant these variables had to be excluded. Burial location is another matter.

Table 3.4. Burial location of Pottery Mound sample by sector.

Burial Sector	**Frequency**	**Percentage**
Northern	42	58.3
Southern	30	41.7
Total	72	100.0

Pottery Mound did not have a single graveyard on the edge of town. Rather, burials have been uncovered all across the site. Because archaeologists and historians have theorized that Pueblo IV settlements had something akin to ethnic enclaves, burial location could potentially be a sign of sub group affiliation, be it ethnic group or migration cohort. The immigration patterns noted at other sites suggest it might also be a good indicator of relative time of death. Because of this, all 72 burials in the sample were plotted out on the site map, which was then divided up into two sectors. As Table 3.4 shows, these burials were by no means uniformly spread.

4. METHODS

The first step in conducting any osteological study is doing a basic inventory of the materials in the collection in question. Seventy-two individuals from the Pottery Mound Collection at the Maxwell Museum of Anthropology, at the University of New Mexico in Albuquerque, New Mexico were examined carefully for this study. The sample contained 13 juveniles who, because sex could not be estimated, were excluded from all statistical analyses related to sex.

Specific Methodology

To conduct this study, a two-page recordation sheet was used (see Appendix B). There were two types of sheets devised for this study: one type for adults and one type for juveniles. Because neonates have no erupted teeth, their presence was simply noted on the main inventory list.

Each individual analysis began with a dental inventory diagram, a sex estimation worksheet, and an age estimation worksheet, all taken from the standards manual (Buikstra and Ubelaker 1994). For juveniles, sex was not estimated, though age was. In addition to ageing using dental eruption diagrams, growth plate fusion was used on all individuals under the age of 28 (Schaefer et al. 2009). Individuals older than age 28 had age estimated using innominate and cranial features (Buikstra and Ubelaker 1994; White 2000).

After the dental inventory was taken and sex and age estimated, all lesions were then recorded on the second page. The presence of the lesion in the mouth was noted, along with the tooth on which the lesion was found. Information on lesion size, surface, and depth was also taken, though it was not utilized in this analysis.

After all measurements were taken, photographs were then taken of the specimen, with special attention paid to any large lesions (4mm or larger). Cloacae were also photographed, especially when they were found in conjunction with carious lesions and abscesses. Some of these photographs have been used to illustrate the pathologies noted in chapter 2.

All data collected were then input into a Microsoft Excel spreadsheet, and analyzed using the SPSS statistical suite version 20.

Estimating sex in skeletal remains. There are many different methods, both mathematical and subjective, that can be used to estimate sex and age using the innominate and the skull. Bass (1995), Buikstra and Ubelaker (1994), Phenic (1969), Krogman and İşcan (1986), Wolfe and colleagues (1994), Skelton (1996), and Acsádi and Nemeskéri (1970) have crafted some of the most popular and oft cited methods. Some of these methods were not designed for use with Native American remains.

Others do not work with the fragmentary remains often encountered in this collection. For the purposes of this study, sex was estimated using the methods outlined by Buikstra and Ubelaker (1994).

Pelvic elements were preferentially used to estimate the sex of each individual using the methods described by Buikstra and Ubelaker (1994) in Standards for Data Collection from Human Skeletal Remains. Buikstra and Ubelaker instruct researchers to look at the innominate, focusing on the pubis, the greater sciatic notch, and the preauricular sulcus. Using the Phenice method they outline, the ventral arc, subpubic concavity and ischiopubic ramus ridge are examined and given a score of 0-3; the greater sciatic notch is scored from 1-5 based on the openness of the angle; and the preauricular sulcus is scored on a scale of 1-4. This information is then recorded on a form included in the standards, which was copied and placed on the data sheet used in this study.

Once this information is gathered, sex can be estimated for the individual in question. This is done by counting the number of 'male" traits, scored as 4-5, and "female" traits, scored as 1-2. A score of "3" was indeterminate. If an individual had more male traits than female traits, they were scored male. If they had more female traits than male traits, they were scored female. Individuals with an equal number of male and female traits were scored as indeterminate.

Many of the innominates in the Pottery Mound collection were damaged. A large number of them were missing their pubic bones, which makes the highly accurate ventral arc sex estimation method impossible. Because of this, cranial analysis was also conducted on each individual in accordance with Buikstra and Ubelaker's (1994) Standards for Data Collection from Human Skeletal Remains. The method they describe was first discussed by Ascadi and Nemeskeri (1970). It requires researchers to score the nuchal crest, mastoid process, supra-orbital margin, supra-orbital ridge/glabella, and the mental eminence on a scale of 1-5. These measurements are then recorded on a form included in the standards, which was copied and placed into the scoring sheet used in this study. As with the innominate analysis, individuals with more "male" traits were deemed male, and those with more "female" traits were deemed female.

Estimating age in skeletal remains. Several different methods were used in conjunction to ensure as accurate an age estimate as possible for each individual. Dental wear and eruption, endplate fusion, and the deterioration of the auricular surface were all used with each specimen to estimate the individual's age.

A number of studies have been done looking at the order in which teeth erupt, and at the age of individuals when their deciduous teeth tend to fall out and permanent teeth erupt in their place (Demirjian et al. 1973; Hillson 1996; İşcan, 1988; Liversidge 1994; Liversidge et al., 1998; Liversidge and Molleson 2004; Mincer et al., 1993; Smith and

Garn 1987; Smith 1991; Ubelaker 1989;). For the purposes of this study, Ubelaker's (1989) dental eruption chart was used, which also appears in Buikstra and Ubelaker's (1994) Standards manual.

Dental eruption variation has the potential to wreak havoc when determining an individual's age (Mincer et al. 1993). Some individuals do not have third molars, which can cause those individuals to be skewed young when using only a dental eruption chart to estimate age (Taylor 1978). Numerous individuals in the Pottery Mound collection were missing some or all of their third molars. To avoid placing these individuals in an inappropriate age category, endplate fusion was then used to verify or disprove an individual's young age estimate.

Numerous studies have been conducted to determine the average age at which endplate fusion occurs. Schaefer and colleagues (2009) compiled a great deal of information on these studies, replicating dozens of tables which can be used to estimate an individual's age using things like bones length and degree of endplate fusion. They have information about every bone in the human body. For the purposes of this study, the level of clavicular fusion, innominate fusion, humeral head, and femoral head fusion were used to estimate age.

According to Schaefer and colleagues (2009), the final bones to fuse are the clavicles, which fuse at age 28. Their charts say the humeral head fuses at 23, the femoral head at 19, the iliac crest at no younger than 14. This information proved quite useful, as many individuals who were missing third molars were found to have died between the ages of 14 and 28 according to the endplate fusion charts.

The last teeth to erupt are the third molars, typically by age 21 (Ubelaker 1989). The last bone in the human skeleton to typically fuse is the clavicle, which becomes one solid bone at age 28 (Schaefer, Black and Scheuer 2009; White 2000). Once the teeth and bones have all reached their final developmental stage, age estimates must be based on how the body wears down. Things like dental wear patterns can be used to estimate an adult's age, as can cranial suture closure, and the appearance of certain joint surfaces. The pubic symphysis and auricular surface have been studied extensively, and a number of methods use these to estimate age.

Numerous individuals in the collection had reached full skeletal maturity, meaning their age could not be estimated using endplate fusion or dental eruption. Others lacked crucial bones, such as the clavicle, which allow accurate age estimation. In those cases, three methods were used to determine the age of the individuals in question. A dental wear chart (Buikstra and Ubelaker 1989) was used to estimate the age of the individuals in question. It showed how the surface of the mandibular molars and premolars, and the maxillary premolars, incisors, and canines change over time. Eight stages of dental wear were recognized on the chart, each with a corresponding age estimate for either hunter-gatherers or agriculturalists. This chart was quite useful, as the images often matched perfectly with the remains in the Pottery Mound collection. Few individuals in the Pottery Mound collection had enough dental damage or unusual dental wear patterns to impede comparisons with the chart.

There was a special consideration that had to be made when using this chart with this collection however. Because the individuals in question were hunter gatherers that practiced agriculture, they could not reliably be placed in either the "Hunter-Gatherer" or "Agriculturalist" category. Instead, both values were recorded. This means that an individual who showed stage 5 wear patterns was recorded as being 35-40 years of age, rather than 35 or 40 years of age.

To get a more accurate age estimate, the pubic symphysis and auricular surface of each individual were also examined when present. A number of the specimens in the Pottery Mound collection were missing their pubic bone, which made pubic symphyseal analysis difficult in many cases. For the purpose of accuracy, the pubic symphysis was used whenever possible. Oftentimes when the element was present, it was not attached to the innominate, but was instead comingled with various small bones in the box of remains. Some of these loose pubic bones were damaged and could not be used to estimate age. Those that were complete, or nearly so, were compared to the descriptions of Todd's (1920) 10 stages of pubic symphyseal Age-Related Change. The diagrams in White (2000), which were originally devised by Todd (1920) were also used, though the written descriptions proved to be far more detailed, and therefore more useful.

The auricular surface was visible in almost all the specimens used for this study, which helped assure consistency in ageing. The method outlined by Lovejoy and colleagues (1985) was used to estimate age using the appearance of the auricular surface. Lovejoy and colleagues (1985) used a set of individuals with known ages to determine what a "typical" auricular surface looks like between ages 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-59, and 60+. Each of these age ranges was referred to as a "phase". The auricular surfaces of each specimen were compared with those discussed in the written descriptions and with pictures of "typical" auricular surfaces provided for each phase. The phase that shared the most characteristics with the specimen in question was determined to be the age range of the individual in life.

After estimating age using dental eruption, dental wear, epiphyseal fusion, pubic symphyseal appearance, and auricular surface appearance, all of the appropriate age ranges were compared and the individual was placed into the age category that came up most frequently. The goal was not to come up with a precise age, say 27, but instead to be able to find an accurate age range so the individual could be placed in the appropriate age cohort. For most specimens, each method gave roughly the same possible age range, usually a five year age range (ex 25-30 according to each method).

Very few specimens had features common for both younger and older individuals. Those specimens whose age estimate resulted in a possible 10-20 year age range (ex 25-30 by dental wear, 40-44 by auricular surface) were examined a second time to ensure that each ageing method had been used and recorded correctly. If the range was still wide, then the individual was placed in the age range group that came up most frequently, tossing out the outlier age estimate. This meant that an individual who had a phase 6 auricular surface (45-49 years old), a phase 9 pubic symphysis (44-50 years old), and stage 4 level of dental wear (30-35 years old) was placed in the 45-50 year age cohort.

This study used a number of different methods of estimating the age and sex of each individual in the population. Because these methods were used in conjunction, the age and sex estimates are likely accurate, and can be used to place individuals in subgroups for analysis with confidence.

Recording carious lesions. Once age and sex were estimated, dental study could begin. There are a number of ways of detecting carious lesions in dry teeth. One tool available for some researchers is the dental x-ray (Hillson 2001). X-rays not only make existing carious lesions visible, they can sometimes show the presence of precavities. Precavities are soft spots on the tooth caused by breakdown of the enamel due to the release of organic acids by oral bacteria. They are thought to be the first stage in the formation of carious lesions. However, they often do not turn into carious lesions and cannot always be reliably found using x-rays. As such most studies do not look for them, including this one.

Instead, this study used what is almost certainly the most common method of caries detection in prehistoric collections: macroscopic examination. All of the population studies mentioned in Chapter 2 used this method. This involves using the naked eye, often in conjunction with a hand lens and strong light, to identify carious lesions. All five visible surfaces of each tooth are carefully examined, and any and all carious lesions are noted on a recordation sheet. In addition to the hand lens and strong light, a dental probe is sometimes used to assist in identifying lesions (Costa 1980; Hillson 2001; Lanfranco and Eggers 2010; Kerr et al. 1990; Tayles et al 2000). The dental probe is used to feel for surface irregularities, and to examine the depth and texture of any irregularities seen. Because many of the teeth in the Pottery Mound collection were coated with some type of varnish, texture could not easily be examined using a probe. Therefore, no probe was used in this study. Instead, only lesions visible under strong light and magnification were noted.

Lesion analysis in archaeological populations: problems. Once lesions are measured and scored, they must then be analyzed using some sort of statistical methodology, with overall dental health being numerically represented somehow. Because many archaeological specimens are missing teeth or suffer from enamel breakage, data loss is an issue. Lots of missing teeth or missing surfaces can artificially inflate or deflate overall counts. Many of the specimens in the Pottery Mound collection were missing numerous teeth. Resorption was noted when visible, though many of the alveoli showed no signs of resorption, suggesting the teeth were lost postmortem or perimortem (Figure 4.1).

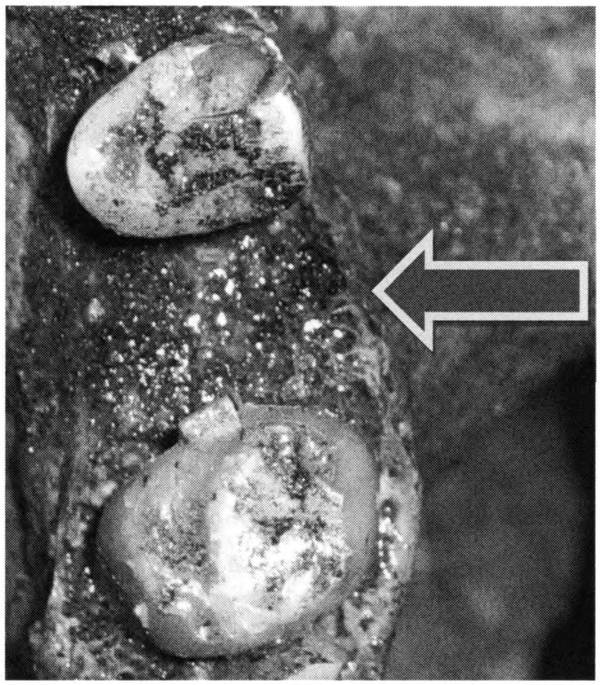


Figure 4.1: Specimen 73.103.48, with completely resorbed alveolus.

Other specimens were missing part of the maxilla or mandible, in some cases the entire element, and all the teeth that went with it. This issue is not uncommon, and requires researchers working with collections such as this to come up with more specialized means of measure that can retain accuracy without providing unnecessary complications.

The raw data on the number of lesions can be calculated, showing lesion rates per mouth within and between populations. This is one of the most common methods of analysis, along with lesion rates by tooth type, and has been used in numerous studies (Hillson 2005; Keene 1986; Kerr et al. 1990). Subjective and objective scales that measure severity are also frequently used (Costa 1980; Lanfranco and Eggers 2010; Tayles et al. 2000).

Surface recording and measuring. Some scientists do not note the surface on which a lesion is found, or its severity (Beckett and Lovell 1994). Most researchers however note where the lesion in question is and how much tissue it has destroyed. The measure of tooth destruction is often expressed by using systems that rate the tooth subjectively on a scale. The scales used vary by researcher. Costa (1980) for example uses a scale of zero to six to rate visible lesions, while Tayles and colleagues (2000) simple noted when a lesion was “massive”. Because these scales are subjective, they are impossible to reproduce and compare.

Because there is no consistency in the literature as to severity, it will not be looked at in this study. Frequency of carious lesions by tooth type and presence/absence are more thoroughly standardized and so will be the two measures used.

Assigning Sub-Group Membership. After the dental inventory was completed, an archive search was then conducted using materials in the Maxwell Museum archives and the Hibben Center for Archaeology research to find information on burial location and grave good type and quantity. Hibben's lack of uniform research design and recordation noted in previous chapters complicated the analysis of grave goods. Some individuals had detailed information about their grave goods recorded during excavation, while others did not. Ambiguous quantities were often recorded in the excavation notes, making a conservative approach necessary when analyzing the data. Any item listed using the plural form, such as sherds, was assumed to be two, while any item listed using the singular, such as tool, was assumed to be one. This could lead to an artificially low grave goods count, and cannot be corrected for at this time.

The number of grave goods an individual had is not the only means of looking at the material culture of an individual in the Pottery Mound population. Different people were found with different types of items. Some studies have used the type of grave goods an individual was found with as a possible indicator of social status. This will be discussed further in Chapter 6.

When looking at the variety of grave goods found, four general types of goods emerged: textiles, tools, pottery, and unusual items. Unusual items were defined as items that did not fit into any of the other three categories, consisting mostly of luxury goods like beads, figurines, and imported gems and minerals (Figure 4.2). Textiles, tools, and pottery were equally common. The unusual items were the least common, even though this category was by far the broadest.

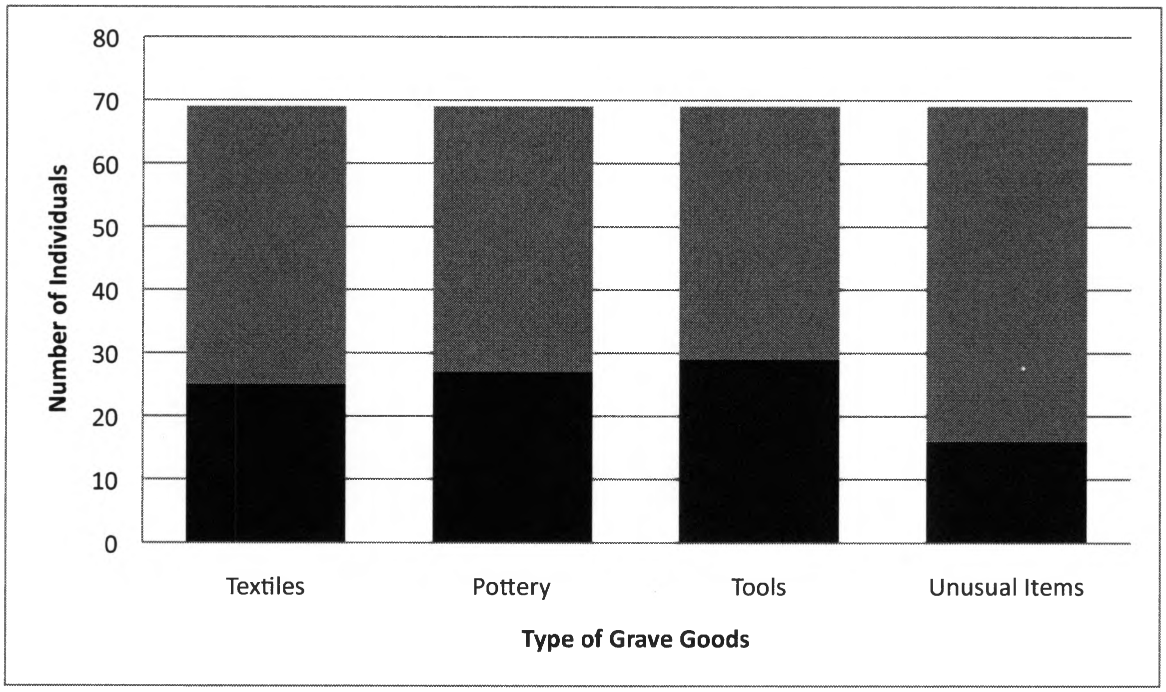


Figure 4.2: Grave good frequency by type

Statistical calculations. There are a number of statistical measures that have been used in the past to examine carious lesion rates in archaeological populations. The frequency of carious lesions overall has been looked at in numerous studies, as has the rate of lesions on specific teeth and within specific groups in a population. Lesion severity is also frequently examined.

This study looks at various sub-groups within the population. Membership in these groups is determined by categorical variables such as sex and burial location, along with scale variables like the number of grave goods present. This necessitates the use of both parametric and nonparametric statistics.

When performing these calculations, the observed caries rate was used when possible (Lukacs 1996). This formula is often used in studies of this kind. The formula for calculating the observed caries rate is shown below:

$$\frac{\text{Number of Carious Teeth Present}}{\text{Number of Teeth Present}}$$

Though some studies try to take into account missing teeth by adjusting this number using a corrected caries rate, much of the literature makes no such adjustments. Because the corrected caries rate is infrequently used, and makes unnecessary assumptions about the population in question, it will not be used in this study.

Some studies analyze the mouth by anterior and posterior tooth types, grouping incisors and canines, and premolars and molars (Hodges 1989). Other studies look at the mouth by tooth type, examining incisors, canines, premolars, and molars separately (Cucina and Tiesler 2003; Lukacs 1992; Walker and Erlandson 1986). The reasons for using one or the other vary by study.

In this study, the four tooth types have been grouped into two different groups: anterior and posterior teeth. This was essential, as certain anterior tooth types were unaffected in various groups, which preclude rigorous statistical study. After comparisons were made between anterior and posterior teeth, molars were then separated out because they were affected so much more frequently than any other tooth type.

Initially a series of one-way ANOVAs and t-tests were done to analyze the data. Though these are robust tests, they tend to skew when using a data set with several values of 0, such as the Pottery Mound data set. Because numerous individuals had no carious lesions, while others had carious lesions in only one of the tooth types under study, there were concerns about the data being skewed. As a result, chi-square analyses were done instead to ensure that the results found were statistically valid.

Chi-square analyses were used to look at the relationship between the observed caries rate and tooth types, age cohort, sex, burial sector, and the presence of unusual grave goods. A chi-square analysis was also done to look at the frequency of males and females affected by carious lesions. Spearman's rho correlation was used to look at the relationship between the number of grave goods an individual had and the number of carious lesions found. A chi-square analysis was performed to look at the relationship between the number of grave goods an individual had and the presence of unusual grave goods. A chi-square analysis was also done to look at the relationship between the number of grave goods found and an individual's burial sector. A value of .05 was used to ensure scientific rigor.

5. RESULTS

Observed caries rates are the focal point of this study. The frequency of individuals with carious lesions was examined using chi-square analysis. Because some teeth are more likely to be affected than others, lesion rates were also looked at by tooth type. These results provide information about the overall dental health of the population, which will help establish broad dietary differences, if any exist.

Subgroup membership

The groups under consideration here are sex, age cohorts, and burial sector. The number and type of grave goods an individual was found with are also examined.
Descriptive Statistics. The first statistical analysis run was descriptive statistical analysis looking at how many individuals were affected by carious lesions (Table 5.1). There were 337 lesions present on the teeth examined. The average number of lesions per individual in the Pottery Mound sample is 4.68, with a standard deviation of 5.43.

Table 5.1. Number of individuals with carious lesions.

Carious Lesions	**Number Affected**	**Percentage**
Present	50	69.4
Absent	22	30.6

Table 5.1 shows that 30.6% of individuals had no carious lesions present, though the data loss caused by postmortem tooth loss may have artificially inflated that number. 69.4% of individuals in the population had 1+ carious lesions. To look at the frequency in greater depth, the observed caries rate was used to compare groups (Lukacs 1996).

Table 5.2. Carious lesions by tooth type.

Tooth Type	Number of Carious Teeth Present	Number of Teeth Present	Observed Caries Ratio
Incisors	13	302	.043
Canines	4	191	.021
Premolars	22	323	.068
Molars	194	485	.400

As Table 5.2 shows, the molars were affected far more extensively than any of the other teeth. This is consistent with the previously discussed theory that a more rugged surface traps more carbohydrate particulates.

Statistical Analyses. Numerous statistical analyses, most of them chi-square, were performed on the Pottery Mound population. In each analysis, individuals who had no data for the independent variable were excluded from the statistical analysis, so as to not treat a lack of data as data.

Table 5.3. Frequency of individuals with and without carious lesions, by age cohort.

Age Groups	**Carious Teeth**	**Percentage**	**Noncarious Teeth**	**Percentage**
Juvenile	3	20	12	80
Young Adult	37	84.1	7	15.9
Older Adult	10	76.9	3	23.1
Total	50	69.4	22	30.5

As Table 5.3 shows, the percentage of individuals with 1+ carious lesion in this population rises and falls with age. Few juveniles have caries, while more than half of young adults and older adults are affected by caries. The slight drop in caries rates between young adults and older adults may simply be a result of older adults losing potentially carious teeth to antemortem tooth loss.

Further analysis was conducted by tooth type, to ensure that there were no statistically significant differences in the rates of teeth affected by tooth type between age groups (Table 5.4).

Table 5.4: Frequency of carious teeth by tooth type for different age cohorts

Age Cohort	**Tooth Type**	**Carious Teeth**	**Teeth Present**	**Ratio**
Juvenile	Incisors	1	53	.018
Juvenile	Canines	0	38	0.00
Juvenile	Premolars	0	21	0.00
Juvenile	Molars	12	106	.113
Young Adult	Incisors	12	212	.056
Young Adult	Canines	1	124	.008
Young Adult	Premolars	14	246	.057
Young Adult	Molars	157	325	.483
Older Adult	Incisors	0	37	0.00
Older Adult	Canines	3	29	.103
Older Adult	Premolars	8	56	.147
Older Adult	Molars	25	54	.463

As Table 5.4 shows, older adults had no carious lesions on their incisors. Juveniles had no lesions on their canines or premolars. Molars were affected in all age cohorts far more often than any other tooth type.

Having several tooth types with no lesions present complicates studies of variance. Because age and the presence of carious lesions are related, it is important to show that age is not disproportionately affecting the observed caries rate. To ensure that any results found in this study are real, and are not simply an artifact of an older population, anterior and posterior teeth have been grouped separately. This has been done in many other studies and is reasonable in this study in particular.

Molars and premolars both have rugged surfaces, and as a result are affected more frequently than canines and incisors, which have smooth surfaces. This is why they are grouped together in many analyses (Hodges 1989). As Table 5.4 shows, in the Pottery Mound population, premolars and molars are both affected more frequently than canines and incisors. The single exception to this is in juveniles, who as a group had one carious incisor and no carious premolars. This is not unexpected, because premolars do not erupt until age 10, and many of the juveniles in this sample died before reaching that age. This could explain why there were less than half as many premolars found as incisors, despite the fact that there are eight of each in a normal adult mouth, and why none of the premolars had any carious lesions.

When grouped into anterior and posterior categories, the expected pattern of rugged posterior teeth being affected at a greater rate appears, with molars being affected at a much higher rate than any other category, as expected (Table 5.5).

Table 5.5: Number of carious teeth by position

Segment	**Carious Teeth**	**Number of Teeth Present**	**Ratio**
Anterior	17	493	.034
Posterior	216	808	.267
Molars	194	485	.400
Total	233	1301	.179

A chi-square analysis showed that this observed difference between anterior and posterior teeth was statistically significant ($X^2 = 81.989$, $p = 0.0001$). Because so many more molars were affected than premolars, chi-square analyses were done to determine if the molars were the cause of this significant difference. Molars and premolars were found to be significantly different ($X^2 = 67.7$, $p = 0.000$). When premolars were grouped with anterior teeth, they were found to be significantly different from molars (X^2 = 169, p = 0.000), and from anterior teeth when looked at alone (X^2 = 4.38, p = 0.036). This confirmed that anterior and posterior were both good categories to use, though molars should be looked at separately to ensure significant results are real.

Once the chi-square results had been taken into account, and it was determined that the categories of anterior, posterior, and molars were most appropriate for this study, a chi-square analysis was performed to compare the observed caries rate of juveniles, younger adults, and older adults, first by anterior and posterior segments, then by looking at molars separately (Table 5.6).

Table 5.6: Chi-square results of age cohort and observed caries rate

Segment	**Juvenile-Young Adult X^2 p Value**	**Juvenile- Older Adult X^2 p Value**	**Young Adult- Older Adult X^2 p Value**
Anterior	.199	.092	.441
Posterior	.000	.000	.994
Molars	.000	.000	.870

A chi-square value of $X^2 = 2.64$, $p = .267$ was found between groups when looking at anterior teeth, suggesting that anterior teeth are affected at a similar rate among the three age cohorts. The results for posterior teeth were different ($X^2 = 62$, $p = 0.000$). Since there was a significant difference between the three cohorts, chi-square analyses were done to compare the posterior teeth of the three groups to determine which groups were different. Chi-square analyses showed a significant difference in the rate of posterior carious teeth between juveniles and younger adults ($X^2 = 60.8$, $p = 0.000$) and between juveniles and older adults ($X^2 = 43.8$, $p = 0.000$). A similar result was found when molars were looked at separately ($X^2 = 23.5$, $p = 0.000$; $X^2 = 14.3$, $p = 0.000$).

This is not unexpected, as juveniles have had their molars for fewer years than both younger and older adults, meaning there has been less time for lesions to form. They also had fewer molars present during life, possessing only 8 deciduous molars rather than 12 permanent molars. There was no significant difference in the rate between younger and older adults posterior teeth ($X^2 = .654$, $p = 0.994$) or molars ($X^2 = .266$, $p = 0.870$), suggesting that any differences found in rates between any other subgroups are not a results of having an older population, once juveniles are taken into account.

Because so much of the literature, both about Pottery Mound and about ancestral Puebloan history, focused on sex and gender roles, sex was examined two ways. The first test was a chi-square analysis to look for differences in the number of males and females affected by dental caries. Indeterminate individuals were removed, leaving a sample of 52 individuals (Table 5.7). Since all juveniles were indeterminate, this means any results will not be affected by the age make-up of the population.

Table 5.7. Frequency of individuals with and without carious lesions, by sex.

Individuals	**Caries Present**	**Percentage**	**Caries Absent**	**Percentage**
Male	25	80.6	6	19.4
Female	16	76.2	5	23.8
Total	41	78.8	11	21.2

The analysis produced a result of no significance ($X^2 = .739$, $p = .700$), indicating that there is no significant difference in the number of males and females with 1+ carious lesions.

Males and females were then compared using the observed caries rate by anterior teeth, posterior teeth, and molars through a chi-square analysis (Table 5.8). A result of no significance was found for anterior teeth ($X^2 = 1.96$, $p = .162$), posterior teeth ($X^2 = 3.52$, $p = .060$), and molars ($X^2 = 2.34$, $p = .126$), meaning the observed caries rate also did not vary across the population by sex.

Table 5.8: Chi-square results for sex

Segment	**X^2**	**P Value**
Anterior	1.96	.162
Posterior	3.52	.060
Molars	2.34	.126

The rest of the analyses performed looked at the complex relationship between burial sector, grave goods, and carious teeth. As mentioned in previous chapters, Pottery Mound was a large settlement inhabited by a number of different ethnic and social groups. How well these different groups were integrated into the settlement as a whole has been examined through the lenses of pottery, murals, architecture, and location within the site.

A chi-square analysis was done to look at the observed caries rate by burial sector (Table 5.9). Juveniles and adults were examined separately to ensure that any difference found was not simply an artifact of having too many juveniles in one group.

Table 5.9: Chi-square results for burial sector, adults only

Segment	**X^2**	**P Value**
Overall	6.82	.009
Anterior	5.71	.017
Posterior	3.76	.052
Molars	3.57	.059

First adults were examined. Because a significant difference was found in the overall rate of caries between the two sectors ($X^2 = 6.82$, $p = .009$), further analysis was performed on anterior teeth, posterior teeth, and molars. A significant difference was found in anterior teeth ($X^2 = 5.71$, $p = .017$). The significance values for posterior teeth ($X^2 = 3.76$, $p = .052$) and for molars ($X^2 = 3.57$, $p = .059$) were very nearly significant and might warrant further investigation.

When juveniles were looked at on their own, no significant difference was found between burial sectors in the overall rate of caries ($X^2 = .610$, $p = .435$), or in rates among posterior teeth ($X^2 = .320$, $p = .572$) or molars ($X^2 = .625$, $p = .429$). There were no carious anterior teeth in the juvenile sample from the southern sector, precluding an analysis of anterior teeth in juveniles.

Although there is no firm operating definition in the literature for Elite versus Common individuals in the ancestral Puebloan world, grave goods were used as possible indicator of social status, and will be discussed in the next chapter. The average number of grave goods possessed by each individual was 4.11, with a standard deviation of 5.14.

Table 5.10. Number of Pottery Mound individuals with specific grave good counts.

Number of Grave Goods	Frequency	Percentage
0	22	31.81
1-4	24	34.78
5-9	13	18.84
10+	10	14.5
Total	69	99.93

Table 5.10 shows that 46 of the 69 individuals in the Pottery mound sample, including juveniles, had roughly 65%, had 4 or fewer grave goods. Only one in three individuals had more than four grave goods.

A Spearman's rho correlation test was done to look at the relationship between the number of grave goods an individual had and the number of carious teeth each individual had. An $r = .035$ suggests a very small positive correlation between the number of carious teeth and the number of grave goods an individual had. The same test was then done using the observed caries rate ($r = .025$). This also suggests a small positive correlation between the observed caries rate and the number of grave goods found. When juveniles were excluded, the correlation was still incredibly small (r = .031). The correlation for juveniles alone was also small and positive (r = .252, r = .255).

The relationship between the number of grave goods an individual had and the presence of unusual grave goods in their funerary assemblage was also examined. First, the variables were examined graphically (Figure 5.1). In Figure 5.1, the X-axis shows individuals with and without unusual grave goods. The Y-axis shows the mean number of grave goods for each group. Individuals with unusual grave goods had an average of 9.62 grave goods, with a very high standard deviation of 5.47, while those without had an average of 2.45 grave goods, with a smaller standard deviation of 3.62. This graph suggests that individuals with unusual grave goods tended to have more grave goods overall.

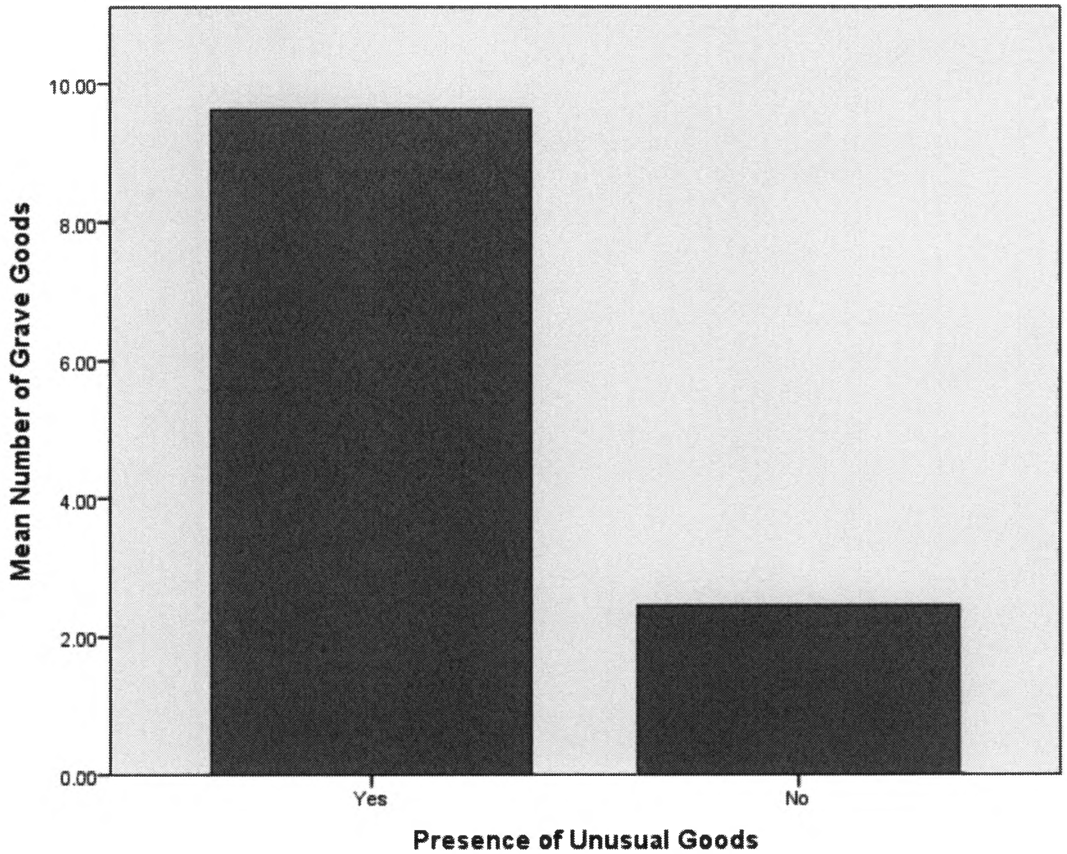


Figure 5.1: Number of grave goods and unusual grave goods

A chi-square analysis was then run to look at the relationship between the number of grave goods an individual had and the presence of unusual grave goods. The results ($X^2 = 28.3$, $p = .000$) show a significant relationship between the number of grave goods an individual had and the presence of unusual grave goods (Table 5.11). Individuals with no grave goods were excluded from this analysis.

Table 5.11: Results for comparison of unusual grave goods and number of grave goods found.

Presence of Unusual Grave Goods	1-4 items	5-9 items	10+ items
Yes	16	24	24
No	80	28	16

As Table 5.11 shows, there was little difference in the number of grave goods an individual had and the presence or absence of unusual grave goods if that individual had 5+ items buried with them. A chi-square analysis was done to see if this difference was statistically significant. No significant difference was found between individuals with 5-9 grave goods and 10+ ($X^2 = 1.74$, $p = .188$). A significant difference was found between individuals with 1-4 grave goods and both 5-9 grave goods ($X^2 = 14.9$, $p = .000$) and individuals with 10+ grave goods ($X^2 = 25.5$, $p = .000$). This suggests that individuals buried with more grave goods were likely to be buried with one or more unusual items, the implications of which will be discussed in Chapter 6.

A chi-square analysis was also run to look at the relationship between the number of grave goods an individual had and their burial sector (Table 5.12). A significance result of. 000 shows a significant relationship between the number of grave goods an individual had and their burial sector.

Table 5.12: Results for comparison of burial sector and number of grave goods.

Burial Sector	0 items	1-4 items	5-9 items	10+ items
North	28	44	44	40
South	60	52	8	0

Chi-square analyses were done to examine this pattern. Individuals with 10+ items were found only in the north, and so could not be studied using chi-square. A significant difference in the number of grave goods present and burial sector was found between individuals with 5-9 items and both 0 items ($X^2 = 36.5$, $p = .000$) and 1-4 items

($X^2 = 21$, $p = .000$). Since so few people from the Southern sector had 5-9 items, this may have skewed the result. No significant difference was found between individuals with 0 items and 1-4 items ($X^2 = 3.79$, $p = .052$), though the near significance suggests that further study may be warranted.

A chi-square analysis was run to look for a relationship between the observed caries rate and the presence of unusual grave goods (Table 5.13).

Table 5.13: Observed caries rate and the presence of unusual grave goods

Segment	**Carious: Unusual Present**	**Total: Unusual Present**	**Carious: Unusual Absent**	**Total: Unusual Absent**
Anterior	2	96	14	303
Posterior	45	157	157	507
Molars	41	84	43	43

The results were not significant for anterior teeth ($X^2 = 1.14$, $p = .286$) though they were significant for posterior teeth ($X^2 = 326$, $p = .000$) and molars ($X^2 = 6.29$, $p = .012$).

6. DISCUSSION

The results of the statistical analyses suggest that overall dental health, as measured by observed caries rates, was not uniform across the site and within the population. Males and females had similar rates, both overall and by tooth type. Adults and juveniles had different rates of caries, as anticipated. Individuals buried in different parts of the site had different observed caries rates, as did individuals with different types and amounts of grave goods. Burial location was found to be related to the type and amount of grave goods found with an individual, indicating that people in different parts of the site were buried with different funerary assemblages. Taken together, these results suggest people at Pottery Mound may have been quite different, both in life and in death.

Implications of Carious Lesion Rate Results

The results of the statistical analyses performed indicate that there were some real differences in the number of individuals affected by dental caries, and the number of caries present on any given tooth segment. These results paint a picture of rather varying levels dental health across the settlement. This could suggest that Pottery Mound, a diverse site with complicated social interactions and clear gender roles, allotted different types or quantities of dietary resources to different people (Cucina and Tiesler 2003).

Further excavation of the site would doubtlessly contribute to our understanding of the trends identified in this study. At this time there are no plans to conduct any further excavation, and any remains that erode out of the Earth are reburied with little to no study.

Pottery Mound in Context. 85% of the individuals in the Pottery Mound population had 1+ dental caries, a high rate for that time and place (Table 6.1). Further study of contemporary populations might lead to a better idea of whether Pottery Mound was significantly different from its contemporaries, and may even give insights as to why they may or may not have had more people affected by dental caries than their contemporaries. The population with the closest rates is the later Gran Quivara group.

Table 6.1. Carious lesions rates across Pueblo IV sites.

Site	Period (CE)	% Affected by Caries	Source
Hawikku	1300-1680	53	Stodder 1996
San Cristobal	1300-1680	57	Stodder 1996
Pecos Pueblo	1300-1550	48	Stodder 1996
Pecos Pueblo	1550-1600	61	Stodder 1996
Pecos Pueblo	1600-1800	43	Stodder 1996
Gran Quivira	1315-1550	69	Stodder 1996
Gran Quivira	1550-1672	85	Stodder 1996
Chaco Canyon	850-1200	69	Akins 1986
Pottery Mound	1350-1475	85	Bradford 2012

Slave wives or partners: Sex and Dental Health at Pottery Mound. The Pueblo IV period was a time of transition in the ancestral Puebloan world. Skeletal studies of 13th century populations have shown that females had higher rates of traumatic injury and long term nutritional stress (Kantner 2001). Some have even suggested this might represent the taking of slave wives, a trend not typical of ancestral Puebloan culture. The murals found at Pottery Mound, along with the study of humeral morphology, show that females were a major part of the workforce during the Pueblo IV period (Hibben 1975; Ogilvie and Hilton 2011). The question then becomes, were these women the slave wives of the 13th century, or equal partners?

The results of this study suggest that males and females had equal access to similar dietary resources. Females and males were affected at roughly equal rates, and in equal ways. There was no significant difference in the frequency of males and females affected by carious lesions, or in the observed caries rate of anterior teeth, posterior teeth, or molars, indicating that males and female had similar degrees of dental health. This suggests that there were no broad dietary differences between males and females at Pottery Mound.

It was clearly not one's sex that determined access and utilization of dietary resources. A study similar to the one done at Harappa would indicate whether males and females were equally valued by the society throughout life (Lukacs 1992). Looking at developmental pathologies, such as enamel hypoplasias, as Lukacs did in Harappa would speak to any differences in the nutritional distribution during early life of males and females, providing nuance to the analysis.

The Wrong Side of the Tracks: Burial Location and Dental Health. The Pueblo IV period was a time of great cultural change in the ancestral Puebloan world (Kantner 2001). Pueblos became larger and more diverse than ever before (Schaafsma 2007a). Much of the literature written to date about Pottery Mound discusses what that diversity looked like, in terms of buildings and material culture (Adler 2007; Eckert 2007). This study both builds off of and adds to that line of inquiry.

The currently accepted narrative of ancestral Puebloan life during the Pueblo IV period suggests that ghettoization often occurred in settlements (Adler 2007). One's area of residence is thought by many to have been determined by when individuals arrived in the settlement (Kantner 2001). This means that burial location could be a good indicator of arrival order in the settlement. Since the Hopi and Zuni immigrants are thought to have arrived at punctuated intervals, this makes burial location a possible indicator of ethnic identity, though there is not enough information at this time to positively correlate any individual burial or sector with a specific ethnic group.

Pueblo IV towns are thought to have often been built in stages, with a single group coming in and building the town center, followed later by immigrants from other regions who expanded the settlement (Kantner 2001). This led to certain sub-groups living in close proximity, which may have allowed them to better retain their original cultural traditions. Such settlement patterning has been observed across space and time, appearing in places as dissimilar as medieval Spain and modern San Francisco. Was Pottery Mound one of these settlements? And if it was, did living apart allow people to retain any of their original ethnic traditions, like traditional foodways? This study suggests it may have.

This incredibly large settlement was only occupied for roughly 150 years, making it unlikely that parts of the site were abandoned and subsequently re-inhabited. The building pattern of the settlement shows that it was inhabited continuously, with new building going on throughout the habitation period. That means that the differences observed spatially across the site represent real differences between individuals in the settlement.

Statistically significant differences were found in the observed caries rates of adults in the northern and southern sectors of the site. There were differences in the overall observed caries rates, and in the observed caries rates of the anterior teeth. The difference between the observed caries rates in the posterior teeth and the molars were nearly significant. Further study may shed more light on this phenomenon. There were no statistically significant differences in the observed caries rates of juveniles, though their population was smaller and not evenly distributed, which might mask differences.

The significant and near significant results found for adults suggests that the diversity of Pottery Mound led to broad dietary differences among individuals and perhaps unequal dietary resource distribution. These new immigrants who lived apart from the town founders appear to have either eaten different types of food, or the same types but in different quantities. Since many groups in North America used their teeth as tools, further study could be done to determine if the differences observed were due to teeth being damaged because of tool use, such as cord working or leather softening, and therefore more susceptible to caries, or through dietary difference.

Social Status and Dental Health. Determining an individual's social status through the grave goods they were found with has a long standing history in both North and South

American prehistoric archaeology (Cucina and Tiesler 2003; Lanfranco and Eggers 2010). Akins (1986) and Buikstra (1984) noted that the number of goods an individual had could be an important indicator of their social status. It was this broad tradition, and it's specific application to Pottery Mound by Hibben, that led to looking at grave goods. Though there is no way to assign any particular individual membership in a social group, some general theories can be discussed.

This study looked at the number of grave goods found and the type of grave goods found. In both cases, taphonomic processes, including excavation issues, could cause these counts to be a bit low. Everything from that era was handmade, whether it was a tool, decorative item, or textile. This suggests every item was, to a certain extent, a valuable item, which means the number of grave goods could be a valid indicator of social status. Many studies use the type of grave goods found as an indicator of socio-economic status, with everyday items like tools being weighted less than unusual items.

The chi-square analysis done indicated there was a real relationship between the number of gave goods an individual possessed and the presence of unusual grave goods. Individuals who had unusual grave goods tended to have more grave goods overall. Why this occurred is unclear. Having more grave goods may have simply made it more likely that an unusual item would be included in the burial assemblage. It may also have been a reflection of life conditions, with some individuals owning only a few staple items, like mats and clothing, while others owned many luxury items like macaw feathers and large pots. Further study would be necessary to make any firm conclusions.

The significant relationship between burial sector and the number of grave goods an individual had adds to this line of inquiry, suggesting that individuals with many grave goods were buried, and possibly lived, apart from those with few grave goods. Individuals in the Northern sector tended to have more grave goods than those in the South. This too suggests that Pottery Mound may have had socio-economic stratification, like many earlier Pueblo settlements. The excavation history shows that the North was also more thoroughly excavated than the South. Further excavation would help determine if this excavation strategy skewed the data.

Grave good type and quantity were related to burial sector. The question then becomes, is there any relationship between what an individual was buried with and their dental health? Did these potential socio-economic differences impact the health of the individuals in question? There is no simple answer to that question yet.

There was a small positive correlation between the number of grave goods an individual was buried with and the observed caries rate, but the correlation was weak. This tells us that individuals buried with relatively few grave goods had the same number of carious lesions, on average, as individuals buried with few grave goods. There is no strong relationship between carious lesions and the number of grave goods an individual was found with. This could be the result of the excavators vague record taking noted earlier, or it could mean that what an individual was buried with is not a good indicator of their socio-economic position in life. It is also possible that an individual's personal wealth did not guarantee them a better diet.

When it was broken down by tooth type however, a relationship appeared between the presence of unusual grave goods and the observed caries rates of posterior teeth, and molars. So, while the individuals were affected similarly on average, the posterior teeth of individuals without unusual grave goods were less carious than those with. That may reflect differences in the material wealth of individuals at Pottery Mound, translating into different menu items or quantities. The social ramifications of wealth and poverty may have extended to diet. Further study of enamel hypoplasias, lesion severity, pathologies, and skeletal stress markers might lend further insight into the relationship between personal wealth and overall health.

7. CONCLUSIONS

What was it like to live in a large, Pueblo IV town like Pottery Mound? Scholars theorize that the highly structured society of Chaco Canyon had been replaced across the land, first by an egalitarian society, then a society in turmoil. What was happening in the ancestral Puebloan world during this period before Spanish incursion? This study paints a picture of a moderately stabilized, but diverse society blooming in the desert.

Diversity and Community

Previously mentioned studies tell us that Pottery Mound, like other ancestral Puebloan communities of its time, was a diverse place. The variation in pottery types, architectural types, and certain burial practices suggests that people from different areas came from different geographic areas to build a settlement. The fact that it was able to sustain a large population for over a century, and shows no signs of forceful incursions (i.e. charred buildings, butchered human bones) implies a more harmonious existence with their neighbors than many contemporary settlements. Was life within the community equally harmonious?

Cooperation. When this population was first examined for this study, only one individual, an older male, showed any obvious signs of physical trauma. He suffered two blows to the crania, each a single sharp line with radiating fractures, perhaps from an axe. He also suffered a fractured pelvis. No other individuals in this study showed signs of massive skeletal trauma. The severely damaged female skeletons of the 12th century slave wives were not found at Pottery Mound. They could all be buried in an unexcavated part of the site, though it is unlikely.

This study suggests instead that men and women at Pottery Mound were both taken care of. There was no difference in the number of lesions overall or by tooth type between men and women in this sample. This suggests that men and women had the same menu, with equal access to a similar pool of dietary resources.

That is not to say there were no differences between men and women. Ogilvie and Hilton (2011) found that women's humeral heads were more developed than those of their male counterparts, suggesting that they performed different types of labor. This means there was likely an ancestral Puebloan definition of "women's work". If the murals are to be believed, it involved agriculture (Hibben 1975).

Despite this apparent division of labor, males and females had similar dental health as measured by observed caries rates. Males and females may have played different roles in the processing of resources, but it did not limit their access to dietary resources.

This suggests that any differences that existed at Pottery Mound did not simply fall along the gender lines seen in other studies.

Personal property. Individuals at Pottery Mound had different types of grave goods, and had them in different quantities. People with more grave goods tended to be buried in different parts of the site than those with few grave goods. When the data is mapped out, the individuals with 10+ grave goods were all located in the Northern Sector. This calls to mind the discussions by Kantner (2001) and Adler (2007) of different ethnic subgroups living in different parts of the site. Whether this was a Zuni neighborhood, a Hopi neighborhood, and an ancestral Puebloan neighborhood is unclear. An analysis of specific types of pottery associated with grave goods, or with parts of the site, could be performed in an attempt to answer this question. However, that is beyond the scope of this study.

Adler (2007) and Kantner (2001) suggested that immigrants were often relegated to the outskirts of town, where they maintained some of their traditional lifeways. The differences in observed caries rates between people from different parts of the site, and between individuals with different amounts and types of grave goods, supports this.

This suggests that the individuals living in different parts of Pottery Mound lived in different ways, and that immigrants may not have fully assimilated. It is also possible that this may simply be an issue of the rich and poor living apart. As discussed in previous chapters, individuals buried with numerous grave goods were buried in a different area than those with few grave goods. Was it the "nice" part of town? Were its residents wealthy migrants, the founders of the settlement, or perhaps fiscally savvy individuals of varied backgrounds? That is likely to remain unclear as a large part of the Northern Sector was washed away because unfilled excavation trenches were allowed to fill with rain and collapse into the Rio Puerco during the 1970s and early 1980s. Further study of skeletal pathology and stress markers could shed light on what, if any, relationship existed between material wealth, burial location, and overall health.

Conclusions. There is no statistically significant difference in the frequency of carious lesions between males and females in the Pottery Mound population. There is also no significant difference in the observed caries rate between males and females.

There is no significant difference in the observed caries rate between young adults and older adults. Juveniles had a lower rate of carious lesions, which is expected since their teeth were literally newer and were exposed to cariogenic bacteria for a much shorter period of time, leading to less tooth decay.

There was a relationship between burial location and the number and types grave goods found, and between those variables and observed caries rates. There was a significant difference in the observed caries rate between individuals in the northern and southern sectors of the site, and between individuals with unusual grave goods and those without. The correlation between the observed caries rate and the number of grave goods was small.

Sex, one of the most studied variables in carious lesion analysis, was not the all important characteristic that it was elsewhere. Material wealth and burial location appear to have been more closely tied to overall dental health. Further studies of nutritional stress could potentially indicate whether it affected overall health. A more detailed analysis of grave goods could shed further light on the patterns found.

These results help round out the picture of Pottery Mound, a Pueblo IV period ancestral Puebloan town. Through careful macroscopic analyses, a picture of Pottery Mound's social organization has emerged. This was a diverse community, as is evidenced by the number of kivas, pottery styles, funerary customs, and dietary traditions. The degree of social inequity and difference present is hard to measure with any precision, due to both data issues and the difficulty of reconstructing any past settlement through material culture alone. The statistical analyses performed in this study make it clear that subgroups of some sort, likely with economic and neighborhood ties, appear to have existed at Pottery Mound. These groups had different observed caries rates, likely a result of having different menus or eating different quantities of the same foodstuffs. Further research is warranted.

8. LITERATURE CITED

Acsádi, G.Y. and J. Nemeskéri. 1970. *History of Human Life Spans and Mortality.* Akdadémiai Kiadó, Budapest

Adler, Michael A. 2007. The Architecture of Pottery Mound Pueblo, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 29-54. University of New Mexico Press: Albuquerque.

Akins, Nancy J. 1986. A Biocultural Approach to Human Burials from Chaco Canyon, New Mexico. *Reports of the Chaco Center, Number 9.* National Park Service and the University of New Mexico. Santa Fe, New Mexico.

Armelagos, George J. 1969. Disease in Ancient Nubia. *Science*. New Series Vol. 135, No. 3864: 255-259.

Beckett, Sean and Nancy C. Lovell. 1994. Dental Disease Evidence for Agricultural Intensification in the Nubian C-Group. *International Journal of Osteoarchaeology* 4: 223-240.

Boraas,J.C., L.B. Messer and M.J. Till. 1988. A Genetic Contribution to Dental Caries, Occlusion, and Morphology as Demonstrated by Twins Reared Apart. *Journal of Dental Research* 67: 1150 – 1155.

Bowen, William H. 2002. Do we need to be concerned about dental caries in the coming millennium? *Critical Reviews in Oral Biology and Medicine* 13: 126-131.

Bretz, W.A., P.M. Corby, N.J. Schork, M.T. Robinson, M. Coelho, S. Costa, M.R. Melo Filho, R.J. Weyant and T.C. Hart. 2005. Longitudinal Analysis of Heritability for Dental Caries Traits. *Journal of Dental Research* 84: 1047 - 1051.

Buikstra, Jane E. and Douglas H. Ubelaker (EDS.). 1994. *Standards for Data Collection from Human Skeletal Remains*. Proceedings of a Seminar at The Field Museum of Natural History. Arkansas Archaeological Survey Research Series No. 44. Fayetteville, Arkansas: Arkansas Archaeological Society.

Bumstead, M.P. 1984. *Human Variation: d13C in Adult Bone Collagen and the Relation to Diet in an Isochronus C4 (Maize) Archaeological Population.* Los Alamos National Laboratory LA-1-259-T, Los Alamos, New Mexico.

Clark, Tiffany C. 2007. An Assessment of the Archaeofaunal Remains from Pottery Mound, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 207-228. University of New Mexico Press: Albuquerque.

Cohen, Mark N. 1984. An Introduction to the Symposium, in *Paleopathology at the Origins of Agriculture*, ed. Cohen and Armelagos, 1-11. Orlando: Academic Press.

Cordell, Linda S. 2007. Preface, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, xi-xiii. University of New Mexico Press: Albuquerque.

Costa, Raymond L., Jr. 1980. Incidence of Caries and Abscesses in Archeological Eskimo Skeletal Samples from Point Hope and Kodiak Island, Alaska. *American Journal of Physical Anthropology* 52: 501 -514.

Crotty, Helen K. 2007. Western Pueblo Influences and Integration in the Pottery Mound Painted Kivas, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 85-108. University of New Mexico Press: Albuquerque.

Cucina, Andrea and Vera Tiesler. 2003. Dental Caries and Antemortem Tooth Loss in the Northern Petén Area, Mexico: A Biocultural Perspective on Social Status Differences among the Classic Maya. *American Journal of Physical Anthropology* 122:1–10.

Demirjian, A., H. Goldstein, and J.M. Tanner. 1973. A New System of Dental Age Assessment. *Human Biology* 45 (2): 211-227.

Dias, G. and N. Tayles. 1997. "Abscess Cavity" A Misnomer. *International Journal of Osteoarchaeology* 7: 548-554.

Dozier, Edward P. 1970. *The Pueblo Indians of North America.* Holt, Rinehart and Winston: New York.

Eckert, Suzanne L. 2007. Understanding the Dynamics of Segregation and Incorporation at Pottery Mound through Analysis of Glaze-Decorated Bowls, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 55-74. University of New Mexico Press: Albuquerque.

-----. 2008. *Pottery and Practice: The Expression of Identity at Pottery Mound and Hummingbird Pueblo*. University of New Mexico Press: Albuquerque.

Featherstone, J.D.B. 2004. The Continuum of Dental Caries - Evidence for a Dynamic Disease Process. *Journal of Dental Research* 83: C-39-C42.

Fejerskov, Ole. 1997. Concepts of Dental caries and Their Consequences for Understanding the Disease. *Community Dentistry and Oral Epidemiology* 25: 5-12.

Gilman, Patricia. 1987. Architecture as Artifact: Pit Structures and Pueblos in the American Southwest. *American Antiquity* 52: 538-564.

Hays-Gilpin, Kelley and Steven A. LeBlanc. 2007. Sikyatki Style in Regional Context, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 109-136. University of New Mexico Press: Albuquerque.

Hibben, Frank C. 1955. Excavations at Pottery Mound, New Mexico. *American Antiquity* 21 (2): 179-180.

-----. 1975. *Kiva Art of the Anasazi at Pottery Mound*. KC Publications: Las Vegas, Nevada.

Hillson, Simon. 1986. *Teeth*. First Edition. Cambridge: Cambridge University Press.

-----. 1996. *Dental Anthropology*. Cambridge: Cambridge University Press.

-----. 2001. Recording Dental Caries in Archaeological Human Remains. *International Journal of Osteoarchaeology* 11: 249-289.

-----. 2005. *Teeth*. Second Edition. Cambridge: Cambridge University Press.

Holliday, Vance T. and David J. Meltzer. 2010. The 12.9 k-a ET Impact Hypothesis and North American Paleoindians. *Current Anthropology* 51 (5): 575-607.

Horowitz, Sidney L., Richard H. Osborne, Frances V. DeGeorge. 1958. Caries Experience in Twins. *Science, New Series*, Vol. 128, No. 3319 (Aug. 8, 1958): 300-301.

İşcan, M.Y. 1988. Rise of Forensic Anthropology. *Yearbook of Physical Anthropology* 31: 203-230.

Kantner, John. 2004. *Ancient Puebloan Southwest.* Cambridge University Press: Cambridge.

Keene, H.J. 1986. Dental Caries Prevalence in Early Polynesians from the Hawaiian Islands. *Journal of Dental Research* 65: 935 - 938.

Kerr, N.W., M.F. Bruce and J.F. Cross. 1990. Caries Experience in Medieval Scots. *American Journal of Physical Anthropology* 83: 69-76.

Kidder, Alfred Vincent. 1924. *An Introduction to the Study of Southwestern Archaeology.* 2000 Edition. Yale University: New Haven.

Krogman, Wilton Marion and Mehmet Yaşar İşcan. 1986. *The Human Skeleton in Forensic Medicine*. Springfield, Illinois: Charles C. Thomas.

Lanfranco, Luis Pezo, and Sabine Eggers. 2010. The Usefulness of Caries Depth, Frequency, and Location in Determining Cariogenicity and Past Subsistence: A Test on Early and Later Agriculturalists from the Peruvian Coast. *American Journal of Physical Anthropology* 143: 75-91

Larmas, M. 2003. Dental Caries Seen from the Pulpal Side: a Non-traditional Approach. *Journal of Dental Research* 82: 253-256.

Lenander-Lumikari, M. and V. Loimaranta. 2000. Saliva and Dental Caries. *Advances in Dental Research* 14; 40 – 47

Lieverse, Angela R. 2009. Diet and the Aetiology of Dental Calculus. *International Journal of Osteoarchaeology* 9: 219-232.

Lillie, M.C. 1996. Mesolithic and Neolithic Populations of Ukraine: Indications of Diet from Dental Pathology. *Current Anthropology* 37 (1): 135-142.

Liversidge, H.M. 1994. Accuracy of Age Estimation from Developing Teeth of a Population of Known Age (0-5.4 Years). *International Journal of Osteoarchaeology* 4: 37-45.

Liversidge, H.M., B. Herdeg, and E.W. Rosing. 1998. Dental Age of Non-Adults. A Review of Dental Methods and Principals. *Dental Anthropology, Fundamentals, Limits and Prospects.* Vienna: Springer.

Liversidge, H.M., and T. Molleson. 2004. Variation in Crown and Root Formation and Eruption of Human Deciduous Teeth. *American Journal of Physical Anthropology* 123: 172-180.

Loesche, Walter J. 1986. Role of Streptococcus mutans in Human Dental Decay. *Microbiological Reviews* Dec: 353-380.

Lovejoy, C.O., R.S. Meindl, T.R. Pryzbeck, and R.P. Mensforth. 1985. Chronological Metamorphosis of the Auricular Surface of the Ilium. *American Journal of Physical Anthropology* 68: 15-28.

Lukacs, J.R. 1981. Dental pathology and nutritional patterns of South Asian Megalith-builders: the evidence from Iron Age Mahujhari. *Proceedings of the American Philosophical Society* 125: 220-237.

-----. 1992. Dental Paleopathology and Agricultural Intensification in South Asia: New Evidence From Bronze Age Harappa. *American Journal of Physical Anthropology* 87:133-150.

-----. 1996. Sex Differences in Dental Caries Rates With the Origin of Agriculture in South Asia. *Current Anthropology* 37(1): 147-153

Lukacs, John R. and Leah L. Largaespada. 2006. Explaining Sex Differences in Dental Caries Prevalence: Saliva, Hormones, and ''Life-History'' Etiologies. *American Journal of Human Biology* 18:540–555.

Marsh, P.D. 1994. Microbial Ecology of Dental Plaque and its Significance in Health and Disease. *Advances in Dental Research* 8: 263-271.

Martin, Debra L., Alan H. Goodman, George J. Armelagos and Ann L. Magennis. 1991. *Black mesa Anasazi Health: Reconstructing Life From Patterns of Death and Disease*. Southern Illinois University at Carbondale Center for Archaeological Investigations Occasional Paper No. 14.

Michel, Mark. 2006. Banned Books, in *Archaeological Ethics, 2nd Edition*, ed. Karen D. Vitelli and Chip Colwell-Chanthaphonh, 176-177. AltaMira Press: Lantham, MD.

Mincer, H.H., E.F. Harris, and H.E. Berryman. 1993. The A.B.F.O Study of Third Molar Development and its use as an Estimator of Chronological Age. *Journal of Forensic Sciences* 38: 379-390.

Phillips Jr., David A. 2007. Site Maps of Pottery Mound (LA 416): A Detailed Mosaic, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 251-258. University of New Mexico Press: Albuquerque.

Rosen, S., H.R. Hunt and C.A. Hoppert. 1961. The Importance of the Genotype on Susceptibility to Dental Caries in the Rat. *Journal of Dental Research* 40: 352-354.

Schaefer, Maureen, Sue Black, and Louise Scheuer. 2009. *Juvenile Osteology: A Laboratory and Field Manual*. New York: Academic Press.

Schaafsma, Polly. 2007a. Introduction: Revisiting Pottery Mound, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 1-14. University of New Mexico Press: Albuquerque.

-----. 2007b. The Pottery Mound Murals and Rock Art: Implications for Regional Interaction, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 137-166. University of New Mexico Press: Albuquerque.

Schwartz, Douglas W. 2000. Kidder and the Synthesis of Southwestern Archaeology, in *An Introduction to the Study of Southwestern Archaeology* by Alfred Kidder, 1-55. Yale University: Connecticut.

Skelton, Randall. 1996. *Laboratory Manual for Forensic Anthropology*. Missoula, Montana: University of Montana.

Smith, B. Holly. 1991. Standards of Human Tooth Formation and Dental Age Assessment. *Advances in Dental Anthropology. Eds. Kelley and Larsen. Pp. 143-166. New York: Wiley-Liss.*

Smith, B.H. and S.M. Garn. 1987. Polymorphisms in Eruption Sequence of Permanent Teeth in American Children. *American Journal of Physical Anthropology* 74: 289-303.

Spielmann, Katherine A. 1989. Colonists, Hunters, and Farmers: Plains-Pueblo Interaction in the Seventeenth Century. In *Columbian Consequences, Volume 1:*

Archaeological and Historical Perspectives on the Spanish Borderlands, West. Ed. David Hurst Thomas, 101-113. Washington D.C.: Smithsonian Institute.

Staat, Robert H., Thomas H. Gawronski, Dawn E. Cressey, Robert S. Harris and Lars E.A. Folke. 1975. Effects of Dietary Sucrose Levels on the Quantity and Microbial Composition of Human Dental Plaque. *Journal of Dental Research* 54: 872-880.

Stodder, Ann L. 1996. Paleoepidemiology of Eastern and Western Pueblo Communities in Protohistoric and Early Historic New Mexico. In *Bioarchaeology Of Native American Adaptation in the Spanish Borderlands*. Eds. Brenda J. Baker and Lisa Kealhofer, 148-176. University of Florida Press: Gainesville.

Tayles, N., K. Dommett and K. Nelson. 2000. Agriculture and Dental Caries? The Case of Rice in Prehistoric South East Asia. *World Archaeology* 32: 68-83.

Taylor, R.M.S. 1978. *Variation in Morphology of Teeth: Anthropologic and Forensic Aspects*. Springfield, Illinois: C.C. Thomas.

Todd, T. Wingate. 1920. Age Changes in the pubic Bone: I. The Male White Pubis. *American Journal of Physical Anthropology* 3(3): 285-334.

Turner, Christy G. 1979. Dental Anthropological Indications of Agriculture Among the - Jomon People of Central Japan. *American Journal of Physical Anthropology* 51: 619-636.

Ubelaker, Douglas H. 1989. *Human Skeletal Remains: Excavation, Analysis, Interpretation, Second Edition.* Washington D.C.: Taraxacum.

Vivian, Patricia. 2007. The Kiva Murals of Pottery Mound: A History of Discovery and Methods of Study: Kivas 1-10, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 75-84. University of New Mexico Press: Albuquerque.

Vivian, R. Gwinn. 2007. Frank C. Hibben and Pottery Mound: Site Research and Interpretation, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 15-28. University of New Mexico Press: Albuquerque.

Watson, J.T. 2008. Prehistoric Dental Disease and the Dietary Shift from Cactus to Cultigens in Northwest Mexico. *International Journal of Osteoarchaeology* 18: 202-212.

Webster, Laurie D. 2007. Ritual Costuming at Pottery Mound: The Pottery Mound Textiles in regional Perspective, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 167-206. University of New Mexico Press: Albuquerque.

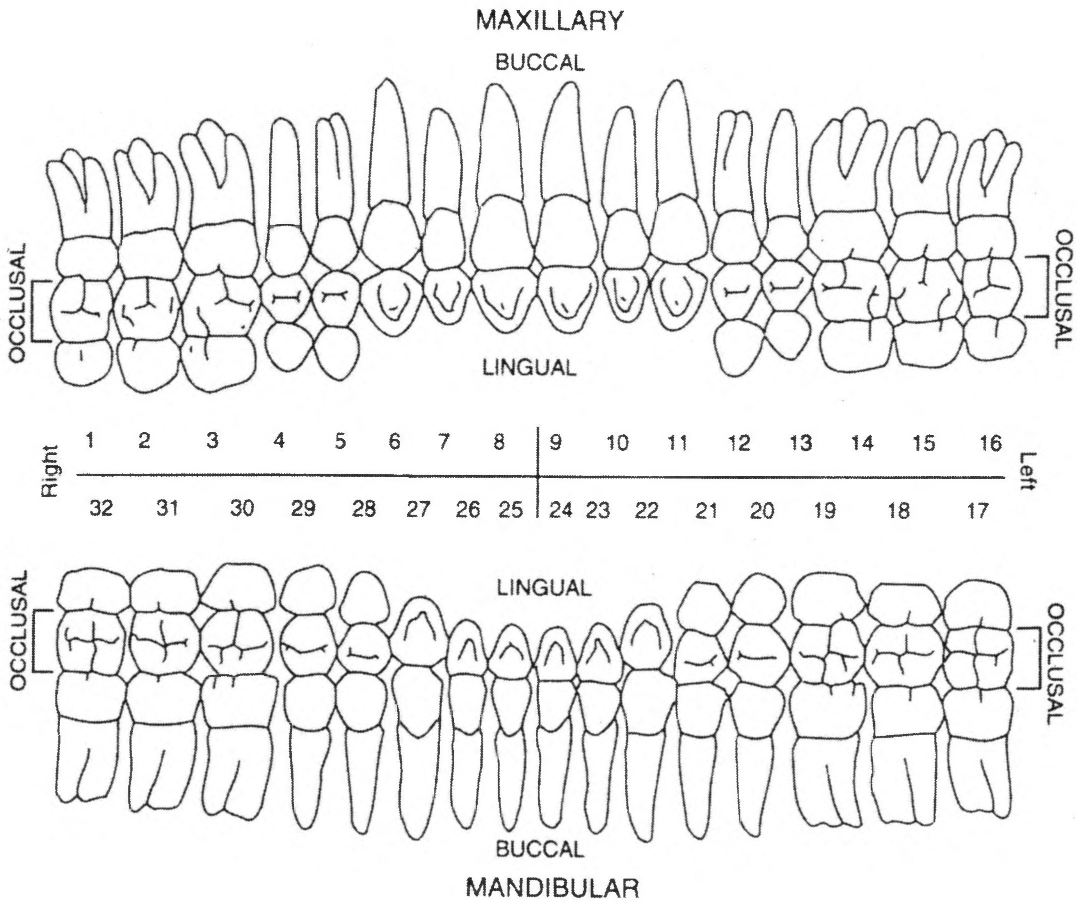
White, Tim. 2000. *Human Osteology, Second Edition.* San Diego, CA: Academic Press.

Wilcox, David R. 2007. Discussion of The Pottery Mound Essays and Some Alternative Proposals, in *New Perspectives on Pottery Mound Pueblo*, ed. Polly Schaafsma, 229-250. University of New Mexico Press: Albuquerque.

Wolfe, Linda D., Leslie Sue Lieberman, and Dale Hutchinson. 1994. *Laboratory Textbook for Physical Anthropology, Fourth Edition.* Raleigh, NC: Contemporary Publishing Company.

Appendix A: Adult Recordation Sheet

Specimen Number: Date:



SEX

Pelvis

	L	R
Ventral Arc (1-3)	___	___
Subpubic Concavity (1-3)	___	___
Ischiopubic Ramus Ridge (1-3)	___	___
Greater Sciatic Notch (1-5)	___	___
Preauricular Sulcus (0-4)	___	___

Estimated Sex, Pelvis (0-5) ______

Skull

	L	M	R
Nuchal Crest (1-5)	___	___	___
Mastoid Process (1-5)	___	___	___
Supraorbital Margin (1-5)	___	___	___
Glabella (1-5)	___	___	___
Mental Eminence (1-5)	___	___	___

Estimated Sex, Skull (0-5) ____ _

Humeral Head (mm): _____
Shaped Skull: __________
Age: ________
Criteria:

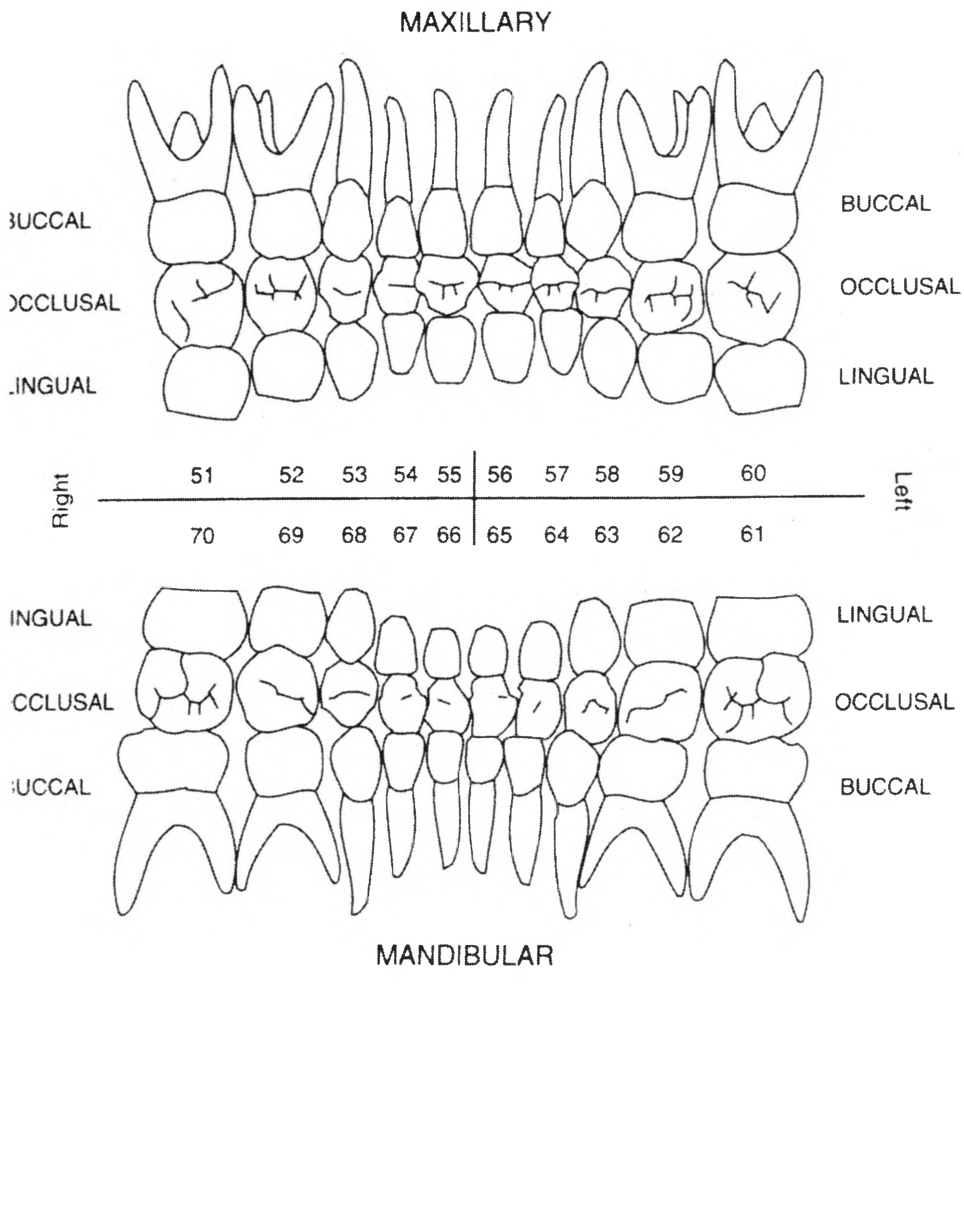
Sex: _______
Criteria:

Lesion:								
Tooth:								
Surface:								
M-D (mm):								
B-L (mm):								
Depth (mm):								
Score (1-4):								
Coalesced (Y/N):								
Near gum (Y/N):								

Notes: ____

Appendix B: Juvenile Recordation Sheet

Specimen Number: Date:



Lesion:								
Tooth:								
Surface:								
M-D (mm):								
B-L (mm):								
Depth (mm):								
Score (1-4):								
Coalesced (Y/N):								
Near gum (Y/N):								

Notes:

Appendix C: Raw Data

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
80.14.5	F	50-?	No data	No data
	F	50-?	No data	No data
	F	50-?	No data	No data
	F	50-?	No data	No data
79.17.1	M	19	No data	No data
	M	19	No data	No data
	M	19	No data	No data
	M	19	No data	No data
83.07.1A	M	30-34	No data	No data
	M	30-34	No data	No data
	M	30-34	No data	No data
	M	30-34	No data	No data
80.14.4	M	35-40	0	None
	M	35-40	0	None
	M	35-40	0	None
	M	35-40	0	None
73.103.27	M	25	0	None
	M	25	0	None
	M	25	0	None
	M	25	0	None
73.103.29	INDET	21-?	0	None
	INDET	21-?	0	None
	INDET	21-?	0	None
	INDET	21-?	0	None

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
80.14.5	North	0	0	0
	North	0	0	0
	North	0	1	0
	North	0	0	0
79.17.1	North	0	7	0
	North	0	2	0
	North	0	8	0
	North	5	11	9
83.07.1A	North	0	2	0
	North	0	1	0
	North	0	7	0
	North	2	9	2
80.14.4	North	0	6	0
	North	0	4	0
	North	0	8	0
	North	5	8	5
73.103.27	North	0	8	0
	North	0	4	0
	North	0	8	0
	North	5	10	6
73.103.29	North	0	0	0
	North	0	1	0
	North	2	4	2
	North	2	7	2

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.50	INDET	20-25	0	None
	INDET	20-25	0	None
	INDET	20-25	0	None
	INDET	20-25	0	None
82.8.2	F	25-30	0	None
	F	25-30	0	None
	F	25-30	0	None
	F	25-30	0	None
83.07.3	INDET	30-35	0	None
	INDET	30-35	0	None
	INDET	30-35	0	None
	INDET	30-35	0	None
83.07.4B	F	20-25	0	None
	F	20-25	0	None
	F	20-25	0	None
	F	20-25	0	None
73.103.80	M	25-30	0	None
	M	25-30	0	None
	M	25-30	0	None
	M	25-30	0	None
73.103.81	M	25-30	0	None
	M	25-30	0	None
	M	25-30	0	None
	M	25-30	0	None
73.103.19	INDET	1.5	0	None
	INDET	1.5	0	None
	INDET	1.5	0	None
	INDET	1.5	0	None

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.50	North	1	5	1
	North	0	4	0
	North	0	7	0
	North	1	1	2
82.8.2	North	0	0	0
	North	0	2	0
	North	0	2	0
	North	7	10	12
83.07.3	North	0	5	0
	North	0	4	0
	North	1	8	1
	North	9	10	16
83.07.4B	North	0	6	0
	North	0	4	0
	North	0	7	0
	North	5	12	6
73.103.80	South	0	5	0
	South	0	2	0
	South	0	6	0
	South	5	10	5
73.103.81	South	0	1	0
	South	0	0	0
	South	0	2	0
	South	3	5	3
73.103.19	South	0	4	0
	South	0	2	0
	South	0	0	0
	South	0	6	0

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.33	M	40	0	None
	M	40	0	None
	M	40	0	None
	M	40	0	None
73.103.34	M	35	0	None
	M	35	0	None
	M	35	0	None
	M	35	0	None
73.103.38	INDET	5	0	None
	INDET	5	0	None
	INDET	5	0	None
	INDET	5	0	None
73.103.43	M	40	0	None
	M	40	0	None
	M	40	0	None
	M	40	0	None
73.103.62	F	30-35	0	None
	F	30-35	0	None
	F	30-35	0	None
	F	30-35	0	None
73.103.63	F	35-40	0	None
	F	35-40	0	None
	F	35-40	0	None
	F	35-40	0	None
73.103.64	M	50-?	0	None
	M	50-?	0	None
	M	50-?	0	None
	M	50-?	0	None

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.33	South	0	1	0
	South	0	1	0
	South	2	3	2
	South	1	3	1
73.103.34	South	0	6	0
	South	0	3	0
	South	0	5	0
	South	2	7	2
73.103.38	South	0	0	0
	South	0	3	0
	South	0	0	0
	South	0	7	0
73.103.43	South	0	2	0
	South	0	1	0
	South	0	2	0
	South	1	1	1
73.103.62	South	0	8	0
	South	0	4	0
	South	0	8	0
	South	2	10	4
73.103.63	South	0	8	0
	South	0	4	0
	South	1	6	1
	South	3	6	5
73.103.64	South	0	1	0
	South	0	1	0
	South	0	0	0
	South	0	0	0

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.66	INDET	3	0	None
	INDET	3	0	None
	INDET	3	0	None
	INDET	3	0	None
73.103.71	M	20-25	0	None
	M	20-25	0	None
	M	20-25	0	None
	M	20-25	0	None
73.103.75	M	35	0	None
	M	35	0	None
	M	35	0	None
	M	35	0	None
73.103.77	INDET	40	0	None
	INDET	40	0	None
	INDET	40	0	None
	INDET	40	0	None
73.103.79	F	20-25	0	None
	F	20-25	0	None
	F	20-25	0	None
	F	20-25	0	None
73.103.1	M	50	1	Textiles
	M	50	1	Textiles
	M	50	1	Textiles
	M	50	1	Textiles
79.29.1	F	35	1	Tools
	F	35	1	Tools
	F	35	1	Tools
	F	35	1	Tools

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.66	South	0	4	0
	South	0	2	0
	South	0	0	0
	South	0	4	0
73.103.71	South	0	1	0
	South	0	1	0
	South	0	0	0
	South	1	4	1
73.103.75	South	0	6	0
	South	0	4	0
	South	0	7	0
	South	1	10	1
73.103.77	South	0	1	0
	South	0	1	0
	South	0	2	0
	South	2	2	2
73.103.79	South	0	8	0
	South	0	4	0
	South	4	8	6
	South	8	10	18
73.103.1	North	0	5	0
	North	0	3	0
	North	0	7	0
	North	6	7	11
79.29.1	North	2	6	2
	North	0	4	0
	North	1	8	1
	North	2	11	2

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.44	INDET	3	1	Textiles
	INDET	3	1	Textiles
	INDET	3	1	Textiles
	INDET	3	1	Textiles
73.103.74	INDET	4	1	Textiles
	INDET	4	1	Textiles
	INDET	4	1	Textiles
	INDET	4	1	Textiles
82.8.6	INDET	9-May	1	Textiles
	INDET	9-May	1	Textiles
	INDET	9-May	1	Textiles
	INDET	9-May	1	Textiles
73.103.35	M	30-35	2	Textiles
	M	30-35	2	Textiles
	M	30-35	2	Textiles
	M	30-35	2	Textiles
87.18.7	F	30-35	2	Textiles
	F	30-35	2	Textiles
	F	30-35	2	Textiles
	F	30-35	2	Textiles
82.08.1	F	25-30	2	Pottery
	F	25-30	2	Pottery
	F	25-30	2	Pottery
	F	25-30	2	Pottery
73.103.13	M	30	3	Tools, Pottery, Textiles
	M	30	3	Tools, Pottery, Textiles
	M	30	3	Tools, Pottery, Textiles
	M	30	3	Tools, Pottery, Textiles

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.44	North	0	8	0
	North	0	4	0
	North	0	0	0
	North	0	8	0
73.103.74	North	0	2	0
	North	0	2	0
	North	0	0	0
	North	0	8	0
82.8.6	North	0	1	0
	North	0	1	0
	North	0	0	0
	North	0	7	0
73.103.35	North	0	1	0
	North	0	1	0
	North	0	0	0
	North	0	0	0
87.18.7	North	3	4	3
	North	0	2	0
	North	0	4	0
	North	2	5	2
82.08.1	North	0	4	0
	North	0	2	0
	North	0	4	0
	North	1	3	1
73.103.13	North	0	6	0
	North	0	3	0
	North	0	8	0
	North	7	11	9

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.24	INDET	5	3	Pottery, Textiles
	INDET	5	3	Pottery, Textiles
	INDET	5	3	Pottery, Textiles
	INDET	5	3	Pottery, Textiles
73.103.46	M	35	4	Unusual, Tools
	M	35	4	Unusual, Tools
	M	35	4	Unusual, Tools
	M	35	4	Unusual, Tools
73.103.15	INDET	25	1	Textiles
	INDET	25	1	Textiles
	INDET	25	1	Textiles
	INDET	25	1	Textiles
73.103.21	M	30	1	Textiles
	M	30	1	Textiles
	M	30	1	Textiles
	M	30	1	Textiles
73.103.3	INDET	9	1	Textiles
	INDET	9	1	Textiles
	INDET	9	1	Textiles
	INDET	9	1	Textiles
73.103.52	INDET	8	1	Textiles
	INDET	8	1	Textiles
	INDET	8	1	Textiles
	INDET	8	1	Textiles
73.103.54	INDET	9	1	Pottery
	INDET	9	1	Pottery
	INDET	9	1	Pottery
	INDET	9	1	Pottery

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.24	North	0	1	0
	North	0	2	0
	North	0	0	0
	North	2	3	2
73.103.46	North	0	7	0
	North	0	4	0
	North	0	8	0
	North	2	5	2
73.103.15	South	0	4	0
	South	0	2	0
	South	0	4	0
	South	2	2	2
73.103.21	South	0	4	0
	South	0	2	0
	South	0	4	0
	South	4	5	9
73.103.3	South	0	4	0
	South	0	4	0
	South	0	5	0
	South	0	8	0
73.103.52	South	0	1	0
	South	0	2	0
	South	0	0	0
	South	4	7	4
73.103.54	South	0	8	0
	South	0	4	0
	South	0	0	0
	South	0	8	0

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.76	M	40	1	Pottery
	M	40	1	Pottery
	M	40	1	Pottery
	M	40	1	Pottery
73.103.20	F	30-35	2	Unusual, Textiles
	F	30-35	2	Unusual, Textiles
	F	30-35	2	Unusual, Textiles
	F	30-35	2	Unusual, Textiles
73.103.57	M	30	2	Pottery
	M	30	2	Pottery
	M	30	2	Pottery
	M	30	2	Pottery
73.103.73	F	35-40	2	Tools, Textiles
	F	35-40	2	Tools, Textiles
	F	35-40	2	Tools, Textiles
	F	35-40	2	Tools, Textiles
73.103.2	F	40	3	Tools, Pottery
	F	40	3	Tools, Pottery
	F	40	3	Tools, Pottery
	F	40	3	Tools, Pottery
73.103.14	INDET	30	4	Unusual, Tools, Textiles
	INDET	30	4	Unusual, Tools, Textiles
	INDET	30	4	Unusual, Tools, Textiles
	INDET	30	4	Unusual, Tools, Textiles
73.103.39	M	25	4	Tools, Pottery
	M	25	4	Tools, Pottery
	M	25	4	Tools, Pottery
	M	25	4	Tools, Pottery

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.76	South	0	4	0
	South	1	3	1
	South	0	6	0
	South	2	8	2
73.103.20	South	0	4	0
	South	0	1	0
	South	0	4	0
	South	1	3	1
73.103.57	South	0	6	0
	South	0	4	0
	South	0	8	0
	South	2	12	3
73.103.73	South	0	4	0
	South	0	4	0
	South	0	6	0
	South	2	4	2
73.103.2	South	0	0	0
	South	0	0	0
	South	0	2	0
	South	0	0	0
73.103.14	South	0	4	0
	South	0	2	0
	South	0	4	0
	South	3	5	3
73.103.39	South	0	2	0
	South	0	2	0
	South	0	6	0
	South	0	11	0

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
73.103.7	M	25	4	Unusual
	M	25	4	Unusual
	M	25	4	Unusual
	M	25	4	Unusual
87.18.3	M	40-45	5	Tools, Pottery
	M	40-45	5	Tools, Pottery
	M	40-45	5	Tools, Pottery
	M	40-45	5	Tools, Pottery
80.14.2	M	45-50	6	Unusual, Tools, Pottery, Textiles
	M	45-50	6	Unusual, Tools, Pottery, Textiles
	M	45-50	6	Unusual, Tools, Pottery, Textiles
	M	45-50	6	Unusual, Tools, Pottery, Textiles
73.103.60	M	30	6	Tools, Pottery
	M	30	6	Tools, Pottery
	M	30	6	Tools, Pottery
	M	30	6	Tools, Pottery
87.18.10	M	35-40	6	Tools
	M	35-40	6	Tools
	M	35-40	6	Tools
	M	35-40	6	Tools
87.18.11	M	50-55	7	Tools, Pottery
	M	50-55	7	Tools, Pottery
	M	50-55	7	Tools, Pottery
	M	50-55	7	Tools, Pottery
80.10.1	F	45-50	7	Tools, Pottery
	F	45-50	7	Tools, Pottery
	F	45-50	7	Tools, Pottery
	F	45-50	7	Tools, Pottery

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
73.103.7	South	0	4	0
	South	0	4	0
	South	0	5	0
	South	1	5	1
87.18.3	North	0	6	0
	North	1	4	1
	North	2	6	2
	North	4	8	4
80.14.2	North	0	2	0
	North	1	4	1
	North	2	8	2
	North	2	6	3
73.103.60	North	0	3	0
	North	0	2	0
	North	0	4	0
	North	0	4	0
87.18.10	North	2	8	2
	North	0	4	0
	North	1	6	1
	North	5	5	9
87.18.11	North	0	7	0
	North	0	4	0
	North	2	8	2
	North	3	8	3
80.10.1	North	0	4	0
	North	0	4	0
	North	0	6	0
	North	2	4	2

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
87.18.9	F	25-30	7	Tools, Pottery, Textiles
	F	25-30	7	Tools, Pottery, Textiles
	F	25-30	7	Tools, Pottery, Textiles
	F	25-30	7	Tools, Pottery, Textiles
87.18.4	F	30-35	8	Unusual, Tools, Pottery
	F	30-35	8	Unusual, Tools, Pottery
	F	30-35	8	Unusual, Tools, Pottery
	F	30-35	8	Unusual, Tools, Pottery
87.18.5	F	25-30	8	Tools, Pottery, Textiles
	F	25-30	8	Tools, Pottery, Textiles
	F	25-30	8	Tools, Pottery, Textiles
	F	25-30	8	Tools, Pottery, Textiles
87.18.13	F	25-30	8	Unusual, Tools, Pottery
	F	25-30	8	Unusual, Tools, Pottery
	F	25-30	8	Unusual, Tools, Pottery
	F	25-30	8	Unusual, Tools, Pottery
87.18.14	M	35-40	8	Unusual, Tools
	M	35-40	8	Unusual, Tools
	M	35-40	8	Unusual, Tools
	M	35-40	8	Unusual, Tools
73.103.48	M	45	6	Unusual, Textiles
	M	45	6	Unusual, Textiles
	M	45	6	Unusual, Textiles
	M	45	6	Unusual, Textiles
73.103.6	INDET	3-Feb	9	Unusual, Tools, Pottery
	INDET	3-Feb	9	Unusual, Tools, Pottery
	INDET	3-Feb	9	Unusual, Tools, Pottery
	INDET	3-Feb	9	Unusual, Tools, Pottery

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
87.18.9	North	0	8	0
	North	0	3	0
	North	0	7	0
	North	4	12	6
87.18.4	North	0	8	0
	North	0	4	0
	North	1	7	1
	North	9	11	19
87.18.5	North	0	0	0
	North	0	0	0
	North	0	3	0
	North	5	10	9
87.18.13	North	0	8	0
	North	0	4	0
	North	1	8	1
	North	9	11	14
87.18.14	North	0	6	0
	North	0	4	0
	North	0	8	0
	North	2	12	2
73.103.48	South	0	4	0
	South	0	3	0
	South	0	5	0
	South	2	7	2
73.103.6	South	0	0	0
	South	0	0	0
	South	0	0	0
	South	0	8	0

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
84.34.1	F	20-25	11	Unusual, Tools
	F	20-25	11	Unusual, Tools
	F	20-25	11	Unusual, Tools
	F	20-25	11	Unusual, Tools
87.18.12	INDET	25-30	11	Tools, Pottery
	INDET	25-30	11	Tools, Pottery
	INDET	25-30	11	Tools, Pottery
	INDET	25-30	11	Tools, Pottery
80.14.1	F	25	12	Tools, Pottery, Textiles
	F	25	12	Tools, Pottery, Textiles
	F	25	12	Tools, Pottery, Textiles
	F	25	12	Tools, Pottery, Textiles
83.24.5	F	30-35	13	Tools, Pottery, Textiles
	F	30-35	13	Tools, Pottery, Textiles
	F	30-35	13	Tools, Pottery, Textiles
	F	30-35	13	Tools, Pottery, Textiles
87.18.2	M	25-30	14	Tools, Pottery, Textiles
	M	25-30	14	Tools, Pottery, Textiles
	M	25-30	14	Tools, Pottery, Textiles
	M	25-30	14	Tools, Pottery, Textiles
84.34.2	M	25-29	15	Unusual, Tools, Pottery, Textiles
	M	25-29	15	Unusual, Tools, Pottery, Textiles
	M	25-29	15	Unusual, Tools, Pottery, Textiles
	M	25-29	15	Unusual, Tools, Pottery, Textiles
83.24.2	INDET	3-Feb	15	Unusual, Tools, Pottery, Textiles
	INDET	3-Feb	15	Unusual, Tools, Pottery, Textiles
	INDET	3-Feb	15	Unusual, Tools, Pottery, Textiles
	INDET	3-Feb	15	Unusual, Tools, Pottery, Textiles

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
84.34.1	North	0	0	0
	North	0	1	0
	North	0	4	0
	North	5	6	8
87.18.12	North	0	8	0
	North	0	4	0
	North	1	8	1
	North	8	9	13
80.14.1	North	0	8	0
	North	0	4	0
	North	1	8	1
	North	10	11	18
83.24.5	North	4	5	4
	North	0	2	0
	North	0	1	0
	North	0	0	0
87.18.2	North	0	4	0
	North	0	2	0
	North	0	4	0
	North	5	10	16
84.34.2	North	0	4	0
	North	1	3	1
	North	0	4	0
	North	0	4	0
83.24.2	North	0	2	0
	North	0	4	0
	North	0	0	0
	North	0	8	0

Accession Number	Sex	Age	Number of Grave Goods	Grave Goods Found
87.18.19	F	15-20	15	Unusual, Tools, Pottery
	F	15-20	15	Unusual, Tools, Pottery
	F	15-20	15	Unusual, Tools, Pottery
	F	15-20	15	Unusual, Tools, Pottery
80.14.3	M	35-40	19	Unusual, Tools, Pottery, Textiles
	M	35-40	19	Unusual, Tools, Pottery, Textiles
	M	35-40	19	Unusual, Tools, Pottery, Textiles
	M	35-40	19	Unusual, Tools, Pottery, Textiles
82.8.4	INDET	1.5	20	Unusual, Tools, Pottery
	INDET	1.5	20	Unusual, Tools, Pottery
	INDET	1.5	20	Unusual, Tools, Pottery
	INDET	1.5	20	Unusual, Tools, Pottery

Accession Number	Burial Sector	Number of Diseased Teeth	Number of Teeth	Number of Caries
87.18.19	North	0	8	0
	North	0	4	0
	North	0	8	0
	North	0	10	0
80.14.3	North	0	7	0
	North	0	4	0
	North	0	8	0
	North	5	9	6
82.8.4	North	1	3	1
	North	0	2	0
	North	0	0	0
	North	1	3	3