A COMPARATIVE BIOARCHAEOLOGY OF K'AXOB & CUELLO: NON-SPECIFIC INFECTION MARKERS & SOCIAL STATUS DIFFERENTIATION IN THE MAYA PRE-CLASSIC PERIOD

A Thesis

Presented to

The Faculty of the Department

of Anthropology

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

By

Katherine A. McElvaney

August, 2018

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ABSTRACT

This thesis explores whether there is a statistical difference in rates of non-specific infection between two Maya Pre-classic villages, K'axob and Cuello, and whether these findings can be correlated to social status differentiation within and between the two villages. Using representative skeletal samples from these populations, an osteological analysis is performed to determine the presence of non-specific infection markers in the form of periosteal reactions. Combining these health indicators with other socioeconomic factors can be informative about the social status of individuals and allow both a correlation of infection rates among suspected elite versus non-elite individuals, as well as make a socioeconomic versus health status comparison between two villages within the region coexisting within the same period. Results show a high overall inclusion of grave goods in the combined Pre-classic samples, with 80% of individuals having some included grave goods compared to 20% with none included. Non-specific infection markers show a low overall infection rate in the combined Pre-classic samples, with 76.2% having no infection markers present while 23.8% showed indication of periosteal reactions. Of those with infection markers present, 84.4% have included grave goods compared to 15.6% without any included goods. The 20% of the combined Pre-classic sample without grave goods present was not found to overlap in any significant way with the 23.8% of the combined Pre-classic sample with infection markers present. Social status differentiation was not found to impact health status in a discernible way.

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Dedicated with love to my parents,

Richard McElvaney & Ria Nicholas

INTRODUCTION

This thesis seeks to define whether there is any statistical difference in rates of non-specific infection on skeletons between two Maya Pre-classic villages, known as K'axob and Cuello, located in the northern lowlands of present-day Belize. I plan to complete a comparative bioarchaeological analysis of skeletal materials from these two samples looking for the presence of periosteal reactions, as well as comparing social status differentiation within and between the two samples shown through differences in mortuary treatments.

Using these two representative skeletal collections and the individuals included, I will perform a bioarchaeological comparison of periosteal reactions on any identifiable long bones, primarily focusing on the tibia or tibia partials. I will then attempt to score any periosteal reactions by level of severity, as well as scoring lesion activity stage. Several methodological strategies are utilized to create my own methodology, including the idea for utilizing stages of lesion severity from Lallo (1973) as described in Weston (2011). Description terms for lesion location and for lesion activity stage follow Buikstra & Ubelaker (1994). Further methodological questions of inquiry into periosteal reactions are outlined in Weston (2011) and followed to the extent they could be applied to these fragmentary skeletal samples. Social status differentiation measures most closely follow Goodman (1998) and Rothschild (1979).

I am hypothesizing that non-specific infection in the form of periosteal reactions can be used as a broad health indicator for a population overall (Weston, 2008). Periostitis can be triggered from a number of etiological causes, most notably from either infection or inflammation, which may or may not be related (Weston, 2011). Inflammation however occurs as a normal part of the immune response, which can in turn be triggered by a number of causes, including an underlying infection. Since one cause of inflammation is infection, for the purposes of this study periosteal reactions will be considered as indicative of non-specific infection. Furthermore, I would suspect the rate of all infections to be relatively high in pre-industrial societies without access to health interventions, as is the case with the Pre-classic Maya. By combining health indicators with socioeconomic indicators such as burial location and the inclusion of grave goods, we can also surmise something about the social status of these individuals and allow both a correlation of infection rates among suspected higher socioeconomic status individuals versus lower socioeconomic status individuals, as well as enabling a socioeconomic status versus health status comparison between two separate villages within the lowland area coexisting within the same period. Inclusion of both these factors—and the variables I've chosen to represent them—allow for a multi-tiered exploration of the relationship between societal health categories and social status differentiation within and between these two population samples.

All skeletal analysis was performed in person on the K'axob skeletal samples, with further guidance from the related literature (Storey, 2004) and via a computer database for the Cuello samples. This database, compiled by Dr. Rebecca Storey of the University of Houston, is an inclusive file containing data originally gathered by Frank and Julie Saul (1991) in Hammond (1991). It is an exhaustive overview with all osteological and mortuary details from each burial including any noted pathologies as well as describing quantity and type of associated grave goods present. For the purposes of this study the database will be referred to simply as the Cuello Database. From the Cuello Database I was able to compile my own database, focusing on the variables and details relevant to my own study, and able to combine the date from Cuello with that from K'axob. Once completed, data could be analyzed both from each site separately as well as combined to enable a complete comparison of variables. This analysis is achieved using the IBM Statistical Package for the Social Sciences (SPSS) program.

Other important bioarchaeological variables such as age at death, sex, and phase within the Pre-classic will be analyzed as broad demographic variables. If the samples are highly deteriorated, however, as I expect will be the case with most of the K'axob collection, age at death and sex will be more difficult to determine conclusively. Therefore, approximate age ranges will need to be employed, as originally described in the relevant literature from both sites and confirmed through my own dentition analysis (when available) for the K'axob sample. For individuals too incomplete or otherwise lacking diagnostic skeletal elements, or otherwise individuals in certain age ranges where the conclusive determination of sex is impossible, a third category under sex of 'indeterminate' will be applied. Preservation of samples will also possibly affect the number of individuals in the sample groups, and so estimates will be based on the suspected minimum number of individuals (MNI) present in the skeletal sample, using relevant literature from both sites to confirm. Within the sample collections, an 'individual' is designated by their burial number from the original excavation notes or from the database. All individuals within each sample will initially be analyzed for variables relating to social status differentiation, and then reevaluated to determine if they meet the requirements needed to explore the relation of social status to infection for this study. Therefore, for the section exploring infection, only individuals complete enough to contain whole or partial tibiae or identifiable tibia fragments, or otherwise other long bone fragments, will be evaluated for the presence or absence of infection markers. Without the inclusion of long bones or long bone fragments, it will be impossible to complete the analysis for infection markers on these individuals within the parameters defined in this study and therefore these individuals are excluded from the final analysis. Mortuary context and analysis of location of interments and any inclusion of associated grave goods will come from existing literary sources (McAnany, Storey, & Lockard, 1999; McAnany & Varela, 1999; Saul & Saul, 1991; Storey, 2004; Robin & Hammond, 1991) as well as from the Cuello Database, and will aid in distinguishing probable social status of individuals within each of the samples. Infection markers are identified via in-person visual analysis for K'axob, and via the Cuello Database descriptions for Cuello. Results of this research project are discussed with the hope they will aid future bioarchaeological inquiry into non-specific infection rates among the Pre-classic Maya in the lowlands of Belize and give an overall picture of health within a framework of social conditions and social status differentiation during this pivotal yet understudied time-period in Maya societal development. Furthermore, if infection rates prove to be statistically similar between K'axob and Cuello, this information could be used to make inferences about other similar Maya groups occupying the lowland region during the Pre-classic. I expect that there will be a similar frequency of non-specific infection between these two villages and therefore a comparison will be possible. Results could then be generally applied to other similar villages within the Pre-classic lowland areas, or possibly throughout the Maya realm. If rates of non-specific infection prove to be dissimilar between K'axob and Cuello, then other social or environmental factors must be accounted for and explored in future research.

The General Problem

If the skeleton is a biological indicator of social and cultural conditions in life, such as health, infection, and inequality, then evidence of such can be used to make greater inferences about the health and socioeconomic circumstances of the society at a certain point in time, and thus aid in making comparisons between culturally similar societies (Larsen, 2015). Can we infer levels of social status differentiation and biological health of a population overall using bioarchaeological and paleopathological (or paleoepidemiological) methods?

In the 21st century United States of America, income level is a major predictor of health status. Many studies have explored the relationship between these two variables, and found a negative correlation, though there is controversy as to whether these results can be cross-culturally or longitudinally applied (Babones, 2008). While there is a high level of debate among the scientific community on the relation of these two variables, more recent work has justified this correlation, at least within the recent United States at the state level of sociopolitical organization, and as it applies to a common measurement of ‘health’, which in this study was life expectancy (Hill, 2018). Within these recent studies over the relationship of these two variables, measures for ‘health’ most often included life expectancy, infant mortality, murder rate, or some combination of these, while social status measures were typically described as inequality measures or income measures (Babones, 2008; Hill, 2018). While these are all important measures—as shown by the many studies that focus on them—this study explores health through a measure of infection rate frequency, or rather a measure of stress and adaptation to that stress rather than the mortality outcomes the three most commonly measured health variables suggest. Social status measures utilized in the above studies are similar in goal to my own, with my study observing grave goods and overall mortuary treatments as measures of social status differentiation. While these are all contemporary studies within the 21st century United States, the question of these studies is similar to my own on the relationship between health and social status or developing social status in terms of emerging social status differentiation in the Pre-classic Maya lowlands.

Suffice it to say, the world of the Pre-classic Maya is not the same as the modern world explored in these health studies. However, with developing social complexity comes a host of new social problems, including the creation and differentiation of groups based on differences in socioeconomic factors. Differences in socioeconomic status and thus social status differentiation in society have existed to some extent since the advent of the concept of ownership after the Neolithic transition. Perhaps as a result, this transition from foraging to sedentary farming also saw a change in the pattern of disease, known in the literature as the first epidemiological transition (Armelagos, Brown, & Turner, 2005). Prior to the Neolithic transition, endemic infectious disease was not a problem of forager societies, due to several ecological and social buffers at play. When we speak about 'stress' or 'stressors' we often refer to culture as evolving as an adaptation to buffer against environmental stress, and yet culture itself can also act as a stressor, just like any other external factor. In this way culture is both a buffer and a stressor, each in a different way and with assorted effects on individuals.

With the shift in subsistence strategy to adopt agriculture however, the relationship of humans to pathogens changed dramatically, as a result of changing ecological and social landscapes. Early foragers had a range of parasites and pathogens, primarily zoonoses, but the type of pathogens experienced during and after the Neolithic transition were markedly different organisms, as were the ecological and social stressors present before and after this transition. For example, domestication of food animals meant humans would be in closer contact with their herd animals and more likely to experience new zoonotic spillover events.

Likewise, concurrent factors including growth in human population size, density, crowding, and sanitation issues associated with sedentism, and agricultural and domestication practices all increased the prevalence of infectious disease risk within the population (Armelagos, et al., 2005; Armelagos & Cohen,1984). With the Neolithic transition and new settlement and subsistence patterns also came the development of social status differentiation and eventually social inequality as a result of increased socioeconomic complexity (Goodman & Martin, 2002; Paynter, 1989).

While the Maya did not have large domesticated herd animals as seen in the Old World, the switch from foraging to more intensive agricultural modes of production, and from tribes to chiefdoms with craft specialization and centralized political power, social differentiation and concurrent differential access to resources would have changed the ecological and social landscape dramatically, and likewise shifted the disease ecology to negatively impact the health of individuals with limit access to resources (Armelagos, et al., 2005).

Specific Problems

1) *Is there a similar extent of discernable social status differentiation within and between the Pre-classic populations represented in the mortuary treatments of the skeletal samples from K'axob and Cuello?*
2) *Is there a similar and discernable pattern of infection within and between these two societies?*
3) *Is there a discernable pattern between infection frequencies and social status differentiation classifications within and between these two societies?*

By answering these specific problems using the population case samples of K'axob and Cuello, I plan to address the issues of infection rates and socioeconomic status and explore whether these issues are related. I expect these two villages will have statistically very similar rates of non-specific infection, since both are geographically and culturally related, as well as both being rural agricultural communities, which implies similar economic income and resource distribution. From reviewing previous applicable research, it is expected that there will be statistically high rates of infection from both sites, as we would expect to observe in a pre-industrial society, and any between sample variability will potentially be due to differences in socioeconomic status between the two villages, with little or no apparent differences in infection rates between individuals related to their age, sex, or significant differences in social status within each population sample. I expect infection rates seen in individuals over all groups to be statistically similar. If there is a similarity in rates of infection between culturally and ecologically similar K'axob and Cuello, as suspected, then that implies the specific problem can be generalized, meaning inferences about health and socioeconomic circumstances can be applied to similar societies. If there is not a similarity in rates of infection between K'axob and Cuello then other health or socioeconomic factors must be accounted for and studied further in future research, such as differences in social stratification within or between the two villages, perhaps due to external factors such as differential trade or availability of resources.

SECTION I:

Background

Defining Bioarchaeology

Bioarchaeology describes the study of human remains found in an archaeological context (Buikstra, 1977; Larsen, 2015; Goodman, 1998; DeWitte, 2015). Therefore, it draws heavily from both archaeology and biological anthropology, or more specifically, from the "New Archaeology", and from biological adaptation (Goodman, 1998). Historically, bioarchaeology has been solely a descriptive discipline falling under a positivist approach. It was concerned exclusively with quantitative data, such as individual stature, age, sex, and infirmities as opposed to more qualitative or interpretive analysis or inquiry (Goodman, 1998). Within the past few decades however, interest in social and cultural processes of the past have led to the creation of a social branch of bioarchaeology with increased interest in interpretive methodology (Agarwal, 2011). This is the examination of how social factors, such as social status, can leave biological markers on the skeleton, including health status indicators. Skeletal data from archaeological contexts can be used to strengthen existing social and cultural theories about past societies as well as protect against the projection of modern cultural norms and biases on to the past and past societies. In this way, skeletal remains offer not only physical evidence of the individual's lived experiences, but also represents how biological characteristics can be created and shaped through cultural and social practices (Agarwal, 2011). It is in this way that cultural behavior shapes biology, and biology shapes cultural behavior. Thus, all manner of information regarding the individual's life, such as health status and occupation, can be inferred from the skeleton. Likewise, factors potentially leading to an individual’s death, such as traumas or pathologies, are also visible on the skeleton. The relationship of these two variables is one focus of social bioarchaeology.

As noted by Agarwal (2011), descriptive-oriented bioarchaeology of the past was mainly typological and thus “places the emphasis on questions about the presence, absence, or degree of a given pathology in a given temporal, geographical, or cultural context” while social bioarchaeology takes on a biocultural approach with interest in “examining the pattern of a pathology in order to elucidate the effects of social, ecological, and political processes on health within and between populations” (Agarwal, 2011, 20). This more modern bioarchaeology, with socioeconomic dimensions to health, simply expands on previous descriptive inquiry, and thus descriptive bioarchaeology is not abandoned but further developed, and deeper anthropological questions such as the relationship between health and social status differentiation at both the within group and between group levels can be addressed.

As bioarchaeology shifted towards a more processual and social dynamic, interest in infirmities of past humans shifted from descriptive and individual-based paleopathological studies to interpretive population-based paleoepidemiological and paleodemographical studies (Goodman, 1998). By doing so, the focus on possible causation of disease shifted to encompass ecological and evolutionary means, or biocultural causes of disease, such as changing demographic landscapes or sociopolitical upsets (Goodman, 1998; Lallo et al, 1978).

While bioarchaeology was highly descriptive historically and continued to be so well into the 1970’s, the first truly pivotal study that expanded the methodological perspectives of the field was Hooten (1930), often cited in the literature as the birth of both the population-based approach and the epidemiological approach to paleopathological and therefore bioarchaeological inquiry and the first establishment of a scientific methodology based in quantitative analysis (Armelagos, 2003). While there are many flaws now recognized in this study, in many ways Hooten (1930) was ahead of the field, which wouldn't apply even basic epidemiological methods until the advent of the "New Archaeology" in the 1970's. Also, highly influential to the early development of bioarchaeology was Washburn's (1951) "New Physical Anthropology", which emphasized a processual rather than classification-based approach with scientific hypothesis testing at the forefront (Armelagos, 2003). This emphasis on processualism is further expanded on by the "New Archaeology" in the field of archaeological theory, as prefaced by Lewis Binford. This has widely been considered the moment when archaeology asserted itself as a true science by adopting a scientific approach based in empirical data and hypothesis testing. From processualism, bioarchaeology also came into its own during this paradigm shift, but in a different way than the rest of the discipline. As with much of archaeology, an emphasis on scientific methodology in bioarchaeology was espoused as well, but the equal emergence of the post-processual movement as a reaction to processualism can be credited with adding an interpretive and contemplative layering grounded in empirical data but also seeking to uncover deeper meaning, as exemplified with social bioarchaeology (Agarwal, 2011; DeWitte, 2015).

In developing American bioarchaeology, perhaps no one name is as synonymous with the subfield as Jane Buikstra (1977). She's widely credited with first merging the fields of archaeology and anthropology by using biological anthropology methods and theories to address archaeological inquiries. By doing so she was able to apply anthropological concepts to past populations by studying human remains found in archaeological contexts. Initially, bioarchaeology evolved from the "New Archaeology" as well as from Hooten (1930) and Washburn (1951), as it did from a wide array of other disciplines, making it truly multidisciplinary and holistic in nature. Likewise, Buikstra, by addressing human remains through the lens of the four-field approach, was able to address a multitude of social, economic, and cultural behaviors utilizing human remains from archaeological contexts, aims which previously had not been considered when studying human remains. Since making a name for herself by defining a whole new subdiscipline within archaeological science in the 1970's, Buikstra has since then been pivotal in advancing the study of human remains and has been a part of countless other studies throughout her long career involving bioarchaeology. See also Buikstra and Ubelaker (1994), Buikstra and Cook (1980), and Buikstra and Beck (2017) for more on her important works.

Modern bioarchaeology can be synthesized into three major foundational tenets, all evolving out of the theories described above, and further described in detail by Agarwal (2011). The first of which being the application of a broad or population-based perspective of study, initially put forth by Hooten (1930) although not fully realized until some decades later. Secondly, and pivotal to the application of the biocultural approach, is the understanding that culture is a means of environmental adaptation and thus cultural and biological adaptation is inherently interconnected (Agarwal, 2011). The environment, culture, and biology are never static states, but rather in constant flux and reactionary to each other. Thirdly is the need for examining and explaining this interconnection of culture and biology as equal parts of the overall adaptive process in order to tell a bioarchaeological story (Agarwal, 2011). Likewise, an individual's culture can act either as a buffer against environmental stress, or as a type of stressor itself. As noted in Armelagos (2003), "by examining stress indicators, ‘cracks’ in the process of adaptation can be used to evaluate the ability of a cultural system to respond to stressors” (Armelagos, 2003, 30). Just as with environmental stressors, cultural stressors cause an individual to respond with adaptation, and certain individual differences or variations can affect how well an individual ultimately adapts, or how well they can ultimately handle the stressor. The effect of the body’s reaction to these stressors can, given enough time, result in biological markers left behind on the skeleton.

Apart from individual experiences of life and death as seen on the physical skeleton, social experiences such as cultural perceptions of death and bereavement can also be inferred through the treatment of human remains, such as accompanying mortuary goods or bodily placement for burial (McAnany, Storey, & Lockard, 1999). Death as a biological process is inevitable, but experience and treatment of death and the dead vary greatly between cultures. For example, the Navajo culture has a palpable fear and disgust of the dead (Shepardson, 1978). They believe any contact or even viewing of a dead body is polluting to the living, and precise rituals are used to ensure that the dead do not return as malevolent ghosts (Shepardson, 1978). Four days is the proper amount of time for grief, during which it is believed the deceased spirit would have entered the afterlife, never to return. Those who were with the individual at the time of death, and those who participated in the burial process are considered polluted and must maintain a distance from the rest of society for this liminal four-day period, after which they are ritually cleansed and allowed to return to normal social life (Shepardson, 1978). The burial location is separate from the activity areas, and often secret and unmarked, with no visitation from kin or others. It is feared however, that if the living do not fulfill these mortuary rituals or were someone to withhold property from appropriate interment with the deceased, that individual would risk suffering from "ghost sickness", or a dread that the spirit of the deceased will not pass quickly to the afterlife but linger and afflict the living with bad luck (Shepardson, 1978). Therefore, the primary motivation for engaging in proper burial rituals is to prevent the spirit from returning, and because of this fear of the polluting and haunting properties of the dead, great care is taken to ensure the spirit is appeased and any negative outcome is avoided. For the Navajo, death is a very clear demarcation between the living and the dead. The opposite can be observed within Maya burial treatments, where the dead are not feared but revered and venerated as ancestors, and not interred far away from the family residence but within or underneath the residential structure, which is often still occupied by the deceased's kin. For the Maya, death is not so clearly delineated, and dying doesn't exclude an individual from being considered a part of the social unit and treated as such. The behavior of interring the deceased within or directly beneath a residential home also strongly suggests that the dead or associations with the dead are not to be feared, as does the behavior of handling and reinterring remains for secondary burials. The Maya do not share the fear that proximity to the dead is polluting for the living, as seen with the Navajo culture.

In addition to physical and social experiences of death, burial contexts can also be informative on socioeconomic and sociopolitical factors present in a society such as social status differentiation. As such one can also assume "that the burial practices of a society are nonrandom and relate to the social structure and ideology of that society" (Robin & Hammond, 1991, 204). For example, in socially stratified societies elite burials are often differentiated from non-elite burials. One such distinction is that elite burials are frequently accompanied by mortuary goods that denote their higher socioeconomic status compared to non-elite burials, which do not typically contain mortuary goods of the same quantity or quality, if any at all (McAnany, Storey, & Lockard, 1999). An individual's socioeconomic status in life, as well as the social status of their kin, is therefore reflected in the type of burial they receive. Burial contexts can also give us insight into how a society saw social factors like status and relatedness by looking at where and how certain individuals were interred. For example, the continuity of strong kinship ties can be observed through the continuous rebuilding of the same residential structures through time and the interment of deceased kin members within these platform constructions (Storey, 2004).

This connection between biology and culture is the overarching focus of this thesis and of primary research interest to me. It is in this way that "bones and biologies come alive when they are seen as part of interacting processes: biological, ecological, sociocultural and political economic" (Goodman & Martin, 2002, 13). The intersection between the physical bodily experience of health and disease and the cultural experience of death and mortuary treatment illustrates the concept of culture influencing biology, and biology influencing culture, as reflected in several theories relevant to this thesis discussed further below.

Theoretical Background of Bioarchaeology

<u>Adaptation</u>

The major theory underlying all of biology, and thus the field of biological anthropology, is adaptation. Likewise, human adaptation also plays a role in bioarchaeological inquiries. How populations evolved and adapted to their surroundings, using culture as an adaptive tool and as a response to the environment is an important concept in cultural ecology, as **"**human adaptability clearly shared an ecological perspective with processual archaeology and bioarchaeology" (Martin, Harrod, & Perez, 2012, 2). Julian Steward, who brought a naturalistic view to the field, is influential as the founder of cultural ecology, or the concept of how culture and the environment interplay and influence each other. Coming from a naturalistic background of study, Steward brought the idea of adaptation into anthropology in a whole new way with the introduction of cultural ecology. Humans, by living in the environment, use culture as an adaptive strategy, and therefore how different cultures are expressed has an environmental and ecological basis (Steward, 1968). Furthermore, the environment over time changes biology in classic biological adaptation as first described by Darwin, but just as importantly, culture changes the environment through cultural behaviors, such as intensive agriculture, which in turn also ultimately influences human biology (Livingstone, 1958).

This relationship between the environment, culture, and biology, from the perspective of health and infection rates, is a focus of this thesis. As previously mentioned, adaptation is the major theory in biological anthropology, and more specifically, Steward's cultural ecology is beneficial to this study because it acknowledges the importance of the environment, both from a biological perspective as well as from a cultural one. Steward's approach, in other words, is all about adaptation. Cultural ecology is therefore an important theory because it bridges two of the sub-disciplines of anthropology quite nicely and fits well within the biocultural approach.

Since K'axob and Cuello exist in close proximity (see *Fig. 2*), it can be assumed that stressors should be uniform across both populations. Differences could exist at the individual level within samples, and could represent social status differentiation within the sample, but any differences between sample populations would have an external basis, such as differential social status within the larger trade networks of the region. Therefore, it would not be the ecological environment causing the difference in stressors, but the cultural environment.

The stress-indicator hypothesis

The presence of periosteal lesions within a population is an important factor in the "stress-indicator hypothesis" or the idea that stressors in life, whether biological or cultural, over time leave a biological marker on the skeleton that can then be interpreted and analyzed (Goodman & Martin, 2002). In this sense, something like infection would leave behind a biological marker that could then be used in conjunction with the skeletal health profiles of the rest of the sample to make inferences about the overall health of a population.

The modern term 'stress' has a multitude of meanings, and that can make defining it concisely more difficult. In biology, 'stress' is generally defined as a change from homeostasis, or the body's normal state of functioning. It follows that certain physiological disturbances accompany this deviation and, especially in the case of chronic 'stress', are resultant in leaving skeletal indicators. These skeletal indicators came to be associated especially with environmental disturbances such as malnutrition and disease. Just as 'stressors' can describe a number of environmental factors and conditions, 'stress' on the body over time can manifest as a multitude of various biological indicators, including enamel hypoplasia, nutritional deficiencies, or infection markers (Larsen, 2015; Goodman, 1984). While bioarchaeological studies of stress typically use multiple stress physiological indicators, for the purposes of this study only non-specific infection markers in the form of periosteal lesions will be used as a measure of 'stress'. The aim is to account for the frequency of just this type of pathology within and between the samples while also considering the social and cultural environment. Disease does not occur in a vacuum so to speak, and so external factors like environmental and cultural stressors, such as social status differentiation, must be examined as well.

The terms 'stress' and 'health' are often used in the literature interchangeably, although they seem to be contradicting states of being (Temple & Goodman, 2014). The concept of 'health' could be considered descriptive of the state of normal biological functioning, or homeostasis. However, this definition does not encompass the full concept of what is meant when we talk about 'health'. This is also true in the field of anthropology in general, as individuals can often describe states of feeling unwell or states of ill health, while the idea of 'health' seems often defined simply by a lack of sickness or disease. However, Temple and Goodman (2014) point out the concept is much more complex than that, combining both the physiological state of being as well as the perceived one, both from the perception of the individual as well as the cultural perception of what it means to be healthy or unhealthy. Furthermore, it could be said that bioarchaeologists "are not measuring health outcomes, but instead, evaluating stress within a community" (Temple & Goodman, 2014).

The osteological paradox

The dichotomy between notions of chronic stress and acute stress in terms of bioarchaeology is best expressed through what is known as the "osteological paradox" (Wood et al., 1992). This theory in its most basic premise posits that skeletal samples, indeed even a perfect random skeletal sample containing all demographic elements equal to that of the living population in question, is inherently unrepresentative of the population at large. How can this be?

Wood et al (1992) addresses this question and outlines several conceptual problems with the individual-level approach to health status, including selective mortality, demographic nonstationarity, and hidden heterogeneity, all of which become research concerns when using a population-based perspective of inquiry. So, the above claim that all skeletal samples are inherently unrepresentative of the overall living population, Wood et al (1992) would assert, was due to issues of selective mortality. The conceptual problem posed by this is that our skeletal sample is static, and, of course, dead, and thus we only have representation of those who died at any given age, not all those who were at risk of death or disease at that age and didn't die, and in this way our sample is prone to selectivity bias (Wood et al., 1992). In this way it is virtually impossible to have a truly representative sample of the overall population because you can never see within the archaeological record the full picture of all individuals who were at risk of death or disease at a certain age yet didn't die. Therefore, the skeletal sample from any age group "is highly selective for lesions that increase the risk of death at that age", meaning there are variations of individual sensitivity within a population that greatly influence the relative mortality found in that sample. Wood et al (1992) further explains this with the example that "the only 20-year-olds we observe in the skeletal sample are those who died at age 20" and yet this is misleading because "many of the other individuals who had been at risk of death at age 20 but who died later, say, at age 60, we observe their characteristics as 60-year-olds, not 20-year-olds", hence what he deems 'selective mortality' (Wood et al., 1992, 344). Individual variations in susceptibility, not just stressors or risk, lead to the mortality seen at any given age.

This is better known as hidden heterogeneity of risks, another conceptual issue outlined by Wood et al (1992). This can best be described as variations in individual susceptibility, also known as frailty. Populations are seldom if ever homogeneous in their makeup and heterogeneity in terms of increased frailty can have a number of causes ranging from genetic differences and predispositions to differential access to resources and social inequality. These variations in the population therefore also create variations in individual response to risk, with individuals with increased frailty being more susceptible to certain risks, like death and disease. Less frail individuals, however, even while experiencing the same level of risk, may not experience death or disease, and therefore, not all individuals experiencing risk also experience mortality (Wood et al., 1992). The issue with this is that risk cannot be known for past populations meaning the true incidence rate is not measurable.

The final conceptual problem highlighted by Woods et al (1992) is demographic nonstationarity, which refers to the changing or nonstationary nature of most populations influenced by fluctuating demographic. Most populations would be nonstationary, that is, experiencing change, while a truly stationary population would be "characterized by closure of migration, constant age-specific fertility and mortality, zero growth rate, and an equilibrium age distribution" (Wood et al., 1992, 344).

How does all this relate to the study question? As noted by Wood et al (1992) and by the osteological paradox, individuals with skeletal lesions are only a small representative of the overall population and likely also only a small sample of all the individuals infected or all the individuals at risk of infection at any given time, and thus a small sample of actual mortality. Skeletal lesions are typical of a chronic stressor or infection, and so those individuals showcasing lesions have undergone stress over an extended period of time. These individuals with lesions may actually be more representative of those with lower susceptibility and higher resiliency, as those with greater susceptibility and lessened resiliency may have succumbed to the infection or stressor before the bone has a chance to react by forming a periosteal lesion (Wood et al., 1992). Individuals with high frailty therefore would be present in the skeletal sample as they would have been more likely to succumb to disease, however the actual evidence of that disease would not be present in the form of bony response.

Wood et al (1992) further illustrates this by eliciting the example of a living populations made up of three subgroups all within the same environment and with potential for exposure to the same stressors. One group doesn't ever experience the stressor and so this group never develops skeletal lesions or related mortality. The second group does experience the stressor, but only to a moderate extent yet consistent enough and over a long enough time period to develop skeletal lesions. Some members of this second group also succumb to the stressor. The third group also experiences the stressor, but to an acute degree, with heightened response—or increased frailty—resulting in increased mortality but no skeletal signs of lesions. Because of the acute nature of the stressor, and the quick onset, mortality occurs before the bone is able to respond, thus this third group, while important to the question of stress and health in the overall population is essentially osteologically invisible. It would appear in the archaeological record that there were only two groups present in this skeletal sample: 'healthy' with no lesions, and 'unhealthy' with lesions. This is deceptively simplistic. For this reason, "skeletal lesions may be expected to underestimate the population prevalences of their associated conditions" or stressors (Wood et al., 1992, 344). This assumed underrepresentation of disease in the sample is then juxtaposed against the selectivity bias of the sample, with either or both being just as likely as the other. While this is discouraging for researchers grappling with these conceptual problems and trying to make sense of population-based studies of health and stress, it's important to keep the osteological paradox in mind when working with skeletal samples.

The osteological paradox has been reexamined since Wood et al (1992) with the same and other researchers proposing additional questions. Responses to the original article include Cohen, Wood, & Milner (1994), Wright & Yoder (2003), and DeWitte & Stojanowski (2015). Clearly there are still many conceptual issues to consider when doing health and stress-based research on bioarchaeological samples.

Body as text

'Body as text' is a useful theoretical framework when thinking about the body as a tool of inquiry into both an individual's life and ultimately their death, as providing scientific and verifiable information about the society that individual belonged to in life. Historical accounts and iconography can help provide a glimpse into how a society viewed itself, but the physical body doesn't embellish the true details. In this way, thinking of the body as a text suggests that "the body is not only socially constructed as an object of knowledge but also 'culturally shaped' by the actual practices and behaviors of the group" (Martin, Harrod, & Perez, 2012, 15). The body, both alive and dead, is a reservoir of culturally symbolic meanings, that can then be 'read' as though it were an actual text. And since actual texts can be victim to unintentional or purposeful elaboration, exaggeration, and flat out fabrication, having the physical body present can provide a truthful 'voice' after death. In life, the theory of body as text incorporates many meaningful physical acts, including body language, manner of culturally specific ways of dress, etc. In death, through the osteological record, the bones become the text from which you can read a wealth of information regarding the individual's life experiences and social identity. This information can also then be used to answer questions about the overall population. These can be sometimes seen in the mortuary context as well, as inclusion of grave goods can show status and therefore social identity. Likewise, the cultural constructs surrounding death and the societal views on death and the afterlife can be observed through a society's funerary traditions, and in antiquity, through their mortuary contexts. For instance, practices of ancestor veneration can clearly be observed in Maya burials, suggesting they did not fear their dead but honored them by interring the dead within structures inhabited by their living relatives. It is in this way that bioarchaeology becomes interpretive rather than purely descriptive in nature. So rather than simply looking for signs of infection within and across these two related populations and merely describing whatever I might find, I instead plan to attempt to explain what I find and further explore possible causes of infection beyond pathogenesis, but by looking from a biocultural perspective.

History of the Maya and the Region

The Maya were one of the major dominant cultures to arise in Mesoamerica (Hammond, 1991). The term 'Mesoamerica'—meaning middle America—is a cultural term as well as a geographical one referring to the land area once dominated by indigenous societies, like the Maya, extending geographically from what is part of present day Mexico and the Yucatán, down through Guatemala, Belize, El Salvador, and Honduras (Hammond, 1991). Even today, descendants of the ancient Maya still inhabit the same region as their forefathers. We can also find their diaspora in many U.S. states.

The Maya are widely considered to have developed one of the most complex cultures of the ancient world, building impressive architectural temple pyramids, developing an advanced writing system, and displaying a high level of complex socioeconomic development and trade. All their success and innovation, as well as their subsequent and famous Classic period societal collapse and abandonment of major city sites, form the 'mystique' of the Maya, an enigma that still captivates many researchers and the public to this day. However, although there is still much to be learned about the lives—and deaths—of these people, recent research has proven insightful and there are countless scholarly publications available covering a wide variety of anthropological topics. Although part of the mystique of the ancient Maya has to do with mostly imagined images of human sacrifice and other acts of ultra-violence and death, newer bioarchaeological insights are shedding light on another lesser known aspect of Maya society: the act of ancestor veneration.

Ancestor veneration cross-culturally

Instead of utilizing the Western custom of cemetery-style burials, ancient Maya kin groups showed veneration to their dead by interring them under occupied residential structures (Storey, 2004; McAnany, 2014). In this way, the living could maintain both their physical proximity as well as their social connection to their ancestors, even after death. In this way, "ancestor veneration" acts as a "quintessential expression of lineage structure" (McAnany, 2014, 14). Often, these extended rituals of ancestor veneration also link a lineage to a place though time, as well as acting as a form of collective social memory (McAnany, 2014). Furthermore, when determining the social status of a deceased, the status of their kin group can be even more important and influential towards the deceased's mortuary treatment. As noted by McAnany (2014), "ancestor veneration ultimately is not about the dead, but about how the living make use of the dead" and thus ancestor veneration behaviors actually act as a "discourse with the past and future" (McAnany, 2014, 162). This is not just characteristic of the ancient Maya, but found cross-culturally through time all over the world.

The modern Maya continue the practice to this day. It is evident that kinship is a very important part of Maya society and much about an individual's place in society can be gleaned from the study of their mortuary context.

Ancestor veneration is not the same as mortuary ritual, but instead "often entails periodic ceremonial practices that may include but also extend beyond interment and funerary rights" (Lau, 2002, 281). Societies that practice ancestor veneration vary widely and can be found across many areas of the globe, but all share a common characteristic in that they exhibit strong kinship ties as a central tenant of their culture. Kinship, lineage, and relatedness are so unifying that even death cannot break the ties. In this way, ancestors are part of the normal cultural schema and respecting elders and venerating deceased past generations are expected behaviors. Unlike with the Navajo culture, cultures with strong histories of ancestor veneration see death not as dehumanizing but rather as an alternative state of being within the normal society, and thus ancestors are remembered often and celebrated rather than feared as vengeful ghosts. Besides the ancient Maya, many other cultures around the globe and throughout time have included ancestor veneration as part of their cultural and religious belief system (Goss, 1999). The Japanese Buddhist tradition for example encourages the living to maintain strong bonds with the deceased through the practice of ancestor veneration even to this day. According to Goss (1999), "in Japan, death marks the beginning of a new phase of family membership" where "the dead become ancestors, who have different roles in the family than when they were living" and yet the kinship bond remains (Goss, 1999, 549). The deceased are then remembered as ancestors and venerated as such for the remainder of the lifetimes of those who remembered them as living people, after which time "their spirit merges with the general sense of family ancestors…who are no longer personally available to the living" (Goss, 1999, 549). Both the idea of another transition long after death, as well as the idea that the deceased spirit is available to the living descendants for favors and mutual benefit is fascinating. The transition after death from a personally memorable spirit, called *hotoke*, to the merger with the general spirit world of the ancestors is really an example of an extended funeral rite, where "the dead remain available to the living for as long as anyone who remembers them as a living person still lives", after which time they go on to become *kami*, ending what equates to a thirty to fifty-year funerary ritual (Goss, 1999, 550). This extended kinship bond through time is very reminiscent to the Maya practice of secondary burial, which is the curation and reinterment of skeletal remains of long deceased relatives as a practice of veneration and perhaps also as social remembrance. Interestingly, the Japanese Buddhist tradition also requires the correct performance of funerary rituals, much like both the Maya and the Navajo, but similarly to the Navajo if the dead are not cared for in the right way and the honorary rituals not performed correctly the spirit can become *gaki*, or a 'hungry ghost', bringing misfortune and malevolent spirit possession to the unfortunate living relatives responsible for the transgression (Goss, 1991, 551). In this way it is up to the living whether the deceased become a *hotoke* or a *gaki* by whether they perform the required rituals correctly and with the correct intent (Goss, 1999). However, as the fate of the deceased depends on the care of the living, likewise the quality of the life of the living depends on the benevolence of the dead; their outcomes depend greatly on each other. An uncared-for spirit, *gaki*, can be transformed back into a more benevolent form only through the renewal of the act of ritual care-taking (Goss, 1999). Performance of the appropriate rituals is just one part of the overall spirit bond. Goss (1999) notes however that care "at a deeper level…including the dead within the family, remembering them, and acting in ways they approve" while "in return, the dead provide comfort and guidance" to the living (Goss, 1999, 553). This deeper level parallels what is observed in Maya ancestor veneration.

Another example is the ancient Recuay of northern Peru who combined ancestor veneration and public feasting as expressions of developing sociopolitical complexity and institutionalized hierarchies (Lau, 2002). One way of doing so was the advent of portable mummy bundles which could be disinterred and transported to feasting ceremonies, at which they were considered active and symbolic participants (Lau, 2002). During such ceremonies, the dead are presented with food offerings and other rites in turn for their favor and influence towards fertility and agriculture (Lau, 2002). Again, this shows the continued importance of the deceased ancestors in living society, both with their continued presence, veneration, and inclusion at ceremonies as well as their perceived influence on important aspect of daily life. Additionally, as with the Japanese Buddhist tradition and with the Pre-classic Maya, the Recuay used ancestor veneration to trace and reinforce kinship relations, which were often influential to preserving sociopolitical successions and access to property and resources, both important to the maintenance of lineages through time (Lau, 2002; McAnany, 2014).

As previously mentioned, Japanese Buddhist culture and the ancient Recuay culture of Peru are perfect examples of the living caring for the dead and treating them as an honored and important part of the extended family. While traditions of ancestor veneration differ across cultures, the idea of maintaining close kinship ties with the deceased seems constant cross-culturally (Goss, 1999). The ancient Maya are no exception. More modern accounts also support the continuation of ancestor ties through time, even among the contemporary Maya.

Architectural achievements

The architectural feats of the Maya further captivate the imagination and, at the peak of the Classic period, included the creation of many elaborate ritual temples, stone pyramids, domestic plazas, stelae and other stone monuments, public courtyards, and ball courts, many of which have survived to this day and have become tourist attractions for the region in modern times, in turn boosting the economy of the modern countries. This provides an incentive for the continued care and preservation of these ancient architectural features, as well as continuing to be seen as symbols for defining the culture and for maintaining regional pride and identity. For instance, the modern and very popular Belizean beer, known as Belikin, displays a drawing of the temple-pyramid at Altun Ha as the brand logo. In any major Belizean city, “Maya ruin” tours by local tour guides are marketed everywhere and easily available, contributing to one of the leading tourist attractions for the inland districts. Part of their continued allure is of course the grandeur of monumental architecture and the sheer size and height of some of the pyramids, combined with the mystery of the famous Classic period collapse in popular imagination. Major Belizean sites such as Xunantunich and Caracol, in addition to their size are also remarkably well-preserved, and as such, maintain a high level of popularity among tourists visiting the country. Maya architecture is also indispensable to researchers because some of the best examples of their writing system in the form of glyphs can be seen displayed on some temple-pyramid walls and in stone-carved stelae and other monuments erected during the Classic period. Aside from these few paintings and carvings, other textual examples are extremely rare (McAnany, 2004).

Large-scale cooperative constructions of public architecture are not just feats of the Classic Maya however (McAnany, 2004). Many important sites, including most notably

Lamanai on the New River, show examples of public architecture constructions long predating the Classic period, and thus predating the influence of divine kingships first occurring in the Classic period. Another example of large-scale construction efforts, at nearby Nohmul, would have "conceivably involved the labor (voluntary or coerced) of K'axob residents", suggestive of both the connections between sites within the New River Complex, as well as the existence of concentrated authority able to coordinate such construction efforts between sites (McAnany, 2004, 6). The presence of such sites in the lowland region can be traced to the middle Pre-classic, much earlier than is typically associated with construction of monumental or public architecture and likewise implying "an equally early evolution of the complex sociopolitical institutions represented in such architecture" (Hansen, 1998, 49). Pre-classic sites throughout the Maya region have shown a notable amount of variation as well, suggesting that social complexity as shown in the different architectural styles emerged separately at each site rather than evolving as the result of influences from precursor societies, such as the Olmec (Hansen, 1998).

By around 300 B.C. in the late Pre-classic "massive augmentations in the size and scale of monumental architecture" in the lowlands "are evident" (Hansen, 1998, 76). By this time Lamanai was clearly the center of the sociopolitical hierarchy of the New River complex, as shown through the construction of a pyramid structure considered the largest built during the late Pre-classic period (McAnany, 2004).

While not an example of monumental architecture, the earliest dated example of Pre-classic residential architecture in the lowlands can be found at Cuello and is dated to approximately 1000 B.C. (Hansen, 1998; Sharer & Traxler, 2006). These early structures consist of apsidal or circular shaped buildings—some of the earliest examples of this building type in the region—and thin plaster floors on low platform structures of stone and clay, with associated post holes, suggesting an overarching wooden construction (Hansen, 1998). Many examples of Pre-classic architecture show up in the archaeological record in this incomplete manner due to poor preservation and erosion of the structures over time, as these superstructures would have been constructed of wood instead of stone and likewise preserve poorly in the tropical environment. It follows then that older examples, as is the case with the Pre-classic structures, have experienced a prolonged exposure to the elements causing more deterioration and damage than Classic period structures. Alternatively, some Pre-classic period structures are buried beneath successive Classic period structures, improving chances of the Pre-classic structures being better intact due to protection from the elements. However, to access these Pre-classic structures often results in the destruction of the overlying Classic period structure. For this reason, Pre-classic period sites are often only glimpsed through a limited number of test pits or excavation trenches in order to preserve the overall integrity of all elements of the site (McAnany, 2004).

Public architecture at K'axob consists of a pyramid structure with construction dating to the late Pre-classic and arising out of increasingly differentiated earlier structures, transforming from a large domestic residence to a public structure consisting of many interred ancestors and other ritual deposits with decreasing domestic activity over time (McAnany, 2004). Due to this transition from functionality to elaboration over time as well as its initial early construction, with many subsequent building extensions erected over time, this structure has been attributed to that of the village leader or chief, and probable founder of K'axob (McAnany, 2004). This hypothesis is further supported by the treatment of a burial located underneath the structure and the inclusion of accompanying elite grave goods, as well as the relative early date of this burial (Storey, 2004).

Cuello also shows evidence of a small (6 meter) stepped pyramid construction dating to around the late Pre-classic period (Gerhardt & Hammond, 1991). As seen with K'axob, the construction of such public architecture hints at the achievement of increasingly differentiated levels of social identity, with authority becoming centered around one or two higher status kin-based groups within each village in order to exert influence on the general population to complete construction on these early examples of public architecture (McAnany, 2004).

Fig. 1: Map of the Maya region showing the location of K'axob & Cuello; adapted from McAnany, 2004

<u>Ecology & subsistence</u>

The Maya region can be topographically divided into two basic sections, the highland region made up of present-day Guatemala, Chiapas state in Mexico, part of southern Belize in the Maya Mountains, and part of western Honduras, and the larger lowlands region, which can then be further divided into southern and northern lowland sections. The northern lowlands comprise of the Yucatán peninsula—inhabitants of which are sometimes referenced as the Yucatán Maya—in the present-day states of Yucatán, northern Campeche, and Quintana Roo of Mexico, and the southern or central lowlands, comprising of areas of northern Guatemala, southern Campeche, parts of Tabasco and Chiapas, and northern Belize, the latter is where K'axob and Cuello are both located (see *Fig. 1* and *Fig. 2*). The southern lowland region is comparably the largest of the regions, with what is referred to as the central lowlands located in the Petén of northern Guatemala and surrounding central inland areas. The central lowlands typically are depicted as encompassing this Petén region, starting around Calakmul in modern day Campeche, and including major sites such as Tikal and Lamanai, with K'axob and Cuello just outside the margins of this concentration. The Petén region is notable as a site of early crop production, which later failed, leading to likely regional migration to more peripheral areas such as K'axob and Cuello, which were primarily agricultural but never large population centers. With the failing of areas like the Petén, regions like the northern Yucatán flourished in the periods following the Pre-classic, and even after the famed Classic period collapse continued to experience continuity for many years (McAnany, 2004). Continuity at both K'axob and Cuello extends into the Classic period, and both were involved in the Classic period collapse.

Differences in ecology between the lowlands and highlands created differences in subsistence strategies for Pre-classic Maya living in these regions. The highlands are more notably characterized by their geology, consisting of steppes and volcanic peaks with a gradation sloping downwards towards the Pacific (Hammond, 1991). This region and its geology is also important to the entire Maya area because of obsidian, greenstone, and cinnabar naturally occurring here and found transported to sites as far north as the Yucatán, showing their importance as elite trade goods and displaying the economic importance of the highland region (Hammond, 1991). The lowland regions, although ecologically similar, consist of the southern and northern divisions, with the north being somewhat drier, and the south being more tropical (Hammond, 1991). Likewise, another major difference is the waterways and rivers, with the north having few sources of above ground water outside of a few cenotes, with most of the water in subterranean rivers, while the south has the source and confluence of many above ground rivers, including the New River (Hammond, 1991).

In the Pre-classic period, the local ecology of K'axob and Cuello was that of the southern lowland region, with tropical, dense jungles interspersed with cleared meadow areas and swamplands. This variety in ecosystems maintains a pronounced biodiversity of plant and animal life, which likely made the region very attractive for the establishment of permanent settlements predating the early Pre-classic. For K'axob in particular, swampland provided a vital resource for the population, and a Y-shaped swamp, known now as Pulltrouser Swamp, is located just adjacent to the site (see *Fig. 2*). This immediate swampland would have aided in providing dietary variety for the inhabitants of Pre-classic K'axob, as well as providing a water source for crop production and naturally occurring shell, which could be used in craft production and is found in an abundance as a grave good utilized in burials. The proximity of Pulltrouser Swamp to K'axob and not to Cuello provides for the primary ecological difference between the sites. Both are within walking distance to the New River, with Cuello somewhat closer, although not directly on this important waterway.

The New River is described by McAnany (2004) as maintaining a continual and relatively calm yet consistent flow even throughout the dry season, which provided both a steady access to fresh water year-round as well as a reliable route for transportation to and from the nearby coastline and other local villages within the area (McAnany, 2004). The proximity to both the river as well as to the nearby coastline provided K'axob and Cuello with easy access to marine and aquatic resources that would have helped supplement their diet by providing greater dietary stability than solely relying on a diet of crops. We know they had contact with the coast by the array of shells, shell fragments, and marine faunal remains found at both sites, suggesting they took full advantage of the range of resources available in the immediate ecosystem and beyond (Miksicek, Wing & Scudder, 1991; Aizpurúa & McAnany, 1999). The New River was also surrounded by fertile wetlands providing yet another source of year-round water and natural resources with which villagers could amend their diets with more variety (McAnany, 2004; Miksicek, 1991; Wing & Scudder, 1991).

For staple crops, the Maya used and continue to use a farming method known as swidden or slash and burn agriculture that both clears the land for farming as well as improves the nutrient content of the soil (McAnany, 2004). Their agriculture focused primarily on maize production then as it still does to this day and was also supplemented with many other crops and with the abundant natural resources found in the immediate environment as well as along the coastline (Miksicek, Wing, & Scudder, 1991).

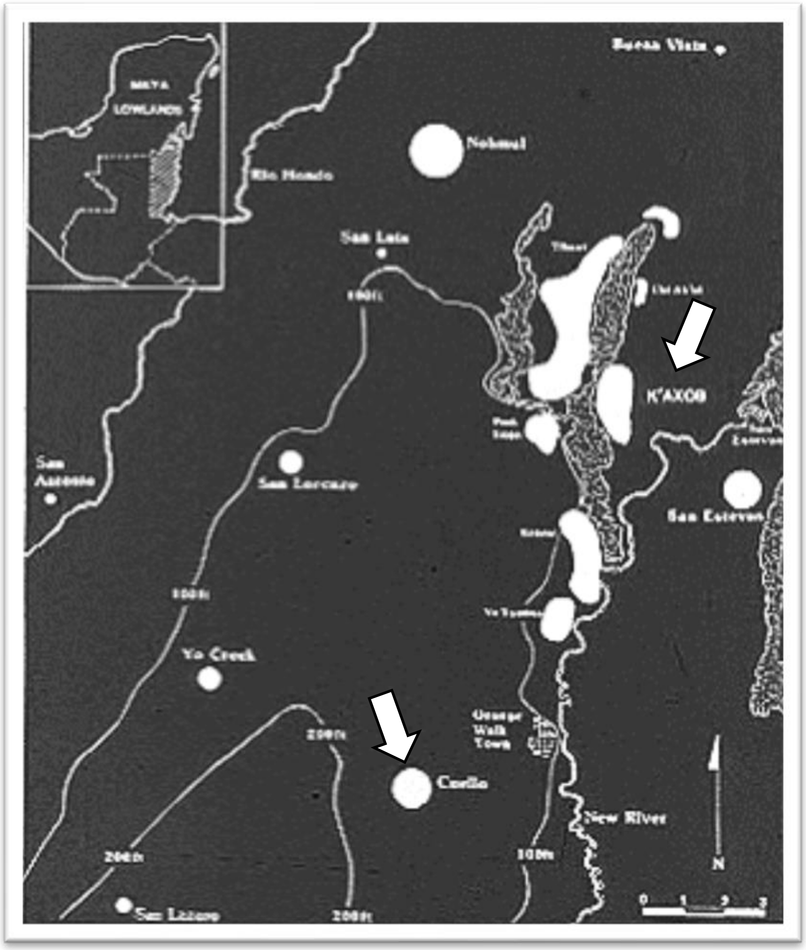

Fig. 2: Map showing the proximity of K'axob and Cuello (approximately 10 km); Adapted from *http://www.bu.edu/tricia/kaxob/classic.shtml*

Socioeconomics & trade

Trade is implied in an archaeological context by the finding of materials or finished goods, and in mortuary contexts with the inclusion of grave good materials, that are not naturally occurring or manufactured in the immediate area. Trade creates connections between groups who are otherwise spatially separated, sometimes by great distances, and therefore the archaeological study of ancient trade can determine socioeconomic connections between groups seemingly unconnected by substantial distance. We are finding often that ancient peoples were surprisingly well adept at long distance travel, and groups previously thought to have no connections may have had contact with each other. This is most easily observable in the archaeological record in two ways: by adoption and then repetition of certain styles of material cultures from outside influence, and by the presence of elite trade goods, or goods and materials consider exotic because they do not naturally occur in the area and so must have been transported there from another location (Hammond, 1991).

Trade was an important economic means for larger Maya city states, but smaller villages, such as Cuello and K'axob, also participated in trade networks. The discovery of elite trade items such as greenstone and obsidian at the sites further suggest they were involved to some extent in regional trade (McAnany, 2004; Hammond, 1991). These are also considered elite trade items since they are exotic to the region, and thus their presence at the site shows likely social status differentiation at the individual or within sample level. Manufactured items, such as shell beads, are also commonly found as burial goods at both sites, suggesting regular contact with the coastal villages like Cerros (Aizpurúa & McAnany, 1999). Ceramics, especially those found at K'axob, show a level of consistency that suggests an already established ceramics complex, as well as increasing consistency over time (McAnany, 2004). As explained by McAnany (2004), "variety in the paste composition of the early pottery of K'axob also implicates a far-flung network for acquiring either temper or finished pottery", however later in the Pre-classic "resources closer to home were more actively exploited" in ceramic production (McAnany, 2004, 12). This shows that while K'axob was primarily a small agriculture village, other forms of economics such as ceramic production also occurred at the site, and that this intensified over time. This also shows a level of regional individualization of materials used over time as on-site production and craft specialization became the norm. Potentially, later in the Pre-classic, ceramics would have been made primarily on-site rather than being imported from outside areas, however, these ceramics could have been exported to other villages in the network, and thus the trade dynamic shifted. Interestingly, the Cuello site shows no indication of a ceramics workshop and yet examples of both locally manufactured as well as probable exotic origin sherds are found (Kosakowsky & Pring, 1991). However, his finding of locally produced ceramics without a corresponding local on-site workshop could be due to the location of focus from the Cuello excavations. While most pottery found was made locally if not directly on-site, trade outside the immediate region did occur at least occasionally, as shown by the finding of more exotic ceramic sherds (Kosakowsky & Pring, 1991). In this way, even small periphery villages participated in the overall trade network of the larger Maya society.

It's important to note that trade networks did not stay static over time, but rather shifted in dynamic, with a succession of sources for exotic goods occurring throughout the Pre-classic (Hammond, 1991). These trade networks continued to develop, expand, and shift throughout the middle and late Pre-classic and well into the Classic period. However, during the late Pre-classic, existing trade ties begin to diminish, and tensions began to grow between the city states in the region, likely resulting in increased warfare and conflict observed from this time period. As a result, the center of power shifted several times. These shifts in power would have also affected the socioeconomic standings of the periphery villages within their scope, who they traded with and how, and thus potentially resulted in changes in demographics or overall population, possibly creating changes to the health of the inhabitants as well by increasing contacts and therefore also potentially increasing disease transmission.

While neither K’axob nor Cuello could be considered to have been urban centers—these were seen more prominently in the Classic period—other sites occupied the apex of the political hierarchy of the New River complex, most notably Lamanai as the seat of regional power during the late Pre-classic (McAnany, 2004). This can be observed by one of the largest late Pre-classic period pyramid structures located at this site (McAnany, 2004). Early monumental architecture such as this, and later sometimes to an even greater scale and size as that seen in the Classic period, began construction around the late Pre-classic period and suggests a centralized system of control as well as a larger population concentration. The undertaking of building such large structures suggests there was an adequately large and compliant population available to do the construction. Furthermore, trade networks were already extensive and complex, as noted by the findings of obsidian and other elite trade goods from far away locales (Hammond, 1991). For example, obsidian in naturally occurring in the highland region and thus would have been brought to sites like K’axob and Cuello via vast trade networks (McAnany, 2004). The discovery of these elite goods in Pre-classic period burials shows the extent of trade already in existence at this early period. The scarcity of elite goods like obsidian and greenstone in Cuello and even more so in K’axob suggest that it was perhaps too rare and valuable to use consistently in ritual deposits (McAnany, 2004). Another alternative to this shortage could be the greater importance of local trade in the late Pre-classic, with a viable yet less active long-distance trading network around the New River complex and beyond (McAnany, 2004).

The settlements in the sociopolitical reach of Lamanai all group around the New River, which would have provided both fresh water access year-round as well as easy transportation between villages. Lamanai sits near the source of the New River, with many other smaller and likely related settlements found downriver along the New River floodplain, including K'axob and Cuello, which stand almost at the midpoint between Lamanai and the coast. The river terminates at the coastline with the village of Cerros, which likely shared a close relation with Lamanai, and that also includes large pyramid structures dating from the late Pre-classic, suggesting a somewhat heightened regional status (McAnany, 2004). While both K'axob and Cuello occupied lower political positions in comparison to Lamanai and most likely Cerros as well, of the two, some evidence suggests Cuello might have maintained a somewhat higher status in the region than K'axob (McAnany, 2004; Hammond, 1991).

Chronology

The Maya Age is categorized into periods representative of the societal development experienced in each and include, in chronological order, the archaic, the formative or Pre-classic, the Classic, the Post-classic, and the colonial period spanning from Spanish colonization around 1500 A.D. The Pre-classic period spanned from approximately 1200 B.C. to 250 A.D., or from the most commonly accepted beginning of the early Pre-classic around 1000-1200 B.C. until the end of the terminal Pre-classic, also called the Proto-classic, at the border of the Classic period around 250 A.D. (Hammond, 1991; McAnany, 2004). Based on current evidence, the Pre-classic period in the Maya lowlands encompassing both K'axob and Cuello acceptably spanned from approximately 1200 B.C. until 250 A.D.

The Pre-classic is further divided into three main time periods, also given chronological designations; early, middle, and late. However, this study will focus exclusively on the middle and late Pre-classic periods at these two sites. The early Pre-classic period spanning from approximately 1200 - 800 B.C., saw the beginnings of the Maya world, with farmers from the north moving into what is now lowland Belize, and establishing permanent agricultural villages, primarily growing maize as a staple crop. Sites like K'axob and Cuello first date to this period, with no evidence from preexisting archaic period settlements found at either of these lowland sites (McAnany & Varela, 1999; Hammond, 1991). The existing ceramic complexes from both sites as well as the evidence of an already well-established maize agriculture during this time period suggest movement into the lowlands from outlying areas rather than genesis and development on site (McAnany, 2004; Hammond, 1991).

The middle Pre-classic period, spanning from around 800 B.C. - 400 B.C., saw a growth in social complexity and, perhaps as consequence of this, an increase in warfare and social stratification. With the formation of increasing social complexity, individuals become grouped or otherwise defined by their occupation, and possibly also by wealth in the form of resources, forming stratifications between social groups and consequently also creating early inequalities. With population growth, resources become commodified and likely distributed disproportionately, with more and better resources being allocated to those in control of most of the wealth and power. Differences in wealth and access to resources between populations lead to competitions which can often devolve into warfare between competing chiefdoms. The social status differentiation at the within sample level can be seen in this period in the mortuary contexts, with the emergence and continued evolution of a variety of burial types and grave good inclusions, especially of exotica, in certain burials as an indication of heightened social status. Both K'axob and Cuello have examples of burials with and without associated grave goods, suggesting differentiation in social status among individuals within the same village. The quality of grave goods, as seen with elite materials such as jade, as well as high quantities of included grave goods also suggest the heightened social status of the interred. If social status differentiation does not exist, then we would expect all graves to be the same with no differences in mortuary treatments or quality and quantity of grave goods.

The late Pre-classic spans from approximately 400 B.C. to 250 A.D. and marks the transition from the Pre-classic into the Classic period of Maya development, sometimes also called the terminal Pre-classic in the literature (McAnany, 2004). Social stratification continues and intensifies during this period, with the societal hierarchy now including divine kingships based on patrilineal descent sometime beginning in the late Pre-classic (Freidel & Schele, 1988). Some studies also suggest this period marked the beginning of some of the earliest examples of the Maya writing system, previously thought to have originated in a later period (Saturno, 2006). The rarity of these Pre-classic hieroglyphs incorrectly presupposes this time period as one "'before history' or at least before Classic period literati forged narratives of time in hieroglyphic texts" (McAnany, 2004, 1). At the terminus of the late Pre-classic, a lesser known societal collapse occurred, eclipsed in popular knowledge by the far more notorious terminal Classic-period collapse beginning around 900 A.D. The lesser known Pre-classic period collapse occurred sometime around 100 – 250 A.D. and resulted in the systematic halting of construction on Pre-classic monumental architecture as well as the abandonment of numerous Pre-classic sites. Like the Classic-period collapse, this terminal Pre-classic period collapse likely was the result of many combined political, economic, environmental, and social factors, but as with the famed Classic period collapse a definitive cause for the Pre-classic period collapse is yet unknown.

The Classic period is the most recognized and studied period of Maya ancient history, with much of their cultural and architectural achievements being thought of as occurring within this period, hence the designation of 'Classic', conjuring up ideals of the European equivalent with similar advances in art and society. For the ancient Maya, this was likewise thought to be a period of flourishing arts, architectural wonders, and divine kings, as well as increased urban population size and the greatest degree of social stratification. The famed collapse at the end of the terminal Classic period—although not likely a single catastrophic event, but rather more a chain of events resulting in a slow decline—began to occur around 900 A.D. in much of the southern lowlands, with northern territories such as in the Yucatán continuing to prosper for some time afterwards. The cause of the collapse is still hotly debated, but one theory posits that environmental changes occurring from intensive agriculture in addition to an extreme drought and the resulting resource shortage are to blame for the progressive abandonment of major city sites during this time period (Huag et al, 2003; Webster et al, 2007; Hodell, Curtis, & Brenner, 1995). The environmental carrying capacity could no longer support the growing population, likely causing an increase in stress and malnutrition, and ultimately the resultant abandonment of the sites could be considered adaptive, as the population would have dispersed into smaller principalities in the periphery, such as to what is modern day Belize, where stressors were lessened and survival potentially more assured. Belize is home to a number of naturally occurring food sources, such as the coastal mangrove swamps, which would have provided some solace to hungry people fleeing from the failing crops of the Petén and other areas of the southern lowlands. Other theories of note regarding the terminal Classic period collapse suggest an increase in warfare between polities and dynastic politics are to blame (Barrett & Scherer, 2005). With the disintegration of centralized power structures such as dynasties, the resulting political instability has a trickle-down effect on all areas of socioeconomics, resulting in increased strain in areas like trade and crop production that would have in turn resulted in the eventual abandonment of more population-dense city sites. Likely it is a mix of elements, none of which being solely responsible, and all contributing to the decline. Following this decline from the Classic period is the Post-classic period, sometimes also known as the Colonial period due to the expansion of Spanish colonists into the region.

While the Classic period has received the most attention, both archaeologically as well as in popular depictions, and as such is the most recognizable of the Maya periods, one must be cautious not to view the Pre-classic and the Post-classic as somehow less-than the Classic, or as less worthy of in-depth study. As McAnany (2004) warns, it is seductive to think of the Classic as “a flower in full bloom, which implies that the Formative period is a bud and the Postclassic period a withered bloom” (McAnany, 2004, 5). The metaphor is a good one, as the Pre-classic should not be studied solely as a precursor—nor the Post-classic as a descendant—of the Classic. Rather, each period should be explored on its own virtues, without the necessity of societal comparisons to the other periods. These comparisons can, of course, be successful and insightful depending on the topic of inquiry, but it’s worth also stepping back from preconceived notions of ranked development or evolution. While distinctions between the periods can be said to exist, the exact distinctions between the Pre-classic and the Classic, for instance, are not as clear cut as imagined. McAnany (2004) reminds us that “societies do transform, although not always in accordance with archaeologically established period boundaries” (McAnany, 2004, 5). Mechanisms such as the development of social distinctions and hierarchies previously thought of as distinctly Classic period developments may not in fact be so clear-cut.

This study will only focus on K’axob and Cuello within the bounds of the middle to late Pre-classic period. While bioarchaeological research into the Maya has commonly focused on the Classic period, more recent studies have focused on the Pre-classic period, initially as a measure against or pre-requisite to other Classic period studies, but occasionally as the primary time-period of study. In terms of paleopathology and paleoepidemiology, studies in the Pre-Classic have had a dietary focus, studying linear enamel hypoplasia, anemia, etc. while few studies in the Pre-classic cover the topic of non-specific infection. While this study seeks to explore socioeconomic status, as many other studies have done as well over the Pre-classic and Classic, it also seeks to combine this information with data about health status in the form of non-specific infection. Mortuary contexts can be insightful about an individual's social status within the population, but could the health of the individual also impact, or be otherwise linked to, their social status and thus possibly reflected in their treatment after death?

History of K'axob

Initial construction and occupation for K'axob began shortly after 800 B.C. and continued consistently throughout the remainder of the Pre-classic period and into the early Post-classic period until around 900 A.D. (McAnany & Varela, 1999; McAnany, 2004; Sharer & Traxler, 2006). A lack of earlier material culture as well as the presence of a layer of bedrock indicate the earliest settlement and occupation date possible for this site is approximately 800 B.C., around the middle Pre-classic period (McAnany & Varela, 1999). Located in the northern lowlands in the Orange Walk District, K'axob during the Pre-classic period was a moderate-sized farming village primarily, although it did participate in the larger trade network of the New River complex (McAnany, Storey, & Lockard, 1999).

Initial excavations at the site began in the 1970's and continued in the 1990's under the guidance of Patricia McAnany. As a result of these excavations, the site has yielded more than 72 burial contexts and over 100 individuals spanning all ages, sexes, and chronological phases within the Pre-classic (McAnany, Storey, & Lockard, 1999). Furthermore, information about ceramics and residence structures were also explored, and these helped establish how the settlement changed over its long occupation. Evidence of occupation continuity throughout the Pre-classic can be seen through the maintenance and expansion of preexisting platform constructions at K'axob, with some of the earliest residential house platforms being continuously rebuilt through time, some for more than a thousand years, establishing what McAnany (2014) refers to as a 'genealogy of place' (McAnany, 2014). Likewise, social complexity can be seen to become more apparent and elaborate over time, as seen through the shift from nuclear residence patterning to "satellite" or more dispersed residential compounds over time (Sharer & Traxler, 2006). Elaboration and variation in burial types also suggests increased social complexity in the form of ancestor veneration as seen through interment beneath floors and in association with new platform constructions, and in emerging social status differentiation as seen through the inclusion of burial goods and variation in burial good types (McAnany, 2004; Storey, 2004; McAnany, Storey, & Lockard, 1999; Sharer & Traxler, 2006).

K'axob shows a likely increase in population over time, as seen through an increase in the number of later Pre-classic period burials as compared to early and middle Pre-classic burials (Storey, 2004). However, this could be due to a sampling bias, as excavations were not conducted on all residences from the site, meaning the individuals from the K'axob sample are representative of only a small portion of the overall population, with most of the individuals from the sample coming from the late Pre-classic with those from the earlier Pre-classic perhaps somewhat underrepresented (Storey, 2004).

Phases for K'axob are chronologically represented through established ceramic complexes (McAnany & Varela, 1999). Starting during the middle Pre-classic period with the early phase Chaakk'ax (*Fig. 3*), excavations have shown a dynamic shift in burial types and treatments over time (Storey, 2004; McAnany, Storey, & Lockard, 1999; McAnany & Varela, 1999). Early phase Chaakk'ax burials tended to be rather simple, with increasing elaboration as well as number of burial types in the later phases. It could be said that the Pre-classic Maya had no one burial type used consistently as much variation and elaboration, especially towards later time periods, can be observed (Storey, 2004).

The K'axob sample consists of individual representative of the early phase Chaakk'ax through the late phase K'atabche'k'ax, or the middle Pre-classic through the late Pre-classic bordering on the Proto-classic, or beginnings of the Classic period of Maya societal development. Since this study focuses on the Pre-classic alone, any individuals conclusively dated to the early Classic period will not be considered in the analysis.

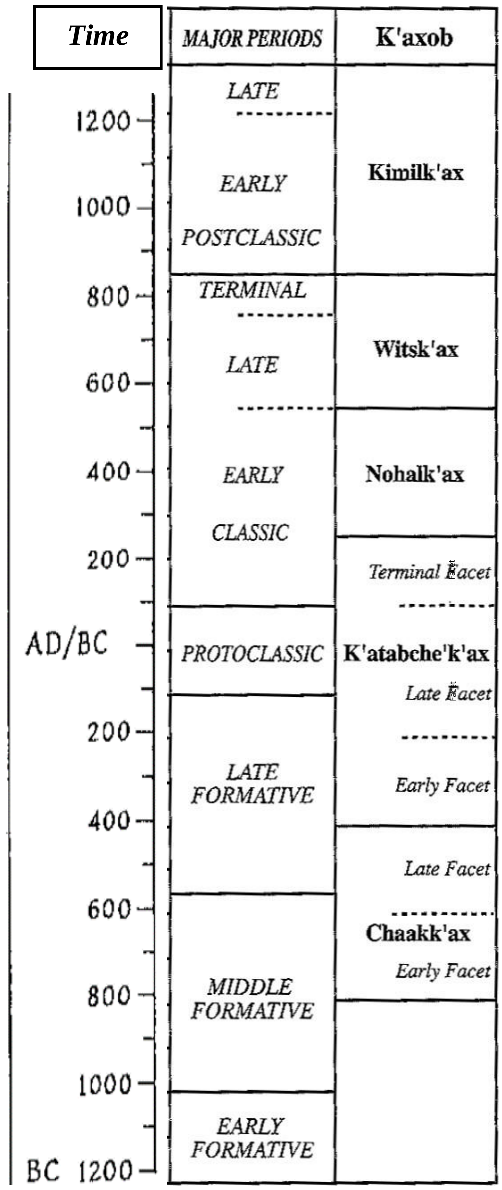

Fig. 3: Chronology of K'axob; adapted from McAnany, 2004; Hammond, 1991

History of Cuello

The second settlement of interest, Cuello, is also located in the northern lowlands of the Orange Walk District. Initially discovered in 1973, early excavations were carried out in the field season of 1975 and continued well into the 1980's (Hammond, 1991). A variety of ceramic complexes were discovered, lending its designation as a Pre-classic period site, with some ceramic types initially not recognized and thus attributed to exotic or earlier forms, suggesting an even earlier date of occupation for the site. This date has since been corrected to around 1200 B.C. based upon the discovery of the already established Swasey-type ceramic complex and is now well within the traditionally accepted chronology of the early Pre-classic period (Hammond, 1991; Hammond, Bauer, & Hay, 2000; Sharer & Traxler, 2006). Occupation at the site continued through the Pre-classic until its abandonment at the end of the Classic period (Wilk & Wilhite, 1991). Cuello remains a prime example of a Pre-classic Maya settlement.

Architecture at Cuello is typical of the Pre-classic with apsidal or semicircular type structures overlaying plaster floors, with continuity of structures being maintained and rebuilt throughout time. Cuello also shows evidence of a small (6 meter) stepped pyramid construction dating to around the late Pre-classic period, also signifying the likelihood of social status differentiation at the site (Gerhardt & Hammond, 1991).

Cuello also had a greater population density compared to K'axob, with a maximum population of at least 2,500 people during the height of its prosperity in the late Pre-classic (Hammond, 1991). Likewise, burials discovered at the site have also yielded the largest collection of Maya Pre-classic skeletal remains, making this an ideal sample to study (Robin & Hammond, 1991; Saul & Saul, 1991). In comparison, the sample from K'axob is smaller than the sample from Cuello (Storey, 2004).

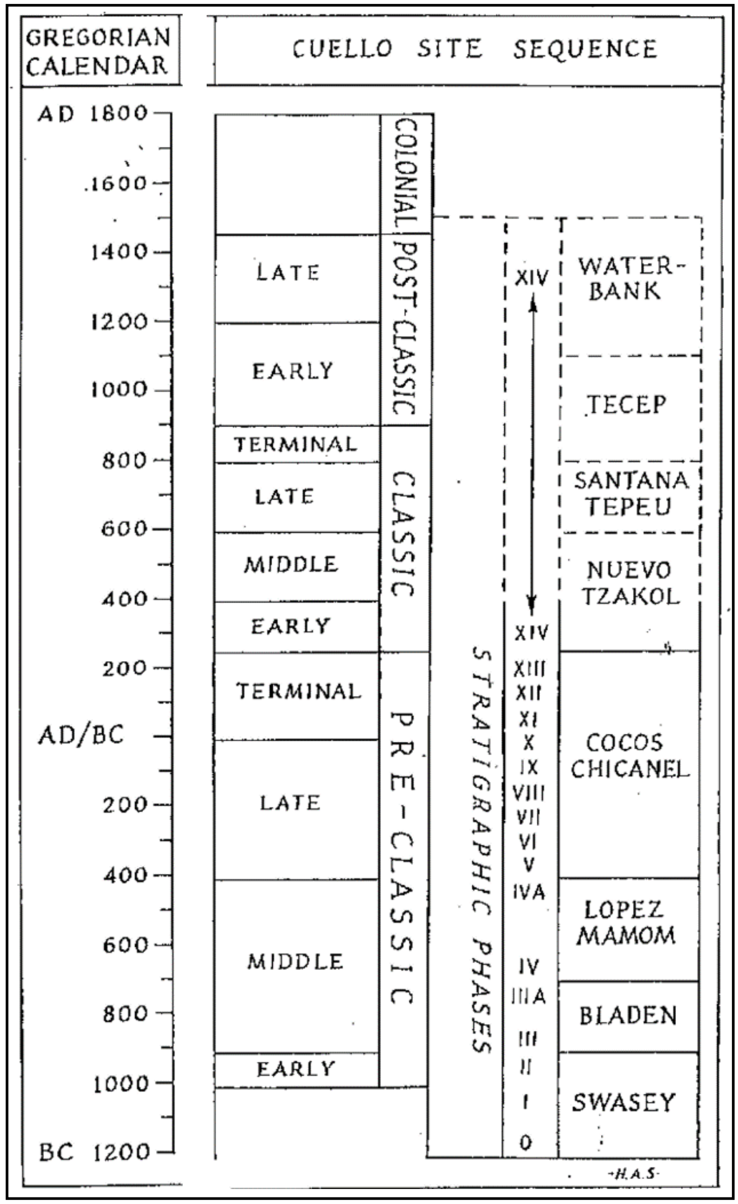

Fig. 4: Chronology of Cuello; adapted from Hammond, 1991

Both K'axob and Cuello are representative of small agricultural societies in the southern lowlands, of minor significance to the larger city-states but still participating with the overall trade network from the periphery, probably under the sociopolitical umbrella of Lamanai as a part of the New River Complex. Both are also representative of the same ecological region of the southern lowlands and thus would have shared many of the same resources, including access to the New River trade network. Both shared similar styles in architecture and settlement patterns, with Cuello also having a small pyramid construction from the late Pre-classic, suggesting its likely slightly heightened status when compared to K’axob. Cuello also had a larger population density, although neither site shows signs of ever having a large population.

SECTION II:

Objectives

In this study there are two main objectives I seek to discuss. The first is to establish frequency of non-specific infection markers within each sample, as well as the frequency of individuals with accompanying grave goods for each sample, and the second objective is to view these variables in relationship with one another to determine if any significant patterns exist. The null hypothesis states that there are no relevant patterns between the variables of health and social status differentiation, while the alternative hypothesis states that there are relevant patterns here and any relationship between the variables of health and social status differentiation are not due to random chance.

Variables I'll be able to compare successfully depend on the preservation status of my samples, and ultimately the final sample size of individual burials containing enough skeletal matter to analyze, but I hope to compare, at minimum infection rates and status markers within each sample population and then between the K'axob and Cuello samples.

Main Variable Types Used to Compare Samples	
Demographic Variables	Sex Age Range Phase
Mortuary Treatment Variables	Grave Goods Present Grave Good Type (ceramics, shell, greenstone, obsidian, other) Burial Location
Non-specific Infection Variables	Lesion Type (active, healing, healed) Lesion Grade (slight, moderate, severe)

Table 1: Main variable types used to compare samples

Non-specific Infection Markers

The term 'non-specific infection' has become a sort of catch-all term when it comes to describing most long bone periosteal lesions without a known cause. This is because disease etiology is nearly impossible to determine from looking at the characteristics of periosteal lesions alone (Weston, 2008; Weston, 2011). The way bones respond to infection or to damage and the healing and remodeling process is uniform regardless of type of insult or injury. This means that the specific causative pathogen of an infection is indeterminable because of the natural physiological characteristic of bone. This is further complicated by the fact that not all infections leave marks on the skeleton at all, and while many infections do not leave any direct evidence on the skeleton, when they "do leave osteological signs [they] produce morphologically overlapping responses, making differential diagnosis impossible" (White, 2000, 390). Regardless of what pathogen is causing the infection, the healing and remodeling process of bone is always the same. In some cases, visual diagnosis can be performed as location of the reaction can be very telling of causation, such as with vertebral lesions and spinal tuberculosis. For less distinctive infections, other methods of inquiry, such as DNA analysis, can be informative, but in many cases, this is both cost prohibitive to perform as well as destructive to the ancient skeletal sample in question. Tibial periosteal reactions most often have an unknown cause; thus, the term non-specific infection is often associated with bioarchaeological examples of periosteal reactions. For the purposes of this study, only the visible presence or absence of lesions will be discussed, as will severity and, when possible, the estimated size of the periosteal lesion in terms of total bone surface infected as outlined in Weston (2011). Once an infection has set into the periosteum, the changes that occur there are non-specific to the type of disease or pathogen causing the infection, thus we apply the term 'non-specific infection' as a descriptive to the lesion.

Periosteal non-specific infections are of course not the only type of infection to affect bone, but they are one of the most commonly found pathologies in archaeological contexts and generally a good indicator of either trauma or infection. With periosteal lesions caused by infectious agents, the culprits are typically very common pathogens like Staphylococcus and Streptococcus, making up some 90% of cases (Ortner & Putschar, 1981; Goodman & Martin, 2002). With trauma, individuals that are at risk for developing periosteal infections generally have either suffered a bone fracture or other assault causing soft tissue damage recently, or have an otherwise weakened immune system, either from an environmental cause like malnutrition or major infection, or from a genetic abnormality effecting the overall immune ability to respond to pathogenic assault and therefore increasing their individual risk susceptibility. In either infection circumstance, bacteria build up and attack the periosteum, resulting in periostitis with involvement of the bone cortex. Often with a fracture, there is an initial trauma that resulted in the original fracture or perhaps a deep perforation of the surface of the skin, allowing infection to set in, and resulting in periostitis described as the "condition of inflammation of the periosteum caused by trauma or infection" which in itself "is not a disease" but rather a reaction to such (White, 2000, 392). This type of bony response affects only the outer (or cortical) layer covering the bone, called the periosteum, which "reacts to insult by forming woven bone that sleeves the underlying cortical bone" (White, 2000, 393). This reaction shows itself through the continuous growth of a layer of new bone and the remodeling to the bone surface. The remodeling results in visually apparent changes and a pitted appearance to the surface cortical layer of the bone (Roberts & Manchester, 2007). This pitted area can then be scored for size and severity, as either slight, moderate, or severe, and noted for location on the tibial surface as proximal, distal, anterior, or posterior, if distinguishable (Weston, 2011). It can also then be rated and categorized as either active, healing, or healed, depending on the structure of the new bone formation, and given a score as such appropriately.

An active periosteal infection is categorized simultaneously by the destruction of underlying cortical bone tissue and the bodily response of new or woven bone formation over the original cortical layer. Bone remodeling, as a response to infection or trauma, is the formation and deposit of initially immature bone at the site of trauma or infection (White, 2000; 2005). This first stage in remodeling often occurs rapidly after an injury or disruption to the natural bone state. As the new bone is deposited, it forms a distinct yet disorganized structure, as the remodeling process is still active, and the original cortical bone still infected and thus unstable. This leads to a unique structure of the woven bone that appears as a pitted surface. All new bone formations, regardless of the cause, are woven bone which is replaced over time with more uniform lamellar bone.

A healing infection can be characterized by a more uniform appearance, as the woven bone structure transforms into lamellar bone (Mays, 1998). This exchange from woven bone to lamellar bone is indicative of healing. For my purposes of scoring lesions as 'healing', a suspected presence of both woven and lamellar bone must be noted.

The absence of any sign of woven bone suggests the lesion has healed and been fully remodeled with lamellar bone (Mays, 1998). Healed lesions, due to absences of very noticeable woven bone and the presence only of lamellar bone, can therefore be more difficult to determine from unaffected cortical surfaces, especially in poorly preserved samples where the cortical bone may have been affected by taphonomic processes. The presence, transition, remodeling, and eventual absence of woven bone can aid in determining if a lesion was active, healing, or healed at the individual's time of death, and can be suggestive of cause of death in some cases. For example, "woven bone alone indicates that the individual died shortly after the disease spread to the skeleton; a mixture of woven and lamellar bone indicates that the individual survived for rather longer [while] the presence only of remodeled (lamellar) bone indicates a healed (or at least quiescent) lesion" (Mays 1998, 181). In other words, if a lesion shows only evidence of woven bone, then healing of that lesion had not begun as the underlying infection is still active, and the individual succumbed from or shortly after the bone infection set in. Partial or complete remodeling, evident by the presence of at least some lamellar bone, indicates a state of healing; that individual did not succumb, at least initially, from that bone infection, and potentially there was another cause of death. Due to the issues outlined in the osteological paradox, as well as potentially poor preservation of the samples, likely cause of death cannot be inferred from presence of periosteal reactions alone and thus is not explored in this thesis. Periosteal reactions, while not indicative of cause of death, may or may not contribute to it, therefore, for the purposes of this study, periostitis will be examined as a stress indicator.

The tibia is most useful here both because of its relative resilience to decomposition as well as its proximity to the surface of the skin. This location is prone to injury and thus prone to infections, which easily spreads into the periosteum. In fact, periostitis is often "most common on tibiae", due to this likelihood of "recurrent minor injury" which therefore irritates or damages the underlying bone (Roberts & Manchester, 2007, 172). Since the tibia is positioned so close to the skin, and as such is so prone to injury, this can result in infection entering the bone from being exposed to the external environment, as is the case with a fracture that punctures the skin (Mays, 1998). Other reasons for likelihood of infections in the tibia include "a cooler surface temperature" increasing susceptibility, "a physiologically inactive surface, leading to bacterial colonization" and the tendency for "blood to stagnate in the lower legs, allowing bacteria to accumulate" (Roberts & Manchester, 2007, 173). Another clear avenue for infection to enter the bone is from infected soft tissue over time affecting the adjacent bone. For example, a tibial bone infection can result from an external skin lesion (Ortner, 2003). Without the presence of an obvious or notable fracture, infection likely set in due to adjacent tissue infection or another cause. This is especially true of chronic tissue infections, because bone is often the last tissue to succumb to infection. When you find an underlying bone infection, it is highly likely the original soft tissue infection was present for an extended period, ultimately leading to infection of adjacent bone.

In certain cases, it is important to determine if the initial cause of the periosteal reaction was from an underlying fracture. This is best done with more complete skeletal samples, unlike K'axob. When looking for possible nearby fractures, it is important to note the difference between an antemortem injury and postmortem (or post-depositional) damage, possibly during excavation or due to overly rough handling. Fractures of this nature are distinguishable because they contain ‘fresh’ breaks, which appear whitish and display an otherwise unweathered appearance at the site of fracture (Mays, 1998). Environmental conditions of the burial can also result in differing degrees of post-depositional damage and decomposition, and this is especially apparent in skeletal samples from tropical Central America where preservation conditions are less than ideal.

Social Status Differentiation Measures

I am positing that infection in general can be studied as an indicator of stress, which itself can be attributed to many various cultural, environmental, and social factors. Social status is often thought of as a cultural buffer against stress through greater access to higher quality resources and diminished strenuous work load, which could protect an individual from work related injury or stress. In theory, better access to resources could be hypothesized to equate to an overall healthier individual, with greater biological resistance to stressors. Likewise, lower status individuals who must do difficult physical labor, while also having more limited access to resources, would be expected to have a greater susceptibility to stressors, and thus would be more prone to developing infections (Padgett, 1996). While this makes sense in theory other factors are also at play. For example, the Classic period elite Maya typically lived in urban areas such as city centers with high population density. While having greater access to resources and a more leisurely lifestyle, the greater concentration of people living within a small area compounded by sanitation issues could negate the physical benefits being of a higher status would afford. While rural lower status individuals would have a natural risk factor for disease by lacking the supposed lifestyle advantages of elites, research has found that rural populations carry a similar infection load to elite populations, despite the fewer number of people living in rural settings, with the population generally dispersed over a much larger land area then elites (Padgett, 1996). One could also argue that rural individuals would have a greater ability to supplement their diet with naturally occurring resources by hunting, fishing, and gathering, rather than solely relying on the agricultural exertions of others. The ability to be creative with subsistence sources rather than relying solely on a single crop is also adaptive.

Without a large network of individuals to encounter through social and physical interactions, infectious disease has a harder time spreading (Roberts & Manchester, 2007). This is not to say necessarily that a higher status and an urban environment protected from or promoted disease; the higher concentration of individuals seen in the city centers could in fact have lower rates of infection than their rural non-elite counterparts, it would just be more difficult to see due to the higher population found in the urban areas. The overall rate of infection may be the same, it may just appear to be different due to dissimilar population numbers between rural and urban environments.

Another indicator of status is differential burial contexts. This includes things like type and amount of grave goods, bodily positioning, grave site location, ancestor veneration or re-interment, and whether the burial represents a single or multiple interment. In many contexts, grave goods are often one of the most obvious indicators of status as they can be correlated to the wealth of the individual. If high value items are placed in the grave, then it’s very likely that that individual is of higher social status. Multiple interments containing small numbers of individuals, either articulated or disarticulated, and usually with some form of grave goods denotes a family burial, while larger multiple interments can indicate sacrifice, and would therefore contain different types of grave goods, relating to ritual (Duncan, 2011). While there is some evidence for ritual sacrifice found in Maya multiple interments, the burials at K'axob and Cuello containing multiple individuals are more likely to be representative of secondary burials as acts of ancestor veneration to maintain kinship ties after death (McAnany, 2004).

Burials can also give an insight into how a specific culture handles the transition between states of life and death, and what symbolic meaning death holds to a society (Becker, 1993). Views about death and the dead in Maya society are reflected in their mortuary treatments. As previously mentioned, many interments are beneath the domestic plazas of inhabited residences, suggesting the Maya maintained close ties to their kin even after death. Graves of this type often show comingling of skeletal elements from multiple individuals, and often as secondary interments, a form of ancestor veneration. Since the Maya practice burying their dead in proximity to their residence, the status of the individuals can be correlated to the size and type of residence. This is another way to negotiate questions of status when there are no grave goods present in a burial. For example, a public burial location would be considered special and indicative of heightened status as it would be against the norm of the standard burial location, which was typically occupied residential structures. However, for the purposes of this study presence or absence of grave goods and grave good type will be primarily used to define social status, with the other mortuary treatment variables of burial location, burial position, burial type, and interment type also considered in the analysis. See *Mortuary treatment variables* section.

<u>SECTION III:</u>

Review of Related Literature

Looking at two related studies exploring the interrelation of non-specific infection and social status, Holsworth (2013) and Padgett (1996), no discernable relationship could be found between the two variables in question. Both studied skeletal populations from the late/terminal Classic period at Copan, Honduras, a population that would have been expected to be under a great deal of environmental and sociopolitical stress at the close of the terminal Classic. However, while similar in research focus to my study, the sample populations from both of these studies were from a different location and from a much later time period. Settlement patterns, social complexity, and population density changed greatly from the Pre-classic to the terminal Classic period and as such these findings cannot be generalized back in time to my sample populations. Likewise, there is an emphasis in both of these studies on the urban/elite versus rural/non-elite dichotomy in terms of social status differentiation. This way of defining and classifying social status differences by splitting your population into two subgroups by residential location differs from my own classification for social status differentiation in the Pre-classic. Neither K'axob nor Cuello could be called urban communities with elites residing in urban cores and non-elites residing at a distance in the periphery, and thus this classification is not applicable to my study; K'axob and Cuello could wholly be considered peripheral villages. Furthermore, social status differentiation in the Pre-classic at the within group level isn't as clear-cut as it would have been in the terminal Classic due to this very dichotomy in using residence patterning to define groups. Social status differentiation in the Pre-classic would have been existent, but probably more nuanced overall (Goodman, 1998). I expect the Pre-classic populations from K'axob and Cuello to both show apparent levels of social complexity, and as social complexity evolves, trade intensifies, and population increases, so does the likelihood for infectious disease transmission (Roberts & Manchester, 2007). Therefore, both K'axob and Cuello should have evident social status differentiation and evidence of relatively high levels of periosteal reactions.

Holsworth 2013

Holsworth (2013) found no differential distribution of non-specific infection in any manner. She states in her abstract that "although intra-group ranking was evident, it could not be detected via indicators of health" (Holsworth, 2013, iv). This suggests that although the society was ranked by status, disease rates could not be used to link an individual to a specific social standing, nor was any distinguishable social status found to be more susceptible to infection. There was however found to be a difference in infection severity based on residential location, with those in the elite city core suffering and ultimately dying from more severe infections while the rural group tended towards more moderate infections with apparent signs of healing, characteristic of heightened immune response (Holsworth, 2013; Padgett, 1996).

Although this study was looking at Copan in a different area of the Maya realm during the terminal Classic period, it is possible that this same pattern can be applied to populations in Pre-classic K'axob and Cuello and, since the time period and area are dissimilar, as are the variables used to measure social status differentiation, alternative outcomes could result. Like Holsworth (2013), I also plan to use periosteal reactions as infection indicators, and likewise also by using full or partial tibias from my sample populations.

Padgett 1996

Padgett (1996) also looked at infection rates in the Classic period Maya at Copan, Honduras, but through the framework of social status as indicated by residency pattern and location, either urban/elite or rural/nonelite status. She theorized that the rural/non-elite population would have higher rates of infection than the urban/elite population due to social status factors such as resource availability. This theory is based on the idea that greater access to resources would result in overall better health, which in turn would provide some protection from infection. Oppositely, an individual who experiences resource scarcity may have diminished immune response and therefore be more susceptible to infection. For Padgett (1996), this disparity is explored through social status, with urban/elite individuals having the access to resources that rural/non-elite may be lacking, thus the urban/elite would be theorized to have better overall health based on this differential access to nutrition and resources. Her findings however, showed that there was no discernable link between status and infection rates. Overall, her study showed that there was a high rate of infection in both the urban/elite population and the rural/non-elite population, and differences in health had more to do with residency than with social status (Padgett,1996). This could be due to population density within the urban centers, which creates overcrowding issues and possible problems with sanitation that could lead to higher exposure to infection. Also, with greater population density comes the easier likelihood for both endemic and epidemic infections to spread more easily. In this sense, rural individuals would encounter fewer other people and thus make the easy spread of infectious disease much more difficult. Like Padgett (1996), I also plan to use a similar methodology of scoring periosteal lesions on the tibia.

Like Holsworth (2013) and Padgett (1996), I aim to explore rates of infection and social status differentiation but using skeletal samples representative of two villages as my populations rather than two distinct groups within a population. While using these two studies as a guide, I am well aware I am looking at a population from an earlier time-period as well as from a different geographical area with differing ecology, and as such, these factors may influence the findings of my study to differ from the findings of Holsworth (2013) and Padgett (1996). Since both K'axob and Cuello are small agriculture villages, the rural/urban dichotomy explored in Padgett (1996) and the urban core versus the rural periphery dynamic in Holsworth (2013) are not variables for my study, and as such the external environment, both culturally and physically, is different from Classic period Copan to Pre-classic K'axob and Cuello. Neither village was ever considered a dense urban center with high population density, and so both can be viewed as peripheral to local major city centers like Lamanai, although they would have had trade connections to the urban centers. For this reason, I suspect that both K'axob and Cuello would have had similar social status as villages within the New River delta complex, with Cuello perhaps being somewhat higher status than K'axob (McAnany, 2004; Hammond, 1991). However, social status differentiation between individuals began to emerge in the middle and late Pre-classic and thus is expected to be apparent in both within sample populations.

<u>Previous research on health in the Pre-classic</u>

Bioarchaeological health research from the Pre-classic has generally focused on dietary factors and associated pathologies such as enamel hypoplasia, diagnostic of nutritional or health disruption during early childhood development, and porotic hyperostosis, often diagnostic of anemia or dietary iron deficiency. While these are caused by other underlying stressors in the environment, they are typically understood as related to some nutritional deficiency or malnutrition. Such studies on the Pre-classic, and notably on Pre-classic Cuello, have included stable isotope analysis of the Pre-classic Maya diet (Tykot et al., 1996), isotopic and zooarchaeological evidence of animal husbandry and diet (Van der Merwe et al, 2002), and use of canines as a food source (Clutton-Brock & Hammond, 1994). Other studies, while focusing on differing geological or ecological regions, tend to have a heavy focus on diet and subsistence, rather than paleopathology, while studies of the Classic Maya time period continue to feature studies on paleodiet, there's an increased interest in paleopathology. This increase in interest in paleopathology during the Classic period is probably due to a number of factors including a higher level of academic and public interest in the Classic period Maya, the ongoing mystery of their famous societal collapse, as well as the difficulty of finding well preserved skeletal samples from the Pre-classic period. For many sites with long occupation histories, the Classic period structures are literally on top of the Pre-classic period structures, making the excavation of large areas of Pre-classic period compounds much more difficult and at the detriment to the Classic period sites above.

Less research has been done on non-specific infections and periosteal reaction, probably due to the difficulty of establishing a causative pathogen, hence the term 'non-specific', which really acts as catch-all term for one of many causes of periostitis or periosteal reactions in archaeological specimens. With further advancement in science, DNA extraction and analysis of some samples has been undertaken, however this is a long and often cost-prohibitive process, and so it typically not done without a strong suspicion of the underlying infectious agent. Similarly, complications involving the osteological paradox also impact the studies done over non-specific infections.

Section IV:

Sample, Methods, & Materials

Sample

Due to factors including poor preservation conditions and limited site excavations exploring the Pre-classic period, both skeletal samples from K'axob and Cuello are relatively small compared to the village populations they represent and so provide only a small glimpse into the overall population dynamics of each village. Despite this, it's worth noting that the Cuello sample appears to be the largest Pre-classic period skeletal sample currently known to researchers, proving essential clues into this early period (Saul & Saul, 1991; Robin & Hammond, 1991). The Cuello sample, being the larger of the two, yields a total of 149 individuals. The K'axob sample is smaller and includes 107 skeletons from the Pre-classic. This number is slightly higher than the actual sample size as several once purported individuals may actually belong to the same individual, as well as a few individuals may be from the early Classic period and cannot be determined conclusively to belong to the Pre-classic. Due to this ambiguity, sample size from K'axob explored in this study is 101 individuals.

Both Pre-classic samples are similar in size and include over a hundred individuals each, 101 for K'axob and 149 for Cuello. To conduct the visual osteological analysis on K'axob, individuals need to include long bones or long bone partials, so a designation of 'lesions present' or 'no lesions present' can be determined. For the purposes of this study, individuals without sufficient identifiable long bone or long bone partials are excluded from the infection marker analysis as well as the final sample analysis over non-specific infection markers and social status differentiation markers. From the initial excavation sample, 78 individuals from K’axob and 111 individuals from Cuello have enough full or partial long bone to be assessed for the presence or absence of infection. Out of 78 individuals from K’axob, 6 showed signs of infection, while out of 111 individuals from Cuello 39 show signs of infection. Final analysis between mortuary treatment variables and infection variables is conducted utilizing only the individuals with signs of infection from both sites in order to gain insights into the relationship between mortuary treatment and infection markers, as well as overall demographic trends for individuals with visible periosteal reactions.

Methods & Materials

I will utilize a biocultural approach using methods from archaeology, cultural and biological anthropology, and health and population demographics. This approach allows for the observation of biological factors as being influenced and molded by social and cultural behaviors. I will look for visible signs of infection by location (if possible) on the tibial surface as proximal, distal, anterior, posterior, or undeterminable, by infection severity, scored as slight, moderate, or severe, as well as scoring any visible lesions as either active, healing, or healed, on skeletal samples from K’axob and likewise from the database of remains from Cuello, and a comparison of rates of infection between the two will be explored. This comparison will allow for a greater understanding of infection rates between these two villages as well as giving insight into the overall health of the two populations from the Pre-classic. Alongside comparing rates of infection, I also plan to look at variables of social status differentiation between individuals based on mortuary context and the presence or absence of grave goods to see if infection rates and social status are in any way related.

For methods of data collection, I will rely on several different textual sources. For guidance in the K'axob osteological analysis, I will utilize "Standards for Data Collection" (Buikstra & Ubelaker, 1994), "Reconstructing health profiles from skeletal remains: The Backbone of History" (Goodman & Martin, 2002), "A Companion to Paleopathology" (Grauer, 2011), "The Human Bone Manual" (White, 2005), and "Human Osteology" (White, 2000). For Cuello I will rely on the preexisting Cuello Database, from which I will collect all relevant data. I will also use IBM Statistical Package for the Social Sciences v. 25 (SPSS), a statistical analysis computer program, to quantify my data, synthesize it, preform an analysis, and to look for statistically significant patterns for comparison.

The University of Houston osteology lab provides an on-site research location for visual skeletal analysis of the K'axob collection housed there at the time. Osteological analysis of the K'axob sample took place over several weeks in the Fall of 2016. The Cuello collection is not on-site, and thus was be remotely analyzed primarily via the Cuello Database as well as via literary sources (Robin & Hammond, 1991; Saul & Saul, 1991).

Of primary interest to this study is the frequency of infection rate in each sample, and in comparison, to the other sample population. Secondary focus is on mortuary treatment and how it relates to those with and without periosteal reactions. For this reason, the data analysis is relatively simple and straightforward, however SPSS software allows for a highly accurate analysis.

Methodology for describing and categorizing periosteal reactions in archaeological specimens has been inconsistent in the literature. From Weston (2008), "a number of researchers have devised classification systems for use in the analysis and description of periosteal new bone production including: Lallo (1973); Strothers and Metress (1975); Cook

(1976); Hackett (1976); Lallo et al. (1978); Mensforth et al. (1978); Grauer (1993), and Buikstra and Ubelaker (1994), but unfortunately no recording system has been universally adopted" (Weston, 2008, 50). While I acknowledge the contributions of each of these studies, the methodology utilized in this thesis borrows from multiple sources, including the idea for stages of lesion severity from Lallo (1973), research questions from Weston (2011), lesion location and lesion stage of healing from Buikstra & Ubelaker (1994). Social status differentiation measures most closely follow Goodman (1998) as first described in Rothschild (1979).

SECTION V:

Variable Selection

To address both the general and specific problems, a variety of variables must be used to explore any patterns between the two populations first, and then further between the two main variables of interest to my study—non-specific infection and social status differentiation—to see if patterns or correlations exist between these as well. Individual entries in my study are identified by their original Operation Number (OP#) and burial identification number (BUR#) assigned by the principal investigators and will appear as OP#-BUR# to identify individual burials. All entries have individual BUR#s but will share OP#s with a varying quantity of other individuals. The OP number designates the operation or excavation under which that individual or group of individuals were discovered and exhumed, also known as the provenience. This can then be used to assume physical proximity as well as temporal relation of multiple individuals with the same OP, as typically they would have been excavated from the same location or provenience and interred around the same time. This is important to know because burial locations in relation to other physical structures such as residential complexes can be insightful for determining social status of individuals interred there. Likewise, multiple interment burials, both primary and especially secondary burials, could suggest relation or kinship, even through time, and thus potentially similar social status of individuals interred.

Variables are classified into two overarching categories, one for describing lesions if present, which is useful in this study for determining 'health', and one for describing mortuary treatment, which is useful for inferring levels of social status differentiation. It is essential to establish a general idea of both of these variable categories to perform a population comparison between K'axob and Cuello, as well as define any patterns between health and social status overall.

Lesion variables

As my primary question is frequency of periosteal reaction within each population and between the two populations, many variables are devoted towards exploring this and further describing and quantifying my observations. The presence of these lesions within a population is an important factor in the "stress-indicator hypothesis" or the idea that stressors in life, whether biological or cultural, over time leave a biological marker on the skeleton that can then be interpreted and analyzed (Goodman & Martin, 2002). In this sense, something like infection would leave behind a biological marker that could then be used in conjunction with the skeletal health profiles of the rest of the sample to make inferences about the overall health of a population.

The first variable addresses the condition of the sample and whether there is enough skeletal material present to address my thesis question. The K'axob collection is highly fragmentary overall, with poor preservation of skeletal materials, a common problem found with remains from this region. Therefore, it is essential to establish if there are any long bones or long bone fragments present from each individual in order to conduct an analysis. Since periosteal reactions are most commonly observed on the long bones, especially the tibia, the presence of these bones, complete or as partials, is crucial. Without the presence of long bones, it is impossible within the parameters of this study to say conclusively if an individual had any periosteal lesions. Luckily, long bones tend to preserve relatively well compared to some of the more fragile skeletal elements, and as such most individuals from the K'axob sample contain long bones or long bone fragments, allowing these individuals to be addressed as part of this study. From those individuals with the required long bones present, the next variable can be established, which is the presence of any lesions or periosteal reactions observable with the naked eye for K'axob, and via previous observations in the Cuello Database for Cuello. If no periosteal reactions are noticed, analysis on that individual in terms of non-specific infection variables is complete. If a lesion is noticed however, further variables are used to describe and classify the lesion. The variable of bone type describes which type of long bone or long bone partial is affected if identifiable. Some fragments are not attributable to a type of bone and so then the distinction of 'undetermined' will be applied. While the tibia is the most commonly affected of the long bones, others that could be included in this variable designation are fibula, femur, radius, ulna, and humerus (Ortner, 2003). The variable of lesion type defines the stage of the reaction and thus the overlying infection and/or new bone formation. For this study, this is designated simply as active, healing, and healed as further denoted by Mays (1998). An active lesion mirrors an active infection in the periosteum overlying the bone, with the dual destruction of necrotic bone and the creation of new lamellar bony structures (Mays, 1998). This has a differing visual appearance from both a healing and a healed reaction. A healing reaction shows striations on the cortical surface of the bone and can appear as an almost skin-like layer of new bone formation (Weston, 2011). These distinctions are further described in the section titled *Non-specific Infection Markers*. The next variable is lesion grade, or level of severity of the lesion, as adapted from Lallo (1973), which is designated in very general terms as severe, moderate, or slight. See Weston (2011) for a description of this rating methodology in further detail. For the Cuello sample, the Cuello Database, when applicable, denotes this as ‘pronounced, moderate, and slight’. For this study, the term ‘severe’ will replace and be equal to ‘pronounced’ from the Cuello Database.

Lesion location is a more difficult variable due to the fragmentary nature of the sample, and is simply defined as “proximal 1/3”, “middle shaft”, or “anterior 1/3”, which describes the approximation of the anatomical direction and location of the lesion on the bone. This is described in further detail in White (2000).

Similarly, lesion size is also difficult to discern in much of the sample, but will, when applicable, describe the relative size of the lesion in terms of overall percentage of bone surface affected. Accounting for the condition of the K’axob sample, I expect most of the lesions observed to be small or medium in coverage size, as the amount of intact and easily observable bone surface is lacking. Furthermore, a designation of large, or otherwise a high percentage of coverage of a lesion on the cortical surface most likely denotes a severe or chronic infection (Goodman & Martin, 2002; Ortner & Putschar, 1981). While I would expect to see this occasionally in a perfectly preserved sample, the condition of the K’axob sample will make the designation of large lesion size unlikely simply due to the absence of complete bones.

For Cuello, lesion grade and sometimes bone type and side are included, but all other lesion variables are not noted in the database for this sample and therefore cannot be included in the comparison to K’axob and therefore will be excluded from the between sample comparative analysis. For this reason, the main lesion variable of concern for both samples will be presence of periosteal lesion and when applicable lesion grade.

Mortuary treatment variables

The mortuary treatment variables used to measure social status differentiation are not based on my own observations but rather from the related literature (Storey, 2004; Goodman, 1998). How an individual is treated in death can give insights into how that person was treated in life, what their social status within their kin group was, as well as what the status of their kin group was within the larger society. These variables are important on their own for understanding whether Pre-classic K'axob had any level of social status differentiation. For example, the inclusion of grave goods in some burials but not in others is a likely sign of social status differentiation, as if there was no differentiation then we would expect all graves to be the same. Therefore, it is probable that the individuals receiving the grave offerings were of a higher social status, based in part on wealth or capital of some kind. Furthermore, there is variation in the type or quality of grave goods. The inclusion of rare or valuable grave goods suggests that the individual, or their kin, were important enough to merit being buried with the goods, implying that the individual or their kin were wealthy enough not to need that capital and could afford to dispose of it in a burial, in a sense as a form of conspicuous consumption, or the public display and disposal of wealth to maintain status. If some individuals are provided with grave goods while others are not this shows that a level of social stratification or differentiation exists. Furthermore, when looked at comparatively with the lesion variables, correlations might occur enabling further exploration into the relationship between social status differentiation and health status in the form of non-specific infection.

The first variable of interest in this section is inclusion of grave goods. Grave goods can be either perishable, imperishable, or a combination of both, however, only those goods imperishable in nature can be observed in the archaeological context of both sites as perishable goods would not be expected to preserve. If grave goods are included, the variable of grave good type can be applied, which denotes the classifications of grave goods found, including categories of ceramic items, shell items, greenstone/jade items, and obsidian items. Items like ceramics are functional or utilitarian and thus are considered common, while items like greenstone and obsidian are not naturally occurring in the immediate environments of either site, and so their presence suggests higher status. Grave good type therefore can be further classified as utilitarian or exotica to help distinguish possible social status differentiation (Goodman, 1998; Rothschild, 1979).

More unique items that cannot be classified in the more informative group categories are simply denoted as 'other'. This could include things like cinnabar or other minerals, faunal bone, etc. Since these types do not have a definitive classification they are not helpful to the overall goal of this study.

The variable of burial location can also be indicative of social status. This describes the location of the burial in relation to the surrounding residential structures or complexes, which in turn are representative of possible social status differentiation. This is one of the few ordinal or ranked variables in this study, with public burials designating higher social status than residential burials or rubble/scattered burials, and so they are ranked as such. Furthermore, the variable of burial type describes whether the individual was uncovered as a primary or secondary interment. As described by McAnany (2004), "a primary interment is one in which the individual is placed soon after death, and the skeleton retains its original placement" whereas "a secondary interment is one in which the individual is represented by a partial, disarticulated skeleton" that can be resultant from behaviors such as "reburial of a disturbed primary inhumation, interment of chopped bits of a sacrificed individual, or a process of treatment that reduces a body to skeletonized elements before inhumation" (Storey, 2004, 109). Originally many secondary burials were assumed to represent individuals who had been ritually sacrificed as they are often discovered as parts of comingled multiple interments (McAnany, 2004). It's worth noting however, that many cultures practice secondary interments in the same or similar fashion to the Maya without any association with sacrifice, and it seems most likely that these secondary interments represent prolonged funerary traditions. The relationship between the living and the dead in Pre-classic Maya society is one of high respect shown by the placement of the deceased underneath or within proximity to currently occupied residential complexes. Over time, these burial complexes become filled with deceased ancestors, thus requiring the exhumation and re-interment of the older remains to make room for those newly deceased. Alternatively, when settlements expand, and residential compounds add additional plazas, the new construction possibly disrupts an older burial, which is then collected and reinterred under the new plaza construction (Storey, 2004).

The variable of burial position is rather complex as the Maya during this time period placed remains in a variety of positions during burial (Storey, 2004; McAnany, Storey, & Lockard, 1999). Furthermore, common burial positions changed and evolved over time to include new variations not seen previously. This variable describes the positioning of the skeleton upon excavation, including supine extended, prone (face-down) extended, partial/scattered, bundled, seated/reclined, flexed, and inverted seated, as well as combinations of these (Storey, 2004; Robin & Hammond, 1991; Saul & Saul, 1991). The number of burial position variations is quite impressive and extensive, but for the purposes of this study only the above mentioned seven types will be utilized for this variable. If excavation notes or database notes lists more than one type of burial position, the first type noted will be used to categorize the burial. This variable and the variables of burial location and burial type are usefully in conjunction for determining overall mortuary treatment and thus inferring social status differentiation. Interment type is the final mortuary treatment variable of interest and is divided into single interments and multiple interments. This describes a single interment if the individual was the only one in the grave, or if there were two or more individuals, a multiple interment.

Demographic variables

Determination of sex and age categories is important for establishing demography of the samples. However, with fragmentary remains this determination becomes more difficult. For the K'axob sample, when skeletal elements were available, sex was determined morphologically by the usual methods (Buikstra & Ubelaker, 1994) and aligned with preliminary sex determinations from the literature (Storey, 2004). Sex determination should be considered an estimation, and is designated as female, male, or indeterminate. For the Cuello sample, all sex determination was pre-established via the Cuello Database and followed for this study.

Age as a variable is represented by ranges which are primarily estimated based on tooth eruption using dental age estimation charts as provided in Buikstra & Ubelaker (1994) and from the extent of dental wear patterning present on permanent teeth. The dental age estimation chart is useful for the estimation of subadult age ranges while dental wear is useful for estimating approximate adult age ranges. It's notable however that tooth wear is an approximate methodology for determining adult age ranges, whereas subadult tooth eruption is usually considered a very good methodology for determining age. This methodology is also checked against the relevant literature whenever possible to confirm accuracy (Storey, 2004).

Age ranges are designated as child of approximately less than or equal to 2 years, juvenile, young adult, adult, and older adult. The designation of child of approximately 2 years or younger is based on unerupted deciduous dentition or deciduous dentition lacking apex formation (Buikstra & Ubelaker, 1994). The designation of juvenile is a broad category based on erupted deciduous dentition, deciduous dentition with wear, formation of permanent dentition crowns, and erupted permanent dentition with incomplete root apexes and slight wear to the occlusal surface (Buikstra & Ubelaker, 1994). These individuals also lack third molars or have unerupted third molars. According to Buikstra & Ubelaker (1994), third molar eruption typically occurs in the late teenage years or early adulthood and as such its eruption designates the line between likely juvenile and young adult (Buikstra & Ubelaker, 1994). The designation of adult is also broad but typically includes individuals with fully erupted and formed permanent dentition and inclusion of erupted third molars, usually with some degree of slight to moderate tooth wear. The category of older adult would likely include individuals over the age of 50 as shown by heavy dental wear patterning. For the sample from K'axob, dentition analysis was performed on site whenever possible as a means of establishing age range and checked with the predeterminations in Storey (2004). For Cuello, since all analysis is completed via the Cuello database, dentition variables were not used to establish age ranges and predetermined age ranges from the Cuello Database were followed.

Phase describes the time period for each individual burial and are further described in the literature (McAnany, 2004; Hammond, 1991). See *Fig. 3* and *Fig. 4* for the chronology of each site. Phase variables show how the demography of each sample population changed over time as well as being applied to both mortuary treatment variables and lesion variables to see if and how these changed over time for each site.

SECTION VI:

Data Analysis Summary

In order to explore the question of non-specific infection and social status differentiation the relationships of each variable need to be analyzed using procedures in the statistical program SPSS. As defined above, there are three categories of variables, including the demographic variables of number of individuals in each sample, age range, sex, and time period distinctions, mortuary treatment variables including grave goods present, types of grave goods, burial position, burial location, burial type, and interment type, and infection variables including long bones present, lesion present, bone type, bone side, lesion type, lesion grade, approximate location on bone, lesion size, and individuals with more than one bone showing signs of infection. Since most of these variables are categorical, the most informative statistical procedures to use for interpretation include basic frequency tables, and crosstabulation and chi-square for comparing variable combinations, within and between sample populations.

In order to answer the questions associated with each variable, some changes to the sample in question must be made. The demographic variable summaries as well as the mortuary variables summaries for within and between samples include the entirety of the Pre-classic sample for each site. To conduct an accurate analysis of the infection markers, only individuals with enough included long bones present with be observed to determine if they have or lack signs of periosteal reactions. To not exclude individuals without sufficient long bones present would risk biasing the sample by possibly underrepresenting cases of periosteal reactions. One of the cautions involved with using bioarchaeological samples is the tendency to underrepresent the prevalence of actual cases of a pathology in the population

(Wood et al, 1992). Since this part of the osteological paradox is an intrinsic problem with bioarchaeological samples, I do not wish to further bias the sample with additional underrepresentation. For the final analysis, the sample will be reduced yet again to include only individuals with lesions present in order to explore the relationship between infection markers and mortuary treatment, as well as to observe any demographic trends, among those with periosteal reactions present.

Demographic variable summary for K'axob

The K'axob sample originally included 107 individuals as stated in the literature (Storey, 2004), but two highly fragmentary individuals were possibly attributed to other existing individuals, making the minimum number of individuals in the K'axob sample 105. This is further narrowed down by 4 individuals potentially dated to the early Classic period and are thus excluded from further analysis, making the new K'axob sample 101 individuals from the Pre-classic period.

The adult category is the largest (32.7%), with young adults also well represented (26.7%), but all age ranges are fairly represented in this sample. Individuals of indeterminate sex (including subadults and very incomplete adult remains) make up the largest group (41.6%) but adult males are also highly represented (39.6%) over females (18.8%), suggesting there is a bias towards male burials in this sample.

Frequency Table by Age Range for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	child	14	13.9	13.9	13.9
	juvenile	13	12.9	12.9	26.7
	ya	27	26.7	26.7	53.5
	adult	33	32.7	32.7	86.1
	older adult	14	13.9	13.9	100.0
	Total	101	100.0	100.0	

Table 2: Frequencies by age range in the Pre-classic sample for K'axob

Frequency Table by Sex for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	40	39.6	39.6	39.6
	female	19	18.8	18.8	58.4
	indeterminate	42	41.6	41.6	100.0
	Total	101	100.0	100.0	

Table 3: Frequencies by sex in the Pre-classic sample for K'axob

Most of the burials date to the late K'atabche'k'ax period (41.6%) with the terminal K'atabche'k'ax (24.8%) and the early K'atabche'k'ax (21.8%) also well represented. In comparison, only 12 burials (11.9%) date to the earlier Chaakk'ax period, combining both the early and later designations (see *Fig.3*). This could be due to a number of factors including possible sampling bias or poor preservation conditions; however, it is likely the smaller sample of burials from the earlier Chaakk'ax period compared to the larger sample from the K'atabche'k'ax is representative of population growth of the settlement through time. K'axob was a smaller settlement early in the Pre-classic, and this is represented by the small sample of burials from the Chaakk'ax period.

Frequency Table by Phase for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	early Chaakk'ax	9	8.9	8.9	8.9
	late Chaakk'ax	3	3.0	3.0	33.7
	early K'atabche'k'ax	22	21.8	21.8	30.7
	late K'atabche'k'ax	42	41.6	41.6	75.2
	terminal K'atabche'k'ax	25	24.8	24.8	100.0
	Total	101	100.0	100.0	

Table 4: Frequencies by phase in the Pre-classic sample for K'axob

Demographic variable summary for Cuello

The Cuello sample includes 149 individual burials attributed to the Pre-classic, although this number seems to vary in the related literature (Robin & Hammond, 1991; Saul & Saul, 1991). Using the Cuello Database, the sample analyzed in this study is 149 individuals. Age ranges for Cuello are defined by Saul & Saul (1991) and followed in the Cuello Database and are considered "very general age categories" as "not to do so would imply a greater accuracy in age determination than is possible with these poorly preserved and fragmentary remains" (Saul & Saul, 1991, 135). Their categorization of 'subadult' is rather broad despite the use of dental aging indicators, and for the purposes of this study, and for simplicity when comparing with the K'axob age ranges, will be grouped into 'child' (0 – 2 years approximately) roughly mirroring Saul & Saul's (1991) category of 'B-4', and 'juvenile' (5 – 18 years approximately) roughly mirroring the remaining 'subadult' categories existing between their designations of 'B-4' and 'young adult' found in Saul & Saul (1991). The addition of 'young adult' (also referred to as 'ya') as separate from both juvenile and adult distinctions is also defined in Saul & Saul (1991) as individuals of approximately 20 to 34 years of age, with the more general 'adult' category encompassing individuals approximately 35 to 54 years of age, and those of about 55+ years designated as ‘older adults’ (Saul & Saul, 1991). These are broad age estimates. Adults make up the largest age category (61.1%) with young adults making up the next largest category (18.1%) and all other categories represented to a lower extent, showing this sample is biased towards adult burials.

Frequency Table by Age Range for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	child	5	3.4	3.4	3.4
	juvenile	20	13.4	13.4	16.8
	ya	27	18.1	18.1	34.9
	adult	91	61.1	61.1	96.0
	older adult	3	2.0	2.0	98.0
	indeterminate	3	2.0	2.0	100.0
	Total	149	100.0	100.0	

Table 5: Frequencies by age range in the Pre-classic sample for Cuello

As with K’axob, the Cuello sample shows a higher percentage of male burials (57%) compared to female burials (13.4%). A substantial percentage (29.5%) are indeterminate sex individuals, meaning they represent either younger individuals or incomplete adult skeletons.

Frequency Table by Sex for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	85	57.0	57.0	57.0
	female	20	13.4	13.4	70.5
	indeterminate	44	29.5	29.5	100.0
	Total	149	100.0	100.0	

Table 6: Frequencies by sex in the Pre-classic sample for Cuello

A similar pattern to K'axob can be seen at Cuello in the number of burials increasing greatly over time as the settlement expanded, with most burials dated to the Cocos Chicanel period, which is further divided into early (34.9%) and late phases (47%), with an additional five individuals lacking in definitive phase associations and thus dated simply as 'late Pre-classic' burials. The Lopez Mamom period (6.7%) and the earliest phase at the site, the combined Swasey-Bladen period (8.1%) are both much less well-represented in the sample supporting the theory of increasing population growth through the Cocos Chicanel period (see *Fig. 4*).

Frequency Table by Phase for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	swasey bladen	4	2.7	2.7	100.0
	bladen	8	5.4	5.4	5.4
	lopez mamom	10	6.7	6.7	97.3
	early cocos Chicanel	52	34.9	34.9	87.2
	cocos Chicanel	70	47.0	47.0	52.3
	late preclassic	5	3.4	3.4	90.6
	Total	149	100.0	100.0	

Table 7: Frequencies by phase in the Pre-classic sample for Cuello

Overall, Cuello had a higher population than K'axob throughout the Pre-classic period (K'axob n=101; Cuello n=149), evidence of a slightly heightened status in the region (McAnany, 2004). Both sites show evidence of expansion over time as seen through the increase in the number of interments in later periods compared to earlier ones, and both seem to be biased towards adult male burials.

Within sample mortuary treatment summary for K'axob

Mortuary treatment variables can be further broken down into grave good variables and burial treatment variables. When exploring mortuary treatment to determine social status differentiation you would expect to see variations between burials. If there was no social status differentiation, then all burials could be expected to show no variations but rather a standardized form. While differentiation is evident, there are also some commonalities. Welsh (1988) noted twenty "Pan Maya" burial customs, although it is worth noting much of his sample came from Classic period sites. A few of his noted patterns include the use of ceramic bowls inverted over the skull in many burials, wealthier individuals being differentiated by burial location, grave good inclusions as uniform throughout the Maya lowlands, that male and female burials contain similar types and amounts of grave goods, and that adults received on average only slightly more or higher quality goods than children (Welsh, 1988). Whether or not these patterns can be expanded to also include Pre-classic burials is debatable, but similar patterns do seem to exist at Pre-classic K'axob and Cuello. For example, burials at both sites contain individuals that were interred with ceramic bowls inverted over their skulls as described by Welsh (1988), making this style a rather common burial type in the Pre-classic as well. Likewise, inclusion of grave goods seems very common place regardless of sex or age categories.

Frequency Table of Grave Goods Present for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	79	78.2	78.2	78.2
	no	22	21.8	21.8	100.0
	Total	101	100.0	100.0	

Table 8: Frequencies of grave goods present in the Pre-classic sample for K'axob

For grave good variables, out of the 101 individuals of the K'axob sample, the majority (78.2%) had some amount of included grave goods, while 22 individuals (21.8%) had no grave goods at all.

As mentioned in Goodman (1998), the presence of grave goods can be divided by type and broadly classified into overarching categories based on assumed function, as either 'utilitarian' or 'exotica', to help distinguish possible social status of the interred. Something classified as utilitarian would be functional items with limited value, such as ceramics, while exotica would be rare and valuable, coming from a distant locale and as such considered an elite item, such as jade or obsidian. For clarity, ceramic items, shell items, and greenstone items are represented in the tables with a '0' for those individuals with none included, and a '1+' for those with one or more items included. This allows a better visualization of the contrast between individuals with and individuals without each type of grave goods. Ceramic items from K'axob are the most commonly found grave good with a majority of the sample (61.4%) having at least one included compared to those without any included (38.6%).

Frequency Table of Ceramics for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	39	38.6	38.6	38.6
	1+	62	61.4	61.4	100.0
	Total	101	100.0	100.0	

Table 9: Frequencies of ceramic items in the Pre-classic sample for K'axob

Shell items are the second most commonly included grave good, although not found in a majority of graves, making shell items more likely to be considered exotica rather than utilitarian material. More burials at K'axob (55.4%) contained no shell compared to those with at least one shell item (44.6%), but the difference is not as huge as expected for an exotica item.

Frequency Table of Shell for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	56	55.4	55.4	55.4
	1+	45	44.6	44.6	100.0
	Total	101	100.0	100.0	

Table 10: Frequencies of shell items in the Pre-classic sample for K'axob

Greenstone items, including jade, however are much rarer and as such conclusively considered exotica, with a majority of burials having none (87.1%) and only 13 individuals having one or more greenstone items (12.9%).

Frequency Table of Greenstone for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	88	87.1	87.1	87.1
	1+	13	12.9	12.9	100.0
	Total	101	100.0	100.0	

Table 11: Frequencies of greenstone items in the Pre-classic sample for K'axob

Obsidian is also an exotic item, found in only one burial (1%) from Pre-classic K'axob. Other items which cannot b easily grouped into these categories and are therefore less informative and not found in most graves (71.3%) with at least one item found in (28.7%). Because of the difficulty in ascribing these goods to a category they will be mentioned but cannot be analyzed further in the parameters of this study.

Frequency Table of Obsidian for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	100	99.0	99.0	99.0
	1+	1	1.0	1.0	100.0
	Total	101	100.0	100.0	

Table 12: Frequencies of obsidian items in the Pre-classic sample for K'axob

For burial treatment variables, burial location, interment type, burial type, and burial position are explored. For K'axob, burial location is more commonly residential (60.4%) compared to public (39.6%). Public burials would likely be more suggestive of heightened social status as residential burials are considered the norm for the Maya.

Frequency Table of Burial Location for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	public	40	39.6	39.6	39.6
	residence	61	60.4	60.4	100.0
	Total	101	100.0	100.0	

Table 13: Frequencies of burial location in the Pre-classic sample for K'axob

Multiple interments are also common (60.4%) compared to single interments (39.6%). Primary burials are only slightly more common (54.5%) than secondary burials (45.5%).

Frequency Table of Burial Type for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	primary	55	54.5	54.5	54.5
	secondary	46	45.5	45.5	100.0
	Total	101	100.0	100.0	

Table 14: Frequencies of burial type in the Pre-classic sample for K'axob

Frequency table of Interment Type for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	single	40	39.6	39.6	39.6
	multiple	61	60.4	60.4	100.0
	Total	101	100.0	100.0	

Table 15: Frequencies of interment type in the Pre-classic sample for K'axob

There is also a significant trend towards single interments being primary burials, and multiple interments being secondary burials, likely due to the disturbance and intentional re-interment of older remains with new burials during additional plaza construction phases (Storey, 2004). This relationship is further supported by a Chi-square of .000 significance, meaning it is not due to random chance.

Burial Type * Interment Type Crosstabulation for K'axob

		Inter Type		
		single	multiple	Total
Burial Type	primary	34	21	55
	secondary	6	40	46
Total		40	61	101

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	24.914[a]	1	.000		
Continuity Correction[b]	22.916	1	.000		
Likelihood Ratio	26.850	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	24.667	1	.000		
N of Valid Cases	101				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 18.22.

b. Computed only for a 2x2 table

Table 16: Crosstabulation and Chi-square of burial type and interment type for K'axob

Burial positions vary extensively, with seven broad categories recognized by this study. Variations and overlap between these exist but groupings are approximate and established by the most closely matching burial position category. When the source lists two positions the first listed is used in this study. Partial/scattered (25.7%), supine extended (24.8%), and bundled (22.8%) are the most common types, with seated (13.9%) and flexed (10.9%) being less common. Two unique types, prone extended (facedown) and inverted seated, each represent one individual (1%) in the sample. These types, being so rare, likely represent the individual's differential status in life (Storey, 2004).

Frequency Table of Burial Position for K’axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	supine extended	25	24.8	24.8	24.8
	prone	1	1.0	1.0	25.7
	partial	26	25.7	25.7	51.5
	bundle	23	22.8	22.8	74.3
	seated	14	13.9	13.9	88.1
	flexed	11	10.9	10.9	99.0
	inverted seated	1	1.0	1.0	100.0
	Total	101	100.0	100.0	

Table 17: Frequencies of burial position in the Pre-classic sample for K’axob

Even from the beginnings of the site in the early Chaakk’ax period, individuals were differentiated by mortuary treatment (Storey, 2004). For example, the prone extended individual from this phase, BUR 1-43, “is one of the most richly accompanied burials at Formative K’axob” (Storey, 2004, 110). He is also one of the earliest burials at the site and as such is likely one of the original founders (Storey, 2004). In addition to his unique burial position, he was also lavishly accompanied with grave goods including two inverted ceramics, one over and one near the skull, a jadeite bead, and numerous shell decorations which were probably at the time of burial an elaborately embroidered robe, a definite marker of higher social status (Storey, 2004). Bundled (95.7%) and partial/scattered (92.3%) make up the only two burial positions associated with secondary burials, with all other burial positions represented entirely by primary burials. These two types are probably indicative of ancestor veneration behaviors.

Within sample mortuary treatment summary for Cuello

Most individuals at Cuello had included grave goods (81.2%) compared to the few without any (18.8%). This dynamic is similar to that seen as K'axob, with only slightly more individuals at K'axob having no included grave goods.

Frequency Table of Grave Goods Present for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	121	81.2	81.2	81.2
	no	28	18.8	18.8	100.0
	Total	149	100.0	100.0	

Table 18: Frequencies of grave goods present in the Pre-classic sample for Cuello

Ceramics were expected to be the most common item, with the majority of burials having one or more (56.4%) compared to those without any included (43.6%). This is less of a difference than seen at K'axob however, where (61.4%) of the burials had at least one included ceramic item compared to those without any included (38.6%). Cuello seems to have more of an even split in representation between individuals with and without ceramic items included.

Frequency Table of Ceramics for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	65	43.6	43.6	43.6
	1+	84	56.4	56.4	100.0
	Total	149	100.0	100.0	

Table 19: Frequencies of ceramic items in the Pre-classic sample for Cuello

Exotica is more common at Cuello than what was observed for K'axob, also suggesting the slightly higher status of Cuello compared to K'axob in the region (McAnany, 2004). However, the majority of burials still did not include exotica. Shell was not found in most of the burials (81.9%), with 27 individuals having one or more shell items (18.1%).

Frequency Table of Shell for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	122	81.9	81.9	81.9
	1+	27	18.1	18.1	100.0
	Total	149	100.0	100.0	

Table 20: Frequencies of shell items in the Pre-classic sample for Cuello

Greenstone items are more abundant at Cuello, found in about a quarter of burials (26.2%) but most do not include any (73.8%). Comparatively, greenstone items at K'axob are found in only (12.9%) of burials with a majority of burials having none (87.1%).

Frequency Table of Greenstone for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	110	73.8	73.8	73.8
	1+	39	26.2	26.2	100.0
	Total	149	100.0	100.0	

Table 21: Frequencies of greenstone items in the Pre-classic sample for Cuello

Likewise, obsidian is also very rare, with only 2 burials (1.3%) containing any compared to the majority without (98.7%). Obsidian is almost unheard of at both sites, found in only one burial (1%), from Pre-classic K'axob and 2 burials (1.3%) at Cuello.

Frequency Table of Obsidian for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	147	98.7	98.7	98.7
	1	2	1.3	1.3	100.0
	Total	149	100.0	100.0	

Table 22: Frequencies of obsidian items in the Pre-classic sample for Cuello

Both greenstone items and obsidian are slightly more represented at Cuello, but both sites show the rarity and likely the prestige value of these exotic items. For other types of uncategorized grave goods, the majority of burials had none (87.2%) compared to one or more items (12.8%).

For Cuello, burial location has an additional category, rubble/fill, representing a likely lower ordinal ranking than the other two categories. Public burial locations are the majority (51%), followed by residential (34.9%), and rubble/fill (14.1%). However, this distribution towards more public burials could be a result of where excavations at Cuello were focused and not necessarily an indication of more higher status individuals in the population. Nevertheless, K'axob shows an opposite trend towards more residential burials compared to public burials.

Frequency Table of Burial Location for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	public	76	51.0	51.0	51.0
	residence	52	34.9	34.9	85.9
	rubble / fill	21	14.1	14.1	100.0
	Total	149	100.0	100.0	

Table 23: Frequencies of burial location in the Pre-classic sample for Cuello

Partial/scattered (22.8%) and bundled (20.1%) represent the most common burial positions, with one unique type, prone extended, being the least represented (2%).

Frequency Table of Burial Position for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	supine extended	20	13.4	13.4	13.4
	prone	3	2.0	2.0	15.4
	partial	34	22.8	22.8	38.3
	bundle	30	20.1	20.1	58.4
	seated	28	18.8	18.8	77.2
	flexed	26	17.4	17.4	94.6
	Indeterminate	8	5.4	5.4	100.0
	Total	149	100.0	100.0	

Table 24: Frequencies of burial position in the Pre-classic sample for Cuello

Primary burial type is more common (57.7%) compared to secondary (42.3%), and multiple interments are more common (54.4%) than single interments (45.6%). This is similar to the pattern at K'axob, although for K'axob the relationship is significant but for Cuello it is not.

Frequency Table of Burial Type for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	primary	86	57.7	57.7	57.7
	secondary	63	42.3	42.3	100.0
	Total	149	100.0	100.0	

Table 25: Frequencies of burial type in the Pre-classic sample for Cuello

Frequency Table of Interment Type for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	single	68	45.6	45.6	45.6
	multiple	81	54.4	54.4	100.0
	Total	149	100.0	100.0	

Table 26: Frequencies of interment type in the Pre-classic sample for Cuello

<u>Between samples mortuary treatment summary</u>

To explore the between sample differences, demographic variables are applied to the above mortuary treatment variables to look for patterns between the sites. To do this the crosstabulation procedure is utilized and Pearson's Chi-square is consulted to see if any significant relationship exists between the variables. For K'axob, 35 males (87.5%) had grave goods present compared to 5 males (12.5%) who had no included grave goods. Females show an even stronger trend towards grave good inclusion, with 18 females (94.7%) having them included compared to only 1 (5.3%) without. For indeterminate sex individuals, 26 (61.9%) had them compared to 16 (38.1%) without. Chi-square shows a significance of .003, indicating a relationship between sex and grave goods present for K'axob.

Grave Goods Present * Sex Crosstabulation for K'axob

			Sex			
			male	female	indeterminate	Total
Grave Goods Present	yes	Count	35	18	26	79
		% within Sex	87.5%	94.7%	61.9%	78.2%
	no	Count	5	1	16	22
		% within Sex	12.5%	5.3%	38.1%	21.8%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.626[a]	2	.003
Likelihood Ratio	12.078	2	.002
Linear-by-Linear Association	7.913	1	.005
N of Valid Cases	101		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.14.

Table 27: Crosstabulation and Chi-square of grave goods present and sex for K'axob

For Cuello the distribution is similar. For males, 70 individuals (82.4%) had included grave goods while 15 (17.6%) had none. Females mirrored the pattern from K'axob almost exactly with 19 individuals (95%) having included grave goods and only 1 (5%) having none. For indeterminate individuals, 32 (72.7%) have grave goods and 12 (27.3%) do not. It's important to note that indeterminate individuals either represent subadults or incomplete adult skeletons, and therefore looking at grave goods by age ranges may be more informative.

Grave Goods Present * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	indeterminate	
Grave Goods Present	yes	Count	70	19	32	121
		% within Sex	82.4%	95.0%	72.7%	81.2%
	no	Count	15	1	12	28
		% within Sex	17.6%	5.0%	27.3%	18.8%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 28: Crosstabulation of grave goods present and sex for Cuello

Looking at both these Pre-classic sample populations combined, 200 individuals (80%) have included grave goods compared to only 50 individuals (20%) without any grave goods.

Frequency Table of Grave Goods Present in Combined Samples

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	200	80.0	80.0	80.0
	no	50	20.0	20.0	100.0
	Total	250	100.0	100.0	

Table 29: Frequencies of grave goods present in the combined Pre-classic samples

For K’axob, females were the most likely to have ceramic items included (89.5%), followed by males (65%), and then indeterminate sex individuals (45.2%). Most males and females from K’axob had included ceramic grave goods, while more indeterminate sex individuals had none. Chi-square of .004 shows this is a significant relationship.

Ceramics * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	Indeterminate	
ceramics	0	Count	14	2	23	39
		% within Sex	35.0%	10.5%	54.8%	38.6%
	1+	Count	26	17	19	62
		% within Sex	65.0%	89.5%	45.2%	61.4%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.164[a]	2	.004
Likelihood Ratio	12.306	2	.002
Linear-by-Linear Association	3.450	1	.063
N of Valid Cases	101		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.34.

Table 30: Crosstabulation and Chi-square of ceramics and sex for K'axob

For shell items, however, females were most likely to have one or more included (57.9%), followed by males (47.5%), and indeterminates (35.7%). The majority of males (52.5%) and indeterminates (64.3%) had no shell items included.

Shell * Sex Crosstabulation for K'axob

			Sex			
			male	female	indeterminate	Total
shell	0	Count	21	8	27	56
		% within Sex	52.5%	42.1%	64.3%	55.4%
	1+	Count	19	11	15	45
		% within Sex	47.5%	57.9%	35.7%	44.6%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 31: Crosstabulation of shell items and sex in the Pre-classic sample for K'axob

Females were also more likely than the other two sex categories to have included greenstone items (21.1%) compared to males (15%) and indeterminates (7.1%). However, the majority of burials across all sex categories had no included greenstone. Obsidian was only found with one individual from K'axob, a male (2.5%).

Greenstone * Sex Crosstabulation for K'axob

			Sex			
			male	female	indeterminate	Total
greenstone	0	Count	34	15	39	88
		% within Sex	85.0%	78.9%	92.9%	87.1%
	1+	Count	6	4	3	13
		% within Sex	15.0%	21.1%	7.1%	12.9%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 32: Crosstabulation of greenstone and sex in the Pre-classic sample for K'axob

Obsidian * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	Indeterminate	
obsidian	0	Count	39	19	42	100
		% within Sex	97.5%	100.0%	100.0%	99.0%
	1+	Count	1	0	0	1
		% within Sex	2.5%	0.0%	0.0%	1.0%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 33: Crosstabulation of obsidian and sex in the Pre-classic sample for K'axob

For Cuello, females also had the highest percentage of included ceramic items (75%), followed by indeterminates (59.1%), and males (50.6%).

Ceramics * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	Indeterminate	
ceramics	0	Count	42	5	18	65
		% within Sex	49.4%	25.0%	40.9%	43.6%
	1+	Count	43	15	26	84
		% within Sex	50.6%	75.0%	59.1%	56.4%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 34: Crosstabulation of ceramics and sex in the Pre-classic sample for Cuello

For shell items, this same pattern continues, with females (40%) having significantly more than the other sex categories compared to indeterminates (18.2%) and males (12.9%). However, the majority of burials across all sex categories lacked included shell. Chi-square shows a significance of .018 for this relationship.

Shell * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	indeterminate	
shell	0	Count	74	12	36	122
		% within Sex	87.1%	60.0%	81.8%	81.9%
	1+	Count	11	8	8	27
		% within Sex	12.9%	40.0%	18.2%	18.1%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.990[a]	2	.018
Likelihood Ratio	6.880	2	.032
Linear-by-Linear Association	1.116	1	.291
N of Valid Cases	149		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.62.

Table 35: Crosstabulation and Chi-square of shell items and sex for Cuello

For greenstone items however, males were more likely to have one or more included (36.5%), followed by females (20%) and indeterminates (9.1%). Most burials did not include greenstone items. Chi-square supports this relationship with a significance level of .003, showing it is not due to random chance.

Greenstone * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	indeterminate	
greenstone	0	Count	54	16	40	110
		% within Sex	63.5%	80.0%	90.9%	73.8%
	1+	Count	31	4	4	39
		% within Sex	36.5%	20.0%	9.1%	26.2%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.703[a]	2	.003
Likelihood Ratio	12.955	2	.002
Linear-by-Linear Association	11.557	1	.001
N of Valid Cases	149		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.23.

Table 36: Crosstabulation and Chi-square of greenstone items and sex for Cuello

For Cuello, obsidian is found in one male (1.2%) and one female (5%) burial, with fewer females represented in the sample making the percentage of obsidian in female burials slightly higher than that found in male burials.

Obsidian * Sex Crosstabulation for Cuello

			Sex			
			male	female	indeterminate	Total
obsidian	0	Count	84	19	44	147
		% within Sex	98.8%	95.0%	100.0%	98.7%
	1+	Count	1	1	0	2
		% within Sex	1.2%	5.0%	0.0%	1.3%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 37: Crosstabulation of obsidian items and sex in the Pre-classic sample for Cuello

For K'axob, all age ranges had a majority of burials with included grave goods compared to those with none.

Grave Goods Present * Age Range Crosstabulation for K'axob

			Age Range					
			child	juvenile	ya	adult	older adult	Total
Grave Goods Present	yes	Count	7	11	20	28	13	79
		% within Age Range	50.0%	84.6%	74.1%	84.8%	92.9%	78.2%
	no	Count	7	2	7	5	1	22
		% within Age Range	50.0%	15.4%	25.9%	15.2%	7.1%	21.8%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 38: Crosstabulation of grave goods present and age range for K'axob

Adults had the highest percentage of included ceramic items (75.8%), followed by young adults (66.7%). Chi-square shows a significance of .013 for this relationship.

Ceramics * Age Range Crosstabulation for K'axob

			Age Range					Total
			child	Juvenile	ya	adult	older adult	
ceramics	0	Count	11	5	9	8	6	39
		% within Age Range	78.6%	38.5%	33.3%	24.2%	42.9%	38.6%
	1+	Count	3	8	18	25	8	62
		% within Age Range	21.4%	61.5%	66.7%	75.8%	57.1%	61.4%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.730[a]	4	.013
Likelihood Ratio	12.813	4	.012
Linear-by-Linear Association	5.878	1	.015
N of Valid Cases	101		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.02.

Table 39: Crosstabulation and Chi-square of ceramics and age range for K'axob

For shell items, older adult burials had the highest percentage included (71.4%) followed by juveniles (53.8%). Chi-square shows a significance of .031 for this relationship.

Shell * Age Range Crosstabulation for K'axob

			Age Range					Total
			child	juvenile	ya	adult	older adult	
shell	0	Count	11	6	19	16	4	56
		% within Age Range	78.6%	46.2%	70.4%	48.5%	28.6%	55.4%
	1+	Count	3	7	8	17	10	45
		% within Age Range	21.4%	53.8%	29.6%	51.5%	71.4%	44.6%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.660[a]	4	.031
Likelihood Ratio	11.038	4	.026
Linear-by-Linear Association	5.924	1	.015
N of Valid Cases	101		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.79.

Table 40: Crosstabulation and Chi-square of shell items and age range for K'axob

Similarly, older adults also have the highest percentage of included greenstone items (28.6%) followed by young adults (18.5%). However, greenstone is absent in the majority of burials across all age categories. Obsidian is only found in one case in an older adult (7.1%).

Greenstone & Age Range Crosstabulation for K'axob

			Age Range					Total
			child	Juvenile	ya	adult	older adult	
greenstone	0	Count	14	12	22	30	10	88
		% within Age Range	100.0%	92.3%	81.5%	90.9%	71.4%	87.1%
	1+	Count	0	1	5	3	4	13
		% within Age Range	0.0%	7.7%	18.5%	9.1%	28.6%	12.9%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 41: Crosstabulation of greenstone and age range in the Pre-classic sample for K'axob

Obsidian * Age Range Crosstabulation for K'axob

			Age Range					Total
			child	Juvenile	ya	adult	older adult	
obsidian	0	Count	14	13	27	33	13	100
		% within Age Range	100.0%	100.0%	100.0%	100.0%	92.9%	99.0%
	1+	Count	0	0	0	0	1	1
		% within Age Range	0.0%	0.0%	0.0%	0.0%	7.1%	1.0%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 42: Crosstabulation of obsidian and age range in the Pre-classic sample for K'axob

For Cuello, all age ranges also had a majority of burials with included grave goods, with the exception of the child age range which had a majority of burials without any included grave goods.

Grave Goods Present * Age Range Crosstabulation for Cuello

		Age Range						Total
		child	juvenile	ya	adult	older adult	indeterminate	
yes	Count	2	14	21	79	3	2	121
	% within Age Range	40.0%	70.0%	77.8%	86.8%	100.0%	66.7%	81.2%
no	Count	3	6	6	12	0	1	28
	% within Age Range	60.0%	30.0%	22.2%	13.2%	0.0%	33.3%	18.8%
Total	Count	5	20	27	91	3	3	149
	% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 43: Crosstabulation of grave goods present and age range for Cuello

Ceramics were included in all older adult burials (100%), followed by a high percentage of adults (57.1%), young adults (55.6%) and juvenile burials (55%), all of which have very similar percentages of burials with included ceramic items. Only the child age range (40%) and indeterminate age individuals (33.3%) had less than half of the burials with included ceramic items.

Ceramics * Age Range Crosstabulation for Cuello

			Age Range						Total
			child	juvenile	Ya	adult	older adult	indeterminate	
ceramics	0	Count	3	9	12	39	0	2	65
		% within Age Range	60.0%	45.0%	44.4%	42.9%	0.0%	66.7%	43.6%
	1+	Count	2	11	15	52	3	1	84
		% within Age Range	40.0%	55.0%	55.6%	57.1%	100.0%	33.3%	56.4%
Total		Count	5	20	27	91	3	3	149
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 44: Crosstabulation of ceramics and age range in the Pre-classic sample for Cuello

Likewise, shell items are also relatively evenly dispersed throughout all age ranges, except for indeterminate age individuals, who had no included shell items. Older adults had the highest percentage (66.7%) followed by the child age range (40%). This is similar to the pattern at K’axob with older adults having the highest percentage of included shell items.

Shell * Age Range Crosstabulation for Cuello

			Age Range						Total
			child	juvenile	ya	adult	older adult	indeterminate	
shell	0	Count	3	15	22	78	1	3	122
		% within Age Range	60.0%	75.0%	81.5%	85.7%	33.3%	100.0%	81.9%
	1+	Count	2	5	5	13	2	0	27
		% within Age Range	40.0%	25.0%	18.5%	14.3%	66.7%	0.0%	18.1%
Total		Count	5	20	27	91	3	3	149
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 45: Crosstabulation of shell and age range in the Pre-classic sample for Cuello

Greenstone is found at the highest percentage with adult burials (35.2%), followed by the child age range (20%). Greenstone is not found in a majority of burials across all age categories. Obsidian is only noted in one young adult burial (3.7%) and one adult burial (1.1%).

Greenstone * Age Range Crosstabulation for Cuello

			Age Range						Total
			child	juvenile	ya	adult	older adult	indeterminate	
greenstone	0	Count	4	19	22	59	3	3	110
		% within Age Range	80.0%	95.0%	81.5%	64.8%	100.0%	100.0%	73.8%
	1+	Count	1	1	5	32	0	0	39
		% within Age Range	20.0%	5.0%	18.5%	35.2%	0.0%	0.0%	26.2%
Total		Count	5	20	27	91	3	3	149
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 46: Crosstabulation of greenstone and age range in the Pre-classic sample for Cuello

Obsidian * Age Range Crosstabulation for Cuello

			Age Range						Total
			child	juvenile	ya	adult	older adult	indeterminate	
obsidian	0	Count	5	20	26	90	3	3	147
		% within Age Range	100.0%	100.0%	96.3%	98.9%	100.0%	100.0%	98.7%
	1+	Count	0	0	1	1	0	0	2
		% within Age Range	0.0%	0.0%	3.7%	1.1%	0.0%	0.0%	1.3%
Total		Count	5	20	27	91	3	3	149
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 47: Crosstabulation of obsidian and age range in the Pre-classic sample for Cuello

For K’axob, grave goods were found at the highest inclusion during the early Chaakk’ax period (88.9%) yet remained included in the majority of burials throughout the Pre-classic, with the most found with late K’atabche’k’ax burials.

Grave Goods Present * time period Crosstabulation for K'axob

			time period					Total
			early Chaakk'ax	late Chaakk'ax	early K'atabche' k'ax	late K'atabche' k'ax	terminal K'atabche' k'ax	
Grave Goods Present	yes	Count	8	2	14	37	18	79
		% within time period	88.9%	66.7%	63.6%	88.1%	72.0%	78.2%
	no	Count	1	1	8	5	7	22
		% within time period	11.1%	33.3%	36.4%	11.9%	28.0%	21.8%
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 48: Crosstabulation of grave goods and phase in the Pre-classic sample for K'axob

Ceramic items occurred in the highest percentage in the late K'atabche'k'ax period (78.6%), followed by the late Chaakk'ax (66.7%), and the terminal K'atabche'k'ax (64%). The early Chaakk'ax and the early K'atabche'k'ax were the only periods where a higher percentage of burials contained no included ceramics compared to those burials including ceramic items.

Ceramics * time period Crosstabulation for K'axob

			time period					
			early Chaakk'ax	late Chaakk'ax	early K'atabche'k 'ax	late K'atabche'k 'ax	terminal K'atabche'k 'ax	Total
ceramics	0	Count	8	1	12	9	9	39
		% within time period	88.9%	33.3%	54.5%	21.4%	36.0%	38.6%
	1+	Count	1	2	10	33	16	62
		% within time period	11.1%	66.7%	45.5%	78.6%	64.0%	61.4%
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 49: Crosstabulation of ceramics and phase in the Pre-classic sample for K'axob

Shell items were included in the highest percentage in the early Chaakk'ax (77.8%) and decreased in inclusion in burials steadily over time to only (20%) in the terminal K'atabche'k'ax.

Shell * time period Crosstabulation for K'axob

			time period					Total
			early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	
shell	0	Count	2	1	9	24	20	56
		% within time period	22.2%	33.3%	40.9%	57.1%	80.0%	55.4%
	1+	Count	7	2	13	18	5	45
		% within time period	77.8%	66.7%	59.1%	42.9%	20.0%	44.6%
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 50: Crosstabulation of shell and phase in the Pre-classic sample for K'axob

Greenstone however has the highest percentage included associated with the terminal K'atabche'k'ax (28%), with the late K'atabche'k'ax burials having pointedly less included greenstone items included (9.5%) despite having the largest population of any Pre-classic time period at the site. The Chaakk'ax period burials contain no included greenstone items at all. Obsidian is only found in a single burial from the late K'atabche'k'ax (2.4%). This shows a shift in the type of grave goods included over time.

Greenstone * time period Crosstabulation for K'axob

			time period					
			early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	Total
greenstone	0	Count	9	3	20	38	18	88
		% within time period	100.0%	100.0%	90.9%	90.5%	72.0%	87.1%
	1+	Count	0	0	2	4	7	13
		% within time period	0.0%	0.0%	9.1%	9.5%	28.0%	12.9%
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 51: Crosstabulation of greenstone and phase in the Pre-classic sample for K'axob

Obsidian * time period Crosstabulation for K'axob

			time period					
			early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	Total
obsidian	0	Count	9	3	22	41	25	100
		% within time period	100.0%	100.0%	100.0%	97.6%	100.0%	99.0%
	1+	Count	0	0	0	1	0	1
		% within time period	0.0%	0.0%	0.0%	2.4%	0.0%	1.0%
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 52: Crosstabulation of obsidian and phase in the Pre-classic sample for K'axob

For Cuello, grave goods were present to a high percentage throughout all Pre-classic time periods, with all burials from the Bladen period (100%) and the late Pre-classic period (100%) including grave goods.

Grave Goods Present * time period Crosstabulation for Cuello

			time period						
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	Total
Grave Goods Present	yes	Count	3	8	7	45	53	5	121
		% within time period	75.0%	100.0%	70.0%	86.5%	75.7%	100.0%	81.2%
	no	Count	1	0	3	7	17	0	28
		% within time period	25.0%	0.0%	30.0%	13.5%	24.3%	0.0%	18.8%
Total		Count	4	8	10	52	70	5	149
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 53: Crosstabulation of grave goods present and phase for Cuello

The Bladen period also shows the highest percentage of burials including ceramic items (87.5%), followed by the late Pre-classic (80%) and the Lopez Mamom (60%). The early Cocos Chicanel period is the only time period without ceramics occurring in a majority of burials.

Ceramics * time period Crosstabulation for Cuello

			time period						Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
ceramics	0	Count	2	1	4	28	29	1	65
		% within time period	50.0%	12.5%	40.0%	53.8%	41.4%	20.0%	43.6%
	1+	Count	2	7	6	24	41	4	84
		% within time period	50.0%	87.5%	60.0%	46.2%	58.6%	80.0%	56.4%
Total		Count	4	8	10	52	70	5	149
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 54: Crosstabulation of ceramics and phase for Cuello

Shell items were most common in the earlier periods, with the highest percentage found during the Lopez Mamom period (70%) followed by the Bladen (62.5%) and the Swasey-Bladen (50%). This is an interesting trend because shell items become rather uncommon after the Lopez Mamom period, occurring in only (11.5%) from the early Cocos Chicanel, (10%) from the late Cocos Chicanel, and occurring in no burials associated with the late Pre-classic. This decrease over time is also seen at K’axob, although there it occurs more gradually throughout the Pre-classic.

Shell * time period Crosstabulation for Cuello

			time period						Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
shell	0	Count	2	3	3	46	63	5	122
		% within time period	50.0%	37.5%	30.0%	88.5%	90.0%	100.0%	81.9%
	1+	Count	2	5	7	6	7	0	27
		% within time period	50.0%	62.5%	70.0%	11.5%	10.0%	0.0%	18.1%
Total		Count	4	8	10	52	70	5	149
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 55: Crosstabulation of shell items and phase for Cuello

Greenstone items are most common in burials dated to the early Cocos Chicanel (42.3%) followed by the Bladen period (37.5%) and the Lopez Mamom (20%). Greenstone is not observed in the Swasey-Bladen or the late Pre-classic. Obsidian is only associated with two burials from the Cocos Chicanel period (2.9%). Again, the types of grave goods included seem to shift throughout time.

Greenstone * time period Crosstabulation for Cuello

			time period						Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
green stone	0	Count	4	5	8	30	58	5	110
		% within time period	100.0%	62.5%	80.0%	57.7%	82.9%	100.0%	73.8%
	1+	Count	0	3	2	22	12	0	39
		% within time period	0.0%	37.5%	20.0%	42.3%	17.1%	0.0%	26.2%
Total		Count	4	8	10	52	70	5	149
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 56: Crosstabulation of greenstone items and phase for Cuello

Obsidian * time period Crosstabulation for Cuello

			time period						
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	Total
obsidian	0	Count	4	8	10	52	68	5	147
		% within time period	100.0%	100.0%	100.0%	100.0%	97.1%	100.0%	98.7%
	1+	Count	0	0	0	0	2	0	2
		% within time period	0.0%	0.0%	0.0%	0.0%	2.9%	0.0%	1.3%
Total		Count	4	8	10	52	70	5	149
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 57: Crosstabulation of obsidian and phase for Cuello

For K’axob, residential burials are more common than public burials across all sex categories, with indeterminate burials having the highest percentage (66.7%) of residential compared to public (33.3%). Females had the next highest representation of residential burials (63.2%) compared to public (36.8%). This high percentage of indeterminate burials associated with residential burial location could be due to the inclusion of subadults in this sex category. The difference between residential and public burials is less defined for males, with slightly more representation in residential burials (52.5%) compared with public burials (47.5%). However, this also shows that males are more representative of public burials than the other sex categories.

Burial Location * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	indeterminate	
Burial Location	public	Count	19	7	14	40
		% within Sex	47.5%	36.8%	33.3%	39.6%
	residence	Count	21	12	28	61
		% within Sex	52.5%	63.2%	66.7%	60.4%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 58: Crosstabulation of burial location and sex for K'axob

For males, all burial positions are represented, but bundled was the most common, representing a quarter of the male burial sample (25%), followed by partial/scattered (22.5%). The two unique burial types, prone extended and inverted seated, are also only represented by males (2.5%). For females, supine extended is the most common position (36.8%), followed by both bundled and seated types evenly represented (21.1%). Indeterminates are most commonly partial/scattered (38.1%), followed by supine extended (23.8%).

Burial Position * Sex Crosstabulation for K'axob

			Sex			
			male	female	indeterminate	Total
Burial Position	supine extended	Count	8	7	10	25
		% within Sex	20.0%	36.8%	23.8%	24.8%
	prone	Count	1	0	0	1
		% within Sex	2.5%	0.0%	0.0%	1.0%
	partial	Count	9	1	16	26
		% within Sex	22.5%	5.3%	38.1%	25.7%
	bundle	Count	10	4	9	23
		% within Sex	25.0%	21.1%	21.4%	22.8%
	seated	Count	5	4	5	14
		% within Sex	12.5%	21.1%	11.9%	13.9%
	flexed	Count	6	3	2	11
		% within Sex	15.0%	15.8%	4.8%	10.9%
	inverted seated	Count	1	0	0	1
		% within Sex	2.5%	0.0%	0.0%	1.0%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 59: Crosstabulation of burial position and sex for K'axob

For burial type, females are more often primary burials (78.9%) compared to secondary burials (21.1%). This pattern also applies to males, although it is a more even divide, with slightly more males being primary burials (52.5%) compared to secondary burials (47.5%). Indeterminates show an opposite pattern however, being more likely to be secondary (54.8%) compared to primary (45.2%). This could be due to the percentage also occurring as partial/scattered remains (38.1%) as well as the process of selectively collecting certain bones to represent an individual in a secondary burial as part of the ancestor veneration process, perhaps excluding bones more diagnostic of sex (Storey, 2004). Chi-square shows a significance level of .047 for the variables of sex and burial type, suggesting the pattern is not due to random chance.

Burial Type * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	Indeterminate	
Burial Type	primary	Count	21	15	19	55
		% within Sex	52.5%	78.9%	45.2%	54.5%
	secondary	Count	19	4	23	46
		% within Sex	47.5%	21.1%	54.8%	45.5%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.096[a]	2	.047
Likelihood Ratio	6.461	2	.040
Linear-by-Linear Association	.465	1	.495
N of Valid Cases	101		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.65.

Table 60: Crosstabulation and Chi-square of burial type and sex for K'axob

For interment type, multiple interments were more common in all sex categories compared to single interments, with indeterminate sex individuals having the highest percentage of multiple interments (66.7%) compared to single interments (33.3%). For females, multiple interments were also more likely (63.2%) in comparison to single interments (36.8%). This pattern continues in males, but to a lesser a degree, with multiple interments slightly more represented (52.5%) compared to single interments (47.5%).

Interment Type * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	Indeterminate	
Inter Type	single	Count	19	7	14	40
		% within Sex	47.5%	36.8%	33.3%	39.6%
	multiple	Count	21	12	28	61
		% within Sex	52.5%	63.2%	66.7%	60.4%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 61: Crosstabulation of interment type and sex for K'axob

For Cuello, public burial location is most common across all sex categories. For males, most burials are public (55.3%) compared to female public burials (50%) and indeterminate sex public burials (43.2%). This is completely opposite of the norm from K'axob, where residential burials are more common than public burials across all sex categories. For Cuello, indeterminate sex individuals were more likely to be residential (36.4%) compared to females (35%) and males (34.1%). Indeterminates were also more likely to be rubble/fill type (20.5%) compared to females (15%) and males (10.6%). If public burial location is ordinally ranked higher than residential burial location, than the difference in normative burial locations between K'axob and Cuello is further indicative of Cuello's possible slightly higher standing in the region. However, the location of excavations at Cuello could be one explanation for this difference between the sites.

Burial Location * Sex Crosstabulation for Cuello

			Sex			Total
			Male	female	indeterminate	
Burial Location	public	Count	47	10	19	76
		% within Sex	55.3%	50.0%	43.2%	51.0%
	residence	Count	29	7	16	52
		% within Sex	34.1%	35.0%	36.4%	34.9%
	rubble / fill	Count	9	3	9	21
		% within Sex	10.6%	15.0%	20.5%	14.1%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 62: Crosstabulation of burial location and sex for Cuello

For burial position, partial/scattered is the most common, with (22.8%) overall in this category. Males were most likely to be bundled (27.1%) followed by partial/scattered (25.9%). Interestingly, females were most likely to be found in the flexed position (35%) followed by both supine extended (25%) and seated (25%). Indeterminates are more commonly partial/scattered (25%), again possibly due to the act of intentional curation or selection of certain bones over others and the lack of inclusion of bones typically used in sexing the skeleton. The unique prone position is found in three individuals from Cuello, two males (2.4%) and one female (5%), in contrast to the single male from K'axob in this position.

Burial Position * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	indeterminate	
Burial Position	supine extended	Count	9	5	6	20
		% within Sex	10.6%	25.0%	13.6%	13.4%
	Prone	Count	2	1	0	3
		% within Sex	2.4%	5.0%	0.0%	2.0%
	Partial	Count	22	1	11	34
		% within Sex	25.9%	5.0%	25.0%	22.8%
	Bundle	Count	23	1	6	30
		% within Sex	27.1%	5.0%	13.6%	20.1%
	Seated	Count	17	5	6	28
		% within Sex	20.0%	25.0%	13.6%	18.8%
	Flexed	Count	11	7	8	26
		% within Sex	12.9%	35.0%	18.2%	17.4%
	Indeterminate	Count	1	0	7	8
		% within Sex	1.2%	0.0%	15.9%	5.4%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 63: Crosstabulation of burial position and sex for Cuello

For burial type, females were much more likely to be primary (90%) compared to secondary (10%). This pattern also exists at K'axob, with more females being primary (78.9%) compared to secondary (21.1%). For Cuello, indeterminates also continue this pattern of primary (59.1%) over secondary (40.9%). However, for K'axob, indeterminate sex individuals were more likely to be secondary (54.8%) over primary (45.2%). Males from Cuello however, show an opposite pattern, with slightly more being secondary (50.6%) compared to primary (49.4%), but this is a rather even split. At K'axob, males were more commonly primary (52.5%) compared to secondary (47.5%), but again this is not much of a difference. It seems apparent males at both sites tend to have a rather even distribution between both primary and secondary burials in comparison to other sex categories where the divide is more prominent. For Cuello, the variables of sex and burial type show a Chi-square significance level of .004, indicating there is a relationship here. These variables at K'axob also show a significant relationship.

Burial Type * Sex Crosstabulation for Cuello

			Sex			
			Male	female	Indeterminate	Total
Burial Type	primary	Count	42	18	26	86
		% within Sex	49.4%	90.0%	59.1%	57.7%
	secondary	Count	43	2	18	63
		% within Sex	50.6%	10.0%	40.9%	42.3%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.978[a]	2	.004
Likelihood Ratio	12.632	2	.002
Linear-by-Linear Association	2.031	1	.154
N of Valid Cases	149		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.46.

Table 64: Crosstabulation and Chi-square of burial type and sex for Cuello

For interment type, males were more commonly multiple interments (64.7%) compared to single interments (35.3%). Females and indeterminates show the opposite patterning however, with females being more likely to be single interments (60%) compared to multiple (40%), and indeterminates being more likely to be single (59.1%) over multiple (40.9%). Chi-square significance level shows .014, indicating a relationship between these variables. Interestingly, K'axob showed a preference to multiple interments over all sex categories.

Interment Type * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	Indeterminate	
Inter Type	single	Count	30	12	26	68
		% within Sex	35.3%	60.0%	59.1%	45.6%
	multiple	Count	55	8	18	81
		% within Sex	64.7%	40.0%	40.9%	54.4%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.538[a]	2	.014
Likelihood Ratio	8.595	2	.014
Linear-by-Linear Association	7.361	1	.007
N of Valid Cases	149		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.13.

Table 65: Crosstabulation and Chi-square of interment type and sex for Cuello

For burial location at K'axob, all age ranges are represented across both location categories. As expected, all age categories were found more likely to be residential, as is the norm for Maya burials. The only age range that did not meets this expectation was the young adult category, which was more likely to be public (63%) compared to residential (37%). Chi-square for these variables shows a significance level of .011.

Burial Location * Age Range Crosstabulation for K'axob

			Age Range					Total
			child	juvenile	ya	adult	older adult	
Burial Location	Public	Count	2	2	17	13	6	40
		% within Age Range	14.3%	15.4%	63.0%	39.4%	42.9%	39.6%
	residence	Count	12	11	10	20	8	61
		% within Age Range	85.7%	84.6%	37.0%	60.6%	57.1%	60.4%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.162[a]	4	.011
Likelihood Ratio	14.005	4	.007
Linear-by-Linear Association	3.299	1	.069
N of Valid Cases	101		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.15.

Table 66: Crosstabulation and Chi-square of burial location and age range for K'axob

The adult age category is more likely to be the supine extended position (33.3%), followed by juveniles in this position (30.8%), and then older adults (28.6%). The child age range is most commonly partial/scattered (42.9%) followed by young adults (40.7%). Older adults are most commonly in the bundled position (35.7%). Both of the unique burial positions are each represented by young adults (3.7%).

Burial Position * Age Range Crosstabulation for K'axob

		Age Range					Total
		child	juvenile	ya	adult	older adult	
supine extended	Count	2	4	4	11	4	25
	% within Age Range	14.3%	30.8%	14.8%	33.3%	28.6%	24.8%
prone	Count	0	0	1	0	0	1
	% within Age Range	0.0%	0.0%	3.7%	0.0%	0.0%	1.0%
partial	Count	6	4	11	5	0	26
	% within Age Range	42.9%	30.8%	40.7%	15.2%	0.0%	25.7%
bundle	Count	3	4	5	6	5	23
	% within Age Range	21.4%	30.8%	18.5%	18.2%	35.7%	22.8%
seated	Count	2	1	2	6	3	14
	% within Age Range	14.3%	7.7%	7.4%	18.2%	21.4%	13.9%
flexed	Count	1	0	3	5	2	11
	% within Age Range	7.1%	0.0%	11.1%	15.2%	14.3%	10.9%
inverted seated	Count	0	0	1	0	0	1
	% within Age Range	0.0%	0.0%	3.7%	0.0%	0.0%	1.0%
Total	Count	14	13	27	33	14	101
	% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 67: Crosstabulation of burial position and age range for K'axob

All age range categories are represented in both primary and secondary interments. For secondary burial categories, juveniles and young adults were more common than primary burials, with juvenile secondary burials more common (61.5%) than primary burials (38.5%), and young adult secondary burials more common (59.3%) compared to primary burials (40.7%). The opposite exists for adult and older adult burials, where primary is more common than secondary burials. Adult primary burials were more common (66.7%) compared to secondary burials (33.3%), while primary burials for older adults were more common (71.4%) compared to secondary burials (28.6%). The child age range was evenly represented across both burials types (50%).

Burial Type * Age Range Crosstabulation for K'axob

			Age Range					Total
			child	juvenile	ya	adult	older adult	
Burial Type	primary	Count	7	5	11	22	10	55
		% within Age Range	50.0%	38.5%	40.7%	66.7%	71.4%	54.5%
	secondary	Count	7	8	16	11	4	46
		% within Age Range	50.0%	61.5%	59.3%	33.3%	28.6%	45.5%
Total		Count	14	13	27	33	14	101
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 68: Crosstabulation of burial type and age range for K'axob

For interment type, multiple interment was more common overall (60.4%) compared to single (39.6%), with all age ranges were more commonly multiple interments except for older adults which were evenly represented between both interment types (50%). Juveniles had the highest percentage of multiple interments (84.6%) compared to single interments (15.4%), followed by young adult multiple interments (66.7%) compared to single (33.3%). Adults were only slightly more likely to be multiple interments (51.5%) compared to single interments (48.5%), but this is hardly a difference.

Inter Type * Age Range Crosstabulation for K’axob

		Age Range					Total
		child	juvenile	ya	adult	older adult	
Single	Count	6	2	9	16	7	40
	% within Age Range	42.9%	15.4%	33.3%	48.5%	50.0%	39.6%
Multi	Count	8	11	18	17	7	61
	% within Age Range	57.1%	84.6%	66.7%	51.5%	50.0%	60.4%
Total	Count	14	13	27	33	14	101
	% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 69: Crosstabulation of interment type and age range for K’axob

For Cuello burial location by age range, the child age category was more likely to be residential (80%) compared to public (20%), as were young adults more likely to be residential (63%) compared to public (29.6%). Interestingly, juveniles were more likely to be public (45%) followed by rubble/fill (30%) and residential (25%). Adults were also more likely to be public (60.4%) compared to residential (27.5%), as were older adults also more likely to be public (66.7%) than residential (33.3%). Overall, public burials were the norm (51%) compared to residential (34.9%) and rubble/fill (14.1%). However, K’axob was the opposite, with residential location being the most common across all age categories save for young adults, which were more likely to be public (63%) compared to residential (37%), also an opposite pattern to the one seen at Cuello where young adults were more likely to be residential than public. It is typical of the ancient Maya to inter their ancestors within the walls and floors of their occupied residences, and so a trend towards more public burials suggests the heightened social status of these individuals and perhaps adds to the evidence that Cuello is of a slightly higher regional status than K'axob (McAnany, 2004; Hammond, 1991).

Burial Location * Age Range Crosstabulation for Cuello

		Age Range						Total
		child	juvenile	ya	adult	older adult	indeterminate	
public	Count	1	9	8	55	2	1	76
	% within Age Range	20.0%	45.0%	29.6%	60.4%	66.7%	33.3%	51.0%
residence	Count	4	5	17	25	1	0	52
	% within Age Range	80.0%	25.0%	63.0%	27.5%	33.3%	0.0%	34.9%
rubble / fill	Count	0	6	2	11	0	2	21
	% within Age Range	0.0%	30.0%	7.4%	12.1%	0.0%	66.7%	14.1%
Total	Count	5	20	27	91	3	3	149
	% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 70: Crosstabulation of burial location and age range for Cuello

For burial position by age range at Cuello, the partial/scattered position was the most common overall, with the child category (40%), the young adult category (33.3%), and indeterminate individuals (33.3%) most representative of this type. The bundled category is the next most common overall at Cuello, with the majority of adult burials (27.5%) in this position. The only other age category found in the bundled position is young adults (18.5%). The juvenile category is more commonly flexed (30%), while the older adult category is more commonly supine extended (66.7%) and flexed (33.3%). Older adults are found in no other burial positions. The unique prone position is represented by one juvenile (5%) and two young adults (7.4%).

Burial Position * Age Range Crosstabulation for Cuello

		Age Range						Total
		child	juvenile	ya	adult	older adult	Indeterm	
supine extended	Count	0	4	4	10	2	0	20
	% within Age Range	0.0%	20.0%	14.8%	11.0%	66.7%	0.0%	13.4%
prone	Count	0	1	2	0	0	0	3
	% within Age Range	0.0%	5.0%	7.4%	0.0%	0.0%	0.0%	2.0%
partial	Count	2	3	9	19	0	1	34
	% within Age Range	40.0%	15.0%	33.3%	20.9%	0.0%	33.3%	22.8%
bundle	Count	0	0	5	25	0	0	30
	% within Age Range	0.0%	0.0%	18.5%	27.5%	0.0%	0.0%	20.1%
seated	Count	0	5	3	20	0	0	28
	% within Age Range	0.0%	25.0%	11.1%	22.0%	0.0%	0.0%	18.8%
flexed	Count	2	6	4	13	1	0	26
	% within Age Range	40.0%	30.0%	14.8%	14.3%	33.3%	0.0%	17.4%
Indeterminate	Count	1	1	0	4	0	2	8
	% within Age Range	20.0%	5.0%	0.0%	4.4%	0.0%	66.7%	5.4%
Total	Count	5	20	27	91	3	3	149
	% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 71: Crosstabulation of burial position and age range for Cuello

For burial type, primary (57.7%) is slightly more represented overall than secondary (42.3%), a pattern that was also found at K'axob. Only two age categories are more commonly found to be secondary. The child age range is more likely to be secondary (60%) over primary (40%), as is the young adult category more likely to be secondary (55.6%) over primary (44.4%). Juveniles are more likely to be primary (85%) than secondary (15%), as are adults more likely to be primary (54.9%) over secondary (45.1%). Older adults are represented entirely by primary burials (100%).

Burial Type * Age Range Crosstabulation for Cuello

			Age Range						Total
			child	juvenile	ya	adult	older adult	indeterminate	
Burial Type	primary	Count	2	17	12	50	3	2	86
		% within Age Range	40.0%	85.0%	44.4%	54.9%	100.0%	66.7%	57.7%
	secondary	Count	3	3	15	41	0	1	63
		% within Age Range	60.0%	15.0%	55.6%	45.1%	0.0%	33.3%	42.3%
Total		Count	5	20	27	91	3	3	149
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 72: Crosstabulation of burial type and age range for Cuello

Interment type for Cuello is slightly more likely overall to be multiple (54.4%) compared to single (45.6%). This pattern also exists at K'axob. For Cuello, single interment of the child age range (60%), the juvenile age range (85%), and older adult age range (66.7%) are more common, while multiple interment is most common in young adults (63%) and adults (62.6%). Juveniles have the highest percentage of single interments (85%) compared to multiple interments (15%), an equal yet completely opposite pattern to the one at K'axob, where juveniles had the highest percentage of multiple interments (84.6%) compared to single (15.4%).

Inter Type * Age Range Crosstabulation for Cuello

			Age Range						Total
			child	juvenile	ya	adult	older adult	indeterm	
Inter Type	single	Count	3	17	10	34	2	2	68
		% within Age Range	60.0%	85.0%	37.0%	37.4%	66.7%	66.7%	45.6%
	multiple	Count	2	3	17	57	1	1	81
		% within Age Range	40.0%	15.0%	63.0%	62.6%	33.3%	33.3%	54.4%
Total		Count	5	20	27	91	3	3	149
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 73: Crosstabulation of interment type and age range for Cuello

For K'axob, residential burials remained the dominant burial location throughout the Pre-classic until the terminal K'atabche'k'ax period, when public burials replaced them at a higher percentage (80%) compared to residential (20%). This phase has the second highest population and so this shift in burial location from the previous norm is interesting. The preceding period, the late K'atabche'k'ax, had the highest population of any phase in the Pre-classic, 42 individuals in total, with residential burials representing the norm (71.4%) compared to public burials (28.6%). In fact, residential burials represent all of the burials from the early Chaakk'ax (100%), and the majority from the late Chaakk'ax (66.7%) compared to public (33.3%), which is represented by one individual, the earliest public burial depicted from this site. It is only in the terminal K'atabche'k'ax that we see a deviation from the typical preference for residential burial location, although these still occur to a lesser extent.

Burial Location * time period Crosstabulation for K'axob

			time period					
			early Chaakk'ax	late Chaakk'ax	early K'atabche' k'ax	late K'atabche' k'ax	terminal K'atabche' k'ax	Total
Burial Location	public	Count	0	1	7	12	20	40
		% within time period	0.0%	33.3%	31.8%	28.6%	80.0%	39.6 %
	residen ce	Count	9	2	15	30	5	61
		% within time period	100.0%	66.7%	68.2%	71.4%	20.0%	60.4 %
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %

Table 74: Crosstabulation of burial location and phase for K'axob

Most individuals from the Chaakk'ax period were supine extended, from the early Chaakk'ax (44.4%) and from the late Chaakk'ax (66.7%). The early Chaakk'ax also had an even representation of partial/scattered individuals (44.4%) and the lone unique burial of the prone extended individual (11.1%), possibly an early founder of the site due to his unusual mortuary treatment (Storey, 2004). The late Chaakk'ax saw no unique burials types nor partial/scattered type but introduced the bundled position (33.3%). This position in combination with the supine extended make up the only two burial position variations from the late Chaakk'ax. The early K'atabche'k'ax saw increasing population as well as increasing mortuary elaboration as shown through new variations in burial position. This could also be interpreted as evidence of increasing social complexity, with which also comes increasing social status differentiation (Goodman, 1998). The early K'atabche'k'ax saw the increase of partial/scattered burials (36.4%) over all other burial types, which is highly suggestive of the act of ancestor veneration, followed by supine extended (31.8%) which has remained popular. The introduction of two new types also coincides with this period, seated (18.2%) and flexed (4.5%). Both of these types increase in use in the late K'atabche'k'ax, especially flexed (19%). Population also increases to the maximum for the Pre-classic at this site, with bundled (31%) and seated (21.4%) positions having the highest representation. The prominence of seated and flexed burial types "would have allowed ritual display and long-term preservation of corpses indicates the increasingly central role of the deceased in structuring the lives of the living" (McAnany, Storey, & Lockard, 1999, 144). Likewise, the popularity of the bundled burial position is reminiscent of the mummy bundles of the Recuay of Peru, who used this burial position in order to easily display and transport ancestors to feasts and other rituals of veneration (Lau, 2002). The other unique burial position, inverted seated, is also from this time period. The terminal K'atabche'k'ax sees seated and flexed positions decrease in use, with partial/scattered (40%) and bundle (28%) becoming more prominent.

Burial Position * time period Crosstabulation for K'axob

		time period					Total
		early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	
supine extended	Count	4	2	7	7	5	25
	% within time period	44.4%	66.7%	31.8%	16.7%	20.0%	24.8%
prone	Count	1	0	0	0	0	1
	% within time period	11.1%	0.0%	0.0%	0.0%	0.0%	1.0%
partial	Count	4	0	8	4	10	26
	% within time period	44.4%	0.0%	36.4%	9.5%	40.0%	25.7%
bundle	Count	0	1	2	13	7	23
	% within time period	0.0%	33.3%	9.1%	31.0%	28.0%	22.8%
seated	Count	0	0	4	9	1	14
	% within time period	0.0%	0.0%	18.2%	21.4%	4.0%	13.9%
flexed	Count	0	0	1	8	2	11
	% within time period	0.0%	0.0%	4.5%	19.0%	8.0%	10.9%
inverted seated	Count	0	0	0	1	0	1
	% within time period	0.0%	0.0%	0.0%	2.4%	0.0%	1.0%
Total	Count	9	3	22	42	25	101
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 75: Crosstabulation of burial position and phase for K'axob

Burial type in the Chaakk'ax is more commonly primary (66.7%) compared to secondary (33.3%) across both early and late distinctions. This pattern continues in the early K'atabche'k'ax with primary more common (63.6%) compared to secondary (36.4%), and in the late K’atabche’k’ax with primary remaining a higher percentage of burials (59.5%) compared to secondary (40.5%). Secondary type burials increase in frequency slightly each time period, but primary burials remain the norm until the terminal K’atabche’k’ax which sees a dramatic shift in this pattern, with secondary burials abruptly ascending to the majority (68%) compared to primary (32%). Secondary type burials are more distinctive of acts of ancestor veneration and the continued care and curation of the remains of kin members through time, so this increase in secondary burials could possibly display an equal increase in both population as well as in ancestor veneration behaviors.

Burial Type * time period Crosstabulation for K’axob

			time period					
			early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	Total
Burial Type	primary	Count	6	2	14	25	8	55
		% within time period	66.7%	66.7%	63.6%	59.5%	32.0%	54.5%
	secondary	Count	3	1	8	17	17	46
		% within time period	33.3%	33.3%	36.4%	40.5%	68.0%	45.5%
Total		Count	9	3	22	42	25	101
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 76: Crosstabulation of burial type and phase for K’axob

As follows with the change in burial type through time, an equivalent and concurrent shift in interment type is expected. Single interments were the majority (55.6%) compared to multiple interments (44.4%) during the early Chaakk’ax, a difference but not a huge contrast in preference. However, the late Chaakk’ax saw only single burials (100%), with the early K’atabche’k’ax showing an even distribution between single and multiple interments (50%).

This pattern shifts with the late K'atabche'k'ax, with multiple interments becoming the major type (66.7%) compared to single interments (33.3%), and the terminal K'atabche'k'ax saw this preference grow, with a majority of multiple interments (72%) compared to single interments (28%). As seen with burial type, interment type shows a shift through time towards secondary and multiple type burials, both of which are indicative of acts of ancestor veneration, as well as a growing village population, both living and deceased, with secondary burials and multiple interments increasing as residences expanded and construction phases and new burials disrupted and reinterred the previously buried.

Inter Type * time period Crosstabulation for K'axob

		time period					
		early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	Total
single	Count	5	3	11	14	7	40
	% within time period	55.6%	100.0%	50.0%	33.3%	28.0%	39.6%
multiple	Count	4	0	11	28	18	61
	% within time period	44.4%	0.0%	50.0%	66.7%	72.0%	60.4%
Total	Count	9	3	22	42	25	101
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 77: Crosstabulation of interment type and phase for K'axob

For Cuello, burial location was exclusively residential during the earlier periods of the site, with (100%) of burials dated to the Swasey-Bladen, Bladen, and Lopez Mamom periods being residential in location. A shift occurred during the early Cocos Chicanel, with the majority of burials being public (65.4%) compared to residential (34.6%). In the Cocos Chicanel, public burials remained the majority (58.6%) compared to residential (17.1%) and now also include rubble/fill (24.3%) as a third category. The late Pre-classic included no residential burials, and a majority of rubble/fill burials (80%) compared to public (20%). For K'axob residential burials were the norm throughout the Pre-classic, with public burials only ascending to the majority during the terminal K'atabche'k'ax.

Burial Location * time period Crosstabulation for Cuello

		time period						Total
		swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
public	Count	0	0	0	34	41	1	76
	% within time period	0.0%	0.0%	0.0%	65.4%	58.6%	20.0%	51.0%
residence	Count	4	8	10	18	12	0	52
	% within time period	100.0%	100.0%	100.0%	34.6%	17.1%	0.0%	34.9%
rubble / fill	Count	0	0	0	0	17	4	21
	% within time period	0.0%	0.0%	0.0%	0.0%	24.3%	80.0%	14.1%
Total	Count	4	8	10	52	70	5	149
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 78: Crosstabulation of burial location and phase for Cuello

Bundled and partial/scattered are the two most common burial types, with (55.8%) of the early Cocos Chicanel being bundled and (35.7%) of the Cocos Chicanel being partial/scattered. Supine extended and indeterminate burial positions are both evenly represented in the Swasey-Bladen (50%), with flexed (37.5%) and supine extended (25%) most common for burials from the Bladen period. The majority of the Lopez Mamom sample is supine extended (70%), with this position becoming unpopular after this time period.

Burial Position * time period Crosstabulation for Cuello

		time period						Total
		swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
supine extended	Count	2	2	7	1	7	1	20
	% within time period	50.0%	25.0%	70.0%	1.9%	10.0%	20.0%	13.4%
prone	Count	0	0	0	0	3	0	3
	% within time period	0.0%	0.0%	0.0%	0.0%	4.3%	0.0%	2.0%
partial	Count	0	0	0	9	25	0	34
	% within time period	0.0%	0.0%	0.0%	17.3%	35.7%	0.0%	22.8%
bundle	Count	0	1	0	29	0	0	30
	% within time period	0.0%	12.5%	0.0%	55.8%	0.0%	0.0%	20.1%
seated	Count	0	1	0	8	19	0	28
	% within time period	0.0%	12.5%	0.0%	15.4%	27.1%	0.0%	18.8%
flexed	Count	0	3	2	5	16	0	26
	% within time period	0.0%	37.5%	20.0%	9.6%	22.9%	0.0%	17.4%
Indeterm	Count	2	1	1	0	0	4	8
	% within time period	50.0%	12.5%	10.0%	0.0%	0.0%	80.0%	5.4%
Total	Count	4	8	10	52	70	5	149
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 79: Crosstabulation of burial position and phase for Cuello

For Cuello, burial type is most often primary across all time periods except for the early Cocos Chicanel, where secondary is more common (69.2%) compared to primary (30.8%). For the early time periods, a high percentage of burials are primary, with (100%)

from the Swasey-Bladen, (75%) from the Bladen, and (90%) from the Lopez Mamom being this type. The Cocos Chicanel period saw a majority of burials as primary (65.7%) compared to secondary (34.3%), whereas the late Pre-classic burials were all primary (100%). K'axob also saw a pattern of a higher percentage of primary burials over secondary burials throughout the Pre-classic, shifting to a higher percentage of secondary burials compared to primary burials only in the terminal K'atabche'k'ax.

Burial Type * time period Crosstabulation for Cuello

		time period						Total
		swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
primary	Count	4	6	9	16	46	5	86
	% within time period	100.0%	75.0%	90.0%	30.8%	65.7%	100.0%	57.7%
secondary	Count	0	2	1	36	24	0	63
	% within time period	0.0%	25.0%	10.0%	69.2%	34.3%	0.0%	42.3%
Total	Count	4	8	10	52	70	5	149
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 80: Crosstabulation of burial type and phase for Cuello

For Cuello, interment type follows a similar pattern to burial type, with single interments being most common across all time periods except for the early Cocos Chicanel, where multiple interments were at a very high percentage (96.2%) compared to single interments (3.8%). From the early periods, most burials were single interments, with (100%)

from the Sasey-Bladen, (87.5%) from the Bladen, and (100%) from the Lopez Mamom being single interments. The Cocos Chicanel also shows a majority of single interments (57.1%) compared to multiple interments (42.9%). The late Pre-classic is entirely single interments (100%). Single interments are also more common in earlier periods at K'axob.

Inter Type * time period Crosstabulation for Cuello

			time period						Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late preclassic	
Inter Type	single	Count	4	7	10	2	40	5	68
		% within time period	100.0%	87.5%	100.0%	3.8%	57.1%	100.0%	45.6%
	mult	Count	0	1	0	50	30	0	81
		% within time period	0.0%	12.5%	0.0%	96.2%	42.9%	0.0%	54.4%
Total		Count	4	8	10	52	70	5	149
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 81: Crosstabulation of interment type and phase for Cuello

<u>Within sample infection summary for K'axob</u>

In order to perform an unbiased analysis on infection markers, individuals must have enough long bone or long bone partials present. For this reason, individuals without sufficient long bone will be excluded from the analysis from this point forward. When considering mortuary treatments both within and between samples, it is informative to utilize the entirety of the available sample population. However, when looking at infection markers within and between samples, and later when comparing infection markers and mortuary treatment variables, the samples must be reduced to include only relevant cases, or individuals with long bones present, or risk biasing the sample by overrepresenting individuals lacking lesions.

For K'axob, despite being highly fragmentary, 78 individuals (77.2%) have enough long bone present to conduct the analysis, with 23 individuals (22.8%) being excluded for lacking long bone.

Long Bones Present for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	78	77.2	77.2	77.2
	no	23	22.8	22.8	100.0
	Total	101	100.0	100.0	

Table 82: Long bones present for K'axob

From the 78 individuals with long bones present, 6 (7.7%) showed signs of periosteal lesions, while 72 (92.3%) showed no signs of lesions. This is substantial as the frequency of non-specific infections markers was expected to be much higher.

Lesion Present for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	6	7.7	7.7	7.7
	no	72	92.3	92.3	100.0
	Total	78	100.0	100.0	

Table 83: Lesions present for K'axob

From these 6 (7.7%) with signs of infection, one individual, BUR 12-6, a young adult male from the terminal K'atabche'k'ax period, showed signs of periosteal reactions on three long bones, both tibiae and the left fibula, indicating a diffuse and probably chronic infection (Goodman, 1984). Only one affected tibia, and not the additional tibia nor fibula with be counted in the final statistical analysis. While not considered in the final statistical analysis, both the additional tibia and the fibula were noted as being ‘healed’ and ‘healing’ in designation, aligned with the theory that this individual probably had this infection for some time and lived with it long enough for signs of healing to be found. Since the purpose of this study is to explore frequency at the within and between population level, and not necessarily to explore individual variations in infection expression, individual BUR 12-6 will be included in the remaining analysis, but his case will only count as a singular account and not as three separate instances of infection. Therefore, his remaining tibia will be included below but not information pertaining to the other affected bones, which can be found in his brief case study above.

As seen with BUR 12-6, the most commonly affected bone type is the tibia in all 6 cases (100%), which was the expected outcome, as it is often cited as the most likely bone to exhibit periostitis (Roberts & Manchester, 2007; Weston, 2011).

Bone Type for K’axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Tibia	6	100.0	100.0	100.0

Table 84: Bone type affected for K’axob

The only other bone type found to be affected in this sample was the left fibula of BUR 12-6. There was only one instance (BUR 12-6) of both tibiae being infected within the same individual. Out of those with lesions, the most common lesion type was classified as healed occurring in 4 cases (66.7%), making up the majority of cases with periosteal reactions, with healing and active designations equally represented by only one case each (16.7%).

Lesion Type for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	active	1	16.7	16.7	16.7
	healing	1	16.7	16.7	33.3
	healed	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Table 85: Lesion type for K'axob

The right tibia was more often involved (66.7%) compared to the left tibia (33.3%).

Side of Lesion for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	right	4	66.7	66.7	66.7
	left	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 86: Side of tibial lesion for K'axob

Lesion grade was more predominately slight in severity (66.7%), with both moderate and severe grade lesions equally represented (16.7%).

Lesion Grade for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	severe	1	16.7	16.7	16.7
	moderate	1	16.7	16.7	33.3
	slight	4	66.7	66.7	100.0
	Total	6	100.0	100.0	

Table 87: Lesion grade for K'axob

Lesion location was somewhat more likely to be the proximal 1/3 or the middle shaft, both equally represented (33.3%), with the distal 1/3 and indeterminate designations equally represented (16.7%) and occurring less. Lesion location should be considered broad estimates as conclusive determinations are difficult with incomplete and fragmentary remains. All location designations are applied to the best of my knowledge with aid from White (2000) but should be considered approximations.

Lesion Location for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	proximal 1/3	2	33.3	33.3	33.3
	middle shaft	2	33.3	33.3	66.7
	distal 1/3	1	16.7	16.7	83.3
	indeterminate	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 88: Lesion location on the tibia for K'axob

Size was most likely to be designated as small (83.3%) followed by medium (16.7%), although this determination is very difficult to make with certainty on such fragmentary remains. Likewise, no lesions could be designated as large, or encompassing a major percentage of the bone cortex, due to the incomplete nature of the remains. For this reason, as well as its rather limited definition, lesion size is not a very informative variable.

Lesion size for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Medium	1	16.7	16.7	16.7
	Small	5	83.3	83.3	100.0
	Total	6	100.0	100.0	

Table 89: Size of lesion for K'axob

Within sample infection summary for Cuello

For Cuello, variables of inquiry are limited to what information is available in the Cuello Database. For this reason, only the variables of lesion present, and lesion grade can be applied to this sample. We can assume if lesions are noted that they most likely occurred on the tibia, although we cannot say this with complete certainty. However, of primary interest to this study is the frequency of lesions present within the population, and then between the two populations. As with K'axob, first individuals without adequate long bone present had to be excluded from the analysis of infection markers. This leaves a large portion of the sample still intact, with 111 individuals (74.5%) out of the Pre-classic sample of 149, with 38 individuals (25.5%) being excluded for lack of long bones present.

Long Bones Present for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	111	74.5	74.5	74.5
	no	38	25.5	25.5	100.0
	Total	149	100.0	100.0	

Table 90: Long bones present for Cuello

Of these 111 individuals with long bones, 39 (35.1%) had lesions present, while 72 (64.9%) had no lesions present.

Lesion Present for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	39	35.1	35.1	35.1
	no	72	64.9	64.9	100.0
	Total	111	100.0	100.0	

Table 91: Lesions present for Cuello

Out of these individuals with lesions present, lesion grade was most likely to be severe (15.3%), followed by slight (12.6%), and moderate (7.2%). Severe lesions are more indicative of an acute and active infection, but without seeing the Cuello sample in person and visualizing these lesions, the designation of severe is undefined, and so the relationship of lesion grade to lesion type is unknown for this sample.

Lesion Grade for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	severe	17	43.6	43.6	43.6
	moderate	8	20.5	20.5	64.1
	slight	14	35.9	35.9	100.0
	Total	39	100.0	100.0	

Table 92: Lesion grade for Cuello

<u>Between samples infection summary</u>

The samples of individuals with enough long bone present is equal between the two samples, with the majority of the sample from K'axob (77.2%) and Cuello (74.5%) being included in the infection marker analysis. Interestingly Cuello shows a much higher rate of individuals with periosteal lesions, 39 individuals (35.1%) compared to 6 from K'axob (7.7%). Lesion grade was also quite different between samples, with the majority from K'axob being slight in severity, while lesions from Cuello were more likely to be designated as severe in grade. While both samples still have a majority of individuals without any visible signs of infection, and with Cuello having a somewhat larger sample size, the percent seen in the Cuello example is more along the lines of what was expected to be observed in a pre-Columbian population, while the percent from K'axob with visible lesions seems unusually small by comparison. Combining both samples, the overall rate for those with visible periosteal lesions present is about a quarter of the Pre-classic sample (23.8%) compared to those without any sings of periosteal lesions (76.2%).

Lesion Present for Combined Samples

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	45	23.8	23.8	23.8
	no	144	76.2	76.2	100.0
	Total	189	100.0	100.0	

Table 93: Lesions present in combined samples of K'axob and Cuello

As found in the above mortuary treatment section, the combined samples were found to have a majority (80%) with included grave goods compared to those without (20%). Could those with included grave goods also coincide with those without periosteal lesions?

For K'axob, females were more likely to have lesions present (17.6%) compared to males (5.3%), however the number of females in this sample (21.8%) is much fewer than the number of males (48.7%) represented.

Lesion Present * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	indeterminate	
Lesion Present	Yes	Count	2	3	1	6
		% within Sex	5.3%	17.6%	4.3%	7.7%
	No	Count	36	14	22	72
		% within Sex	94.7%	82.4%	95.7%	92.3%
Total		Count	38	17	23	78
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 94: Crosstabulation of lesion present and sex for K'axob

This is also true of the Cuello sample, with males making up the majority (64.9%) of the sample, followed by indeterminates (18%) and females (17.1%). For Cuello, females were also more likely to have lesions (52.6%) compared to males (40.3%), however, as with K'axob, the number of females in the Cuello sample is much fewer than the number of males, making this a notable statistic. There are no indeterminate sex individuals with lesions present for Cuello. Interestingly, the females at Cuello are slightly more likely to have lesions (52.6%) than not (47.4%), and a Chi-square test of the variables of lesion present and sex shows a significance of .001, suggesting this relationship is not due to random chance. This significance level is not seen with the same variable combination at K'axob despite the same pattern of a lower sample representation and yet a higher lesion percentage found in females.

Lesion Present * Sex Crosstabulation for Cuello

			Sex			Total
			Male	female	indeterminate	
Lesion Present	yes	Count	29	10	0	39
		% within Sex	40.3%	52.6%	0.0%	35.1%
	no	Count	43	9	20	72
		% within Sex	59.7%	47.4%	100.0%	64.9%
Total		Count	72	19	20	111
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	14.221[a]	2	.001
Likelihood Ratio	20.557	2	.000
Linear-by-Linear Association	7.401	1	.007
N of Valid Cases	111		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.68.

Table 95: Crosstabulation and Chi-square of lesion present and sex for Cuello

For K'axob, lesions are only found in the three adult age range designations and not in either of the child or juvenile categories. Adults had the highest percentage of lesions present (13.3%), followed by older adults (7.7%) and young adults (4.8%). Adults represent the largest proportion of the sample (38.5%) so it is expected that they would also have the largest lesion percentage. However, young adults make up the next largest proportion of the sample (26.9%) and yet account for only a small infection percentage (4.8%), compared to older adults, who make up (16.7%) of the sample with (7.7%) of this age range having lesions present.

Lesion Present * Age Range Crosstabulation for K'axob

			Age Range					
			child	juvenile	ya	adult	older adult	Total
Lesion Present	yes	Count	0	0	1	4	1	6
		% within Age Range	0.0%	0.0%	4.8%	13.3%	7.7%	7.7%
	no	Count	5	9	20	26	12	72
		% within Age Range	100.0%	100.0%	95.2%	86.7%	92.3%	92.3%
Total		Count	5	9	21	30	13	78
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 96: Crosstabulation of lesion present and age range for K'axob

For Cuello, all age categories have some percent of lesions present except for the child age range, of which only one individual was noted in the sample. Lesions are present in (100%) of older adults, but this sample is also only represented by one individual. Out of the remaining age ranges, adults make up the largest proportion of the sample (67.6%), followed by young adults (19.8%), and then juveniles (10.8%). Adults also show the highest percentage of lesions (37.3%), followed by young adults (31.8%), and juveniles (25%).

Lesion Present * Age Range Crosstabulation for Cuello

			Age Range					Total
			child	juvenile	ya	adult	older adult	
Lesion Present	yes	Count	0	3	7	28	1	39
		% within Age Range	0.0%	25.0%	31.8%	37.3%	100.0%	35.1%
	no	Count	1	9	15	47	0	72
		% within Age Range	100.0%	75.0%	68.2%	62.7%	0.0%	64.9%
Total		Count	1	12	22	75	1	111
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 97: Crosstabulation of lesion present and age range for Cuello

For K'axob, lesions do not become present in the sample until the late K'atabche'k'ax (12.1%) and the terminal K'atabche'k'ax (10%). Overwhelmingly however the majority of the population from all Pre-classic time periods at K'axob is free of periosteal lesions. The late and terminal K'atabche'k'ax saw increased population growth as seen by the increase in burials dated to these periods. An increase in population density could be expected to also increase spread of pathogens (Roberts & Manchester, 2007). However, the early K'atabche'k'ax period also saw an increase in population and yet no visible periosteal lesions can be associated with individuals for this period.

Lesion Present * time period Crosstabulation for K'axob

			time period					
			early Chaakk'ax	late Chaakk'ax	early K'atabche'k'ax	late K'atabche'k'ax	terminal K'atabche'k'ax	Total
Lesion Present	yes	Count	0	0	0	4	2	6
		% within time period	0.0%	0.0%	0.0%	12.1%	10.0%	7.7%
	no	Count	8	2	15	29	18	72
		% within time period	100.0%	100.0%	100.0%	87.9%	90.0%	92.3%
Total		Count	8	2	15	33	20	78
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 98: Crosstabulation of lesion present and phase for K'axob

For Cuello, periosteal lesions can be associated with individuals from all Pre-classic time periods. Most individuals in this sample come from the Cocos Chicanel (55%) and the early Cocos Chicanel (32.4%) periods, with earlier periods much less well represented. Despite this, the Lopez Mamom period has the highest percentage of lesions present (75%) although the sample from this period is small (3.6%). The Cocos Chicanel period has the next highest percent of lesions present (45.9%) but represents a substantial part of the sample (55%). However, due to the limited number of individuals from the earlier time periods in the sample, a pattern cannot be determined by statistical procedures.

Lesion Present * time period Crosstabulation for Cuello

			time period					Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	
Lesion Present	yes	Count	1	2	3	5	28	39
		% within time period	25.0%	33.3%	75.0%	13.9%	45.9%	35.1%
	no	Count	3	4	1	31	33	72
		% within time period	75.0%	66.7%	25.0%	86.1%	54.1%	64.9%
Total		Count	4	6	4	36	61	111
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 99: Crosstabulation of lesion present and phase for Cuello

Relation of variables within sample for K'axob

The next two sections will synthesize the above data over demographic variables, mortuary treatment, and infection markers. For the K'axob sample, 38 males (95%), 17 females (89.5%), and 23 indeterminate sex individuals (54.8%) had enough long bones present to do the infection analysis, 78 individuals (77.2%) of the original sample of 101. The Chi-square for the relationship between long bones present and sex shows a significance level of .000, supporting that this relationship is not due to random chance.

Long Bones Present * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	indeterminate	
Long Bones Present	yes	Count	38	17	23	78
		% within Sex	95.0%	89.5%	54.8%	77.2%
	no	Count	2	2	19	23
		% within Sex	5.0%	10.5%	45.2%	22.8%
Total		Count	40	19	42	101
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.858[a]	2	.000
Likelihood Ratio	21.864	2	.000
Linear-by-Linear Association	18.802	1	.000
N of Valid Cases	101		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.33.

Table 100: Crosstabulation and Chi-square of long bones present and sex for K'axob

From these 78 individuals the sample is further filtered to exclude individuals without visible lesions in order to compare social status differentiation variables and demographic variables using only those with periosteal reactions present.

From the 78 with included long bone, 6 individuals have lesions present (7.7%). Out of this new sub-sample, 2 individuals are males (33.3%), 3 individuals are females (50%), and 1 individuals is indeterminate sex (16.7%).

Frequency Table by Sex with Lesions for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	2	33.3	33.3	33.3
	female	3	50.0	50.0	83.3
	indeterminate	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 101: Frequencies by sex of lesion sub-sample for K'axob

No child or juvenile age ranges had lesions, while adults had the highest representation (66.7%), followed by both young adults and older adults equally (16.7%).

Frequency Table by Age Range with Lesions for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ya	1	16.7	16.7	16.7
	adult	4	66.7	66.7	83.3
	older adult	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 102: Frequencies by age range of lesion sub-sample for K'axob

Only the late K'atabche'k'ax and the terminal K'atabche'k'ax had individuals with lesions present, 4 individuals from the late K'atabche'k'ax (66.7%) and 2 from the terminal K'atabche'k'ax (33.3%).

Frequency Table by Phase with Lesions for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	late K'atabche'k'ax	4	66.7	66.7	66.7
	terminal K'atabche'k'ax	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 103: Frequencies by phase of lesion sub-sample for K'axob

For grave goods present, 5 (83.3%) had one or more included, while only 1 (16.7%) had none.

Frequency Table of Grave Goods Present

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	5	83.3	83.3	83.3
	no	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 104: Frequencies of grave goods present of the lesion sub-sample for K'axob

All males (100%) and all indeterminate sex individuals (100%) had included grave goods, while the majority of females (66.7%) had included grave goods. Only one female (33.3%) had none.

Grave Goods Present * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	Indeterminate	
Grave Goods Present	yes	Count	2	2	1	5
		% within Sex	100.0%	66.7%	100.0%	83.3%
	no	Count	0	1	0	1
		% within Sex	0.0%	33.3%	0.0%	16.7%
Total		Count	2	3	1	6
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 105: Crosstabulation of grave goods present and sex in K'axob sub-sample

Likewise, all young adults (100%) and all older adults (100%), as well as a majority of adults (75%) had included grave goods, while one adult did not (25%).

Grave Goods Present * Age Range Crosstabulation for K'axob

			Age Range			Total
			ya	adult	older adult	
Grave Goods Present	yes	Count	1	3	1	5
		% within Age Range	100.0%	75.0%	100.0%	83.3%
	no	Count	0	1	0	1
		% within Age Range	0.0%	25.0%	0.0%	16.7%
Total		Count	1	4	1	6
		% within Age Range	100.0%	100.0%	100.0%	100.0%

Table 106: Crosstabulation of grave goods present and age range in K'axob sub-sample

This is aligned with Welsh's (1988) premise that grave good inclusion is a common trend among the Maya, but individuals were hypothesized to have diminished grave good inclusion associated with periosteal lesion presence, a trend not seen here. As expected, ceramics were the most common grave good type, with 5 individuals (83.3%) having one or more included ceramic items.

Frequency Table of Ceramics for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	16.7	16.7	16.7
	1+	5	83.3	83.3	100.0
	Total	6	100.0	100.0	

Table 107: Frequencies of ceramic items of the lesion sub-sample for K'axob

The only individual without a ceramic item included is an adult female from the late K'atabche'k'ax period.

Ceramics * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	indeterminate	
recoded ceramics	0	Count	0	1	0	1
		% within Sex	0.0%	33.3%	0.0%	16.7%
	1+	Count	2	2	1	5
		% within Sex	100.0%	66.7%	100.0%	83.3%
Total		Count	2	3	1	6
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 108: Crosstabulation of ceramics and sex in K'axob sub-sample

Shell was less common, with 2 individuals (33.3%) having included shell and 4 individuals (66.7%) having none. The two with included shell are one male and one female, while the indeterminate sex individual had no included shell items.

Frequency Table of Shell for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	66.7	66.7	66.7
	1	2	33.3	33.3	100.0
	Total	6	100.0	100.0	

Table 109: Frequencies of shell items of the lesion sub-sample for K'axob

Shell * Sex Crosstabulation for K'axob

			Sex			Total
			male	female	indeterminate	
recoded shell	0	Count	1	2	1	4
		% within Sex	50.0%	66.7%	100.0%	66.7%
	1+	Count	1	1	0	2
		% within Sex	50.0%	33.3%	0.0%	33.3%
Total		Count	2	3	1	6
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 110: Crosstabulation of shell items and sex in K'axob sub-sample

Greenstone and obsidian were not present in any graves associated with individuals with periosteal lesions. However, due to the rarity of these goods at K'axob, their absence could be purely coincidental. Generally, the percentage present for each grave good type seems to mirror the pattern from the overall Pre-classic population, with ceramics being most common in both cases, followed by shell, which is the most common of the exotica items, with greenstone even less represented and obsidian the rarest of all.

Residential burials are the only burial location associated with this sub-sample, also mirroring the trends from the overall population.

Frequency Table of Burial Location for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	residence	6	100.0	100.0	100.0

Table 111: Frequencies of burial location of the lesion sub-sample for K'axob

Burial position is evenly split between supine extended (33.3%) and seated (33.3%), with bundled (16.7%) and flexed (16.7%) less represented.

Frequency Table of Burial Position for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	supine extended	2	33.3	33.3	33.3
	Bundle	1	16.7	16.7	50.0
	Seated	2	33.3	33.3	83.3
	Flexed	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 112: Frequencies of burial positions of the lesion sub-sample for K'axob

All positions had included grave goods present except for the single flexed individual, a primary and multiple interment. Three burial types, prone extended, partial/scattered, and inverted seated, are not represented by any individuals with visible periosteal reactions. The two unique types, prone extended and inverted seated, were hypothesized to be perhaps representative of special status and so the lack of lesions present follows the premise that higher status individuals would be more likely to not have periosteal reactions. However, these unique burials are only represented by a single individual each and so burial position and lack of lesions present could be purely coincidental.

Burial type is most often primary (83.3%) compared to secondary (16.7%), while interment type is evenly split between single (50%) and multiple interments (50%).

Frequency Table of Burial Type for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	primary	5	83.3	83.3	83.3
	secondary	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Table 113: Frequencies of burial type of the lesion sub-sample for K'axob

Frequency Table of Interment Type for K'axob

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	single	3	50.0	50.0	50.0
	multiple	3	50.0	50.0	100.0
	Total	6	100.0	100.0	

Table 114: Frequencies of interment type of the lesion sub-sample for K'axob

All single interments are primary burials (100%), with a majority of multiple interments also primary (66.7%) compared to secondary (33.3%).

Burial Type * Inter Type Crosstabulation for K'axob

			Inter Type		Total
			single	multiple	
Burial Type	primary	Count	3	2	5
		% within Inter Type	100.0%	66.7%	83.3%
	secondary	Count	0	1	1
		% within Inter Type	0.0%	33.3%	16.7%
Total		Count	3	3	6
		% within Inter Type	100.0%	100.0%	100.0%

Table 115: Crosstabulation of burial type and interment type in K'axob sub-sample

A majority of primary burials had grave goods included (80%) compared to none (20%), while the one secondary burial also had included grave goods (100%). All single interments included grave goods (100%), while the majority of multiple interments also included grave goods (66.7%) compared to one individual with none (33.3%).

Grave Goods Present * Burial Type Crosstabulation for K'axob

			Burial Type		Total
			primary	secondary	
Grave Goods Present	yes	Count	4	1	5
		% within Burial Type	80.0%	100.0%	83.3%
	no	Count	1	0	1
		% within Burial Type	20.0%	0.0%	16.7%
Total		Count	5	1	6
		% within Burial Type	100.0%	100.0%	100.0%

Table 116: Crosstabulation of grave goods present and burial type in K'axob sub-sample

Grave Goods Present * Interment Type Crosstabulation for K'axob

			Inter Type		Total
			single	multiple	
Grave Goods Present	yes	Count	3	2	5
		% within Inter Type	100.0%	66.7%	83.3%
	no	Count	0	1	1
		% within Inter Type	0.0%	33.3%	16.7%
Total		Count	3	3	6
		% within Inter Type	100.0%	100.0%	100.0%

Table 117: Crosstabulation of grave goods present and interment type in K'axob sub-sample

Despite having lesions present, 5 out the 6 individuals in the lesion sub-sample have included grave goods, two individuals even have shell items present (33.3%) although this is considered an exotica item related to some level of prestige. While the lesion sub-sample is very small, this is still an interesting pattern and highly suggestive that, at K'axob, social status differentiation exists but does not relate, in a detectable or quantifiable way at least, to health status.

<u>Relation of variables within sample for Cuello</u>

For Cuello, out of the original sample of 149 individuals, 111 individuals (74.5%) had long bones present, 72 males (84.7%), 19 females (95%), and 20 indeterminates (45.5%). A majority of indeterminates, 24 individuals (54.5%) did not have long bone present. Chi-square shows the relation of this variable combination is significant at the .000 level.

Long Bones Present * Sex Crosstabulation for Cuello

			Sex			Total
			male	female	Indeterminate	
Long Bones Present	yes	Count	72	19	20	111
		% within Sex	84.7%	95.0%	45.5%	74.5%
	no	Count	13	1	24	38
		% within Sex	15.3%	5.0%	54.5%	25.5%
Total		Count	85	20	44	149
		% within Sex	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.622[a]	2	.000
Likelihood Ratio	27.908	2	.000
Linear-by-Linear Association	20.446	1	.000
N of Valid Cases	149		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.10.

Table 118: Crosstabulation and Chi-square of long bones and sex in Cuello Sub-sample

Narrowing the sample down even further to include only those individuals with lesions present, out of 111 individuals with long bone present, 39 had periosteal reactions. Of this sub-sample, 29 are males (74.4%) and 10 are females (25.6%). No indeterminate sex individuals had any visible lesions.

Frequency Table by Sex with Lesions for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	29	74.4	74.4	74.4
	female	10	25.6	25.6	100.0
	Total	39	100.0	100.0	

Table 119: Frequencies by sex of lesion sub-sample for Cuello

The majority of this sub-sample were adults (71.8%) followed by young adults (17.9%), juveniles (7.7%), and older adults (2.6%). No individuals of the child age range had identifiable periosteal reactions.

Frequency Table by Age Range with Lesions for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Juvenile	3	7.7	7.7	7.7
	Ya	7	17.9	17.9	25.6
	Adult	28	71.8	71.8	97.4
	older adult	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

Table 120: Frequencies by age range of lesion sub-sample for Cuello

The Cocos Chicanel had the highest percentage of individuals with lesions present (71.8%) followed by the early Cocos Chicanel (12.8%).

Frequency Table by Phase with Lesions for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	swasey bladen	1	2.6	2.6	100.0
	Bladen	2	5.1	5.1	5.1
	lopez mamom	3	7.7	7.7	97.4
	early cocos Chicanel	5	12.8	12.8	89.7
	cocos Chicanel	28	71.8	71.8	76.9
	Total	39	100.0	100.0	

Table 121: Frequencies by phase of the lesion sub-sample for Cuello

Interestingly, grave goods were present with 33 individuals with periosteal lesions (84.6%) as compared to 6 individuals with lesions and no included grave goods (15.4%).

Grave Goods Present for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	33	84.6	84.6	84.6
	no	6	15.4	15.4	100.0
	Total	39	100.0	100.0	

Table 122: Frequencies of grave goods present of the lesion sub-sample for Cuello

A high percentage of females had grave goods included (90%) compared to males with included grave goods (82.8%). Only one female (10%) and 5 males (17.2%) had no included grave goods.

Grave Goods Present * Sex Crosstabulation for Cuello

			Sex		
			male	female	Total
Grave Goods Present	yes	Count	24	9	33
		% within Sex	82.8%	90.0%	84.6%
	no	Count	5	1	6
		% within Sex	17.2%	10.0%	15.4%
Total		Count	29	10	39
		% within Sex	100.0%	100.0%	100.0%

Table 123: Crosstabulation of grave goods present and sex in Cuello sub-sample

All age ranges had more individuals with grave goods present than without, with the exception of juveniles with one individual out of three having included grave goods (33.3%).

Grave Goods Present * Age Range Crosstabulation for Cuello

			Age Range				Total
			juvenile	ya	adult	older adult	
Grave Goods Present	yes	Count	1	6	25	1	33
		% within Age Range	33.3%	85.7%	89.3%	100.0%	84.6%
	no	Count	2	1	3	0	6
		% within Age Range	66.7%	14.3%	10.7%	0.0%	15.4%
Total		Count	3	7	28	1	39
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 124: Crosstabulation of grave goods present and age range in Cuello sub-sample

A majority of individuals with lesions (66.7%) had included ceramics, while exotica inclusion was decreased but not decidedly rare, with shell found in 8 cases (20.5%), greenstone in 10 cases (25.6%), and obsidian in only one case (2.6%), an adult female from the Cocos Chicanel period. For ceramics, 18 males (62.1%) and 8 females (80%) had this grave good type included.

Frequency Table of Ceramics of Sub-sample for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	13	33.3	33.3	33.3
	1+	26	66.7	66.7	100.0
	Total	39	100.0	100.0	

Table 125: Frequencies of ceramic items of the lesion sub-sample for Cuello

Ceramics * Sex Crosstabulation for Cuello

			Sex		Total
			male	female	
recoded ceramics	0	Count	11	2	13
		% within Sex	37.9%	20.0%	33.3%
	1+	Count	18	8	26
		% within Sex	62.1%	80.0%	66.7%
Total		Count	29	10	39
		% within Sex	100.0%	100.0%	100.0%

Table 126: Crosstabulation of ceramics and sex in Cuello sub-sample

Adults (75%) and older adults (100%) had the highest percentages of included ceramic items.

Ceramics * Age Range Crosstabulation for Cuello

			Age Range				Total
			juvenile	Ya	adult	older adult	
ceramics	0	Count	2	4	7	0	13
		% within Age Range	66.7%	57.1%	25.0%	0.0%	33.3%
	1+	Count	1	3	21	1	26
		% within Age Range	33.3%	42.9%	75.0%	100.0%	66.7%
Total		Count	3	7	28	1	39
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 127: Crosstabulation of ceramics and age range in Cuello sub-sample

For shell, only 6 males (20.7%) and 2 females (20%) had any included, again suggestive of this item's higher status.

Frequency Table of Shell for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	31	79.5	79.5	79.5
	1+	8	20.5	20.5	100.0
	Total	39	100.0	100.0	

Table 128: Frequencies of shell items of the lesion sub-sample for Cuello

Shell * Sex Crosstabulation for Cuello

			Sex		Total
			male	female	
shell	0	Count	23	8	31
		% within Sex	79.3%	80.0%	79.5%
	1+	Count	6	2	8
		% within Sex	20.7%	20.0%	20.5%
Total		Count	29	10	39
		% within Sex	100.0%	100.0%	100.0%

Table 129: Crosstabulation of shell items and sex in Cuello sub-sample

Shell was found to the highest percentage in the older adult burial (100%) but was also present to a lesser extent in adult (21.4%) and young adult (14.3%) burials.

Shell * Age Range Crosstabulation for Cuello

			Age Range				Total
			juvenile	ya	adult	older adult	
shell	0	Count	3	6	22	0	31
		% within Age Range	100.0%	85.7%	78.6%	0.0%	79.5%
	1+	Count	0	1	6	1	8
		% within Age Range	0.0%	14.3%	21.4%	100.0%	20.5%
Total		Count	3	7	28	1	39
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 130: Crosstabulation of shell items and age range in Cuello sub-sample

Greenstone is present in 8 male burials (27.6%) and 2 female burials (20%), somewhat congruent with the pattern of inclusion seen with shell.

Frequency Table for Greenstone for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	29	74.4	74.4	74.4
	1+	10	25.6	25.6	100.0
	Total	39	100.0	100.0	

Table 131: Frequencies of greenstone items of the lesion sub-sample for Cuello

Greenstone * Sex Crosstabulation for Cuello

			Sex		Total
			male	female	
greenstone	0	Count	21	8	29
		% within Sex	72.4%	80.0%	74.4%
	1+	Count	8	2	10
		% within Sex	27.6%	20.0%	25.6%
Total		Count	29	10	39
		% within Sex	100.0%	100.0%	100.0%

Table 132: Crosstabulation of greenstone items and sex in Cuello sub-sample

Young adults had the most included greenstone, with 4 out of 7 individuals having some included (57.1%).

Greenstone * Age Range Crosstabulation for Cuello

			Age Range				Total
			juvenile	ya	adult	older adult	
greenstone	0	Count	3	3	22	1	29
		% within Age Range	100.0%	42.9%	78.6%	100.0%	74.4%
	1+	Count	0	4	6	0	10
		% within Age Range	0.0%	57.1%	21.4%	0.0%	25.6%
Total		Count	3	7	28	1	39
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 133: Crosstabulation of greenstone items and age range in Cuello sub-sample

Although very rare in the overall Pre-classic sample, obsidian occurs in one burial out of the lesion sub-sample at Cuello, an adult female.

Frequency Table of Obsidian for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	38	97.4	97.4	97.4
	1+	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

Table 134: Frequencies of obsidian items of the lesion sub-sample for Cuello

The inclusion of exotica materials is higher at Cuello than at K'axob even within those individuals with periosteal lesions present, again likely evidence of the increased regional status of Cuello (McAnany, 2004; Hammond, 1991).

Burial location was public in 22 cases (56.4%), residential in 9 cases (23.1%), and rubble/fill in 8 cases (20.5%). This is interesting because public burial type is suggestive of an individual's importance and status, and so this was not hypothesized to be seen in a majority of burials for those with periosteal reactions, although it is worth noting that this burial location is also the most common in the overall population.

Frequency table of Burial Location for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	22	56.4	56.4	56.4
	residence	9	23.1	23.1	79.5
	rubble / fill	8	20.5	20.5	100.0
	Total	39	100.0	100.0	

Table 135: Frequencies by burial location of the lesion sub-sample for Cuello

Burial position was most often flexed, found in 12 individuals (30.8%), and seated in 11 individuals (28.2%). One of the prone individuals (2.6%), a juvenile male from the Cocos

Chicanel period, also showed signs of periosteal reactions. This is important because this was suspected to be a special burial position indicative perhaps of an individual's higher status (Storey, 2004). The discovery of this type associated with periosteal reactions is noteworthy. Furthermore, this prone individual did not have any associated grave goods included, perhaps indicative that this is not a burial position suggestive of heightened status at this site.

Frequency Table of Burial Position for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	supine extended	5	12.8	12.8	12.8
	Prone	1	2.6	2.6	15.4
	Partial	8	20.5	20.5	35.9
	bundle	1	2.6	2.6	38.5
	seated	11	28.2	28.2	66.7
	Flexed	12	30.8	30.8	97.4
	Indeterminate	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

Table 136: Frequencies by burial position of the lesion sub-sample for Cuello

Burial type is primary in a majority of cases (76.9%) compared to secondary (23.1%). It follows that interment type is most often single (61.5%) compared to multiple (38.5%).

Frequency Table of Burial Type for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	primary	30	76.9	76.9	76.9
	secondary	9	23.1	23.1	100.0
	Total	39	100.0	100.0	

Table 137: Frequencies by burial type of the lesion sub-sample for Cuello

Frequency Table of Interment Type for Cuello

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	24	61.5	61.5	61.5
	Multiple	15	38.5	38.5	100.0
	Total	39	100.0	100.0	

Table 138: Frequencies by interment type of the lesion sub-sample for Cuello

Looking at burial location, grave goods occur in 20 cases (90.9%) of public burials, and 9 cases (100%) of residential burials of individuals with lesions present. Interestingly, grave goods were equally represented in rubble/fill individuals (50%), despite this being considered ordinally ranked lower than either public or residential burial location designations. This pattern of a high percentage of included grave goods follows the pattern seen in the Cuello population in its entirety, however the inclusion of grave goods was hypothesized to be reduced in individuals with periosteal lesions, a pattern not supported by the data so far from this site. Likewise, 20 individuals (90.9%) out of the 39 were public burials, also considered more likely to suggest heightened status and not a pattern that was expected to be found among individuals with lesions present to this extent.

Grave Goods Present * Burial Location Crosstabulation for Cuello

			Burial Location			Total
			public	residence	rubble / fill	
Grave Goods Present	Yes	Count	20	9	4	33
		% within Burial Location	90.9%	100.0%	50.0%	84.6%
	No	Count	2	0	4	6
		% within Burial Location	9.1%	0.0%	50.0%	15.4%
Total		Count	22	9	8	39
		% within Burial Location	100.0%	100.0%	100.0%	100.0%

Table 139: Crosstabulation of graves goods present and burial location in Cuello sub-sample

Most of the infection sample individuals are in the flexed position, with 10 cases (83.3%) including grave goods compared to none (16.7%), and in the seated position, with 11 cases (100%) including grave goods.

Grave Goods Present * Burial Position Crosstabulation for Cuello

		Burial Position							Total
		supine extended	prone	partial	bundle	seated	flexed	Indeter.	
yes	Count	5	0	5	1	11	10	1	33
	% within Burial Position	100.0%	0.0%	62.5%	100.0%	100.0%	83.3%	100.0%	84.6%
no	Count	0	1	3	0	0	2	0	6
	% within Burial Position	0.0%	100.0%	37.5%	0.0%	0.0%	16.7%	0.0%	15.4%
Total	Count	5	1	8	1	11	12	1	39
	% within Burial Position	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %	100.0%	100.0%

Table 140: Crosstabulation of grave goods present and burial position in Cuello sub-sample

Primary burial type was the most common (76.9%) with most of these individuals having included grave goods (86.7%) compared to secondary burials, which were less of the sample (23.1%), yet with most of these having included grave goods (77.8%). Grave goods were present in 22 individuals (91.7%) of single burials, and in 11 individuals (73.3%) of multiple interments with lesions present. The majority of primary burials are also single interments (95.8%). This is not a surprising pattern as the act of ancestor veneration and the collection and re-interment of older remains into fresh burials would create a number of secondary and multiple interments.

Grave Goods Present * Burial Type Crosstabulation for Cuello

			Burial Type		Total
			primary	secondary	
Grave Goods Present	yes	Count	26	7	33
		% within Burial Type	86.7%	77.8%	84.6%
	no	Count	4	2	6
		% within Burial Type	13.3%	22.2%	15.4%
Total		Count	30	9	39
		% within Burial Type	100.0%	100.0%	100.0%

Table 141: Crosstabulation of grave goods present and burial type in Cuello sub-sample

Grave Goods Present * Interment Type Crosstabulation for Cuello

			Inter Type		Total
			single	multiple	
Grave Goods Present	yes	Count	22	11	33
		% within Inter Type	91.7%	73.3%	84.6%
	no	Count	2	4	6
		% within Inter Type	8.3%	26.7%	15.4%
Total		Count	24	15	39
		% within Inter Type	100.0%	100.0%	100.0%

Table 142: Crosstabulation of grave goods present and interment type in Cuello sub-sample

What is surprising however, is the mortuary variation still apparent in the sub-sample. Most individuals still had included grave goods, 33 individuals with periosteal lesions (84.6%) as compared to 6 individuals with lesions and no included grave goods (15.4%). Exotica items are not uncommon to this sub-sample, with shell (20.5%) and greenstone (25.6%) somewhat equally represented. Obsidian was even discovered in one case (2.6%). Public burials are also the norm, with 22 cases (56.4%), while residential location is associated with 9 cases (23.1%), and rubble/fill with 8 cases (20.8%). For Cuello, as with

K'axob, it would seem that social status differentiation does exist but does not relate in a quantifiable way to health status.

Relation of variables between samples

Out of the 45 individuals with lesions present, from K'axob (13.3%) and from Cuello (86.7%), 31 are males (68.9%), 13 are females (28.9%), and one is indeterminate sex (2.2%).

Combined Lesion Sub-sample

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	K'axob	6	13.3	13.3	13.3
	Cuello	39	86.7	86.7	100.0
	Total	45	100.0	100.0	

Table 143: Frequencies by Pre-classic sample of combined lesion sub-sample

Frequency table by Sex for Combined Lesion Sub-sample

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	31	68.9	68.9	68.9
	female	13	28.9	28.9	97.8
	indeterminate	1	2.2	2.2	100.0
	Total	45	100.0	100.0	

Table 144: Frequencies by sex for combined lesion sub-sample

Adults overall had the highest percentage of representation (71.1%), followed by young adults (17.8%), juveniles (6.7%), and older adults (4.4%). There are no child age range individuals with periosteal reactions in either sample population. This shows the sample is biased towards adult male burials, as are both overall Pre-classic samples.

Frequency Table by Age Range for Combined Lesion Sub-sample

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	juvenile	3	6.7	6.7	6.7
	ya	8	17.8	17.8	24.4
	adult	32	71.1	71.1	95.6
	older adult	2	4.4	4.4	100.0
	Total	45	100.0	100.0	

Table 145: Frequencies by age range for combined lesion sub-sample

Cuello has individuals from all Pre-classic periods with lesions present, with the highest percentage of any period with both sites included coming from the Cocos Chicanel (62.2%). K'axob only has representation from the two later periods, the late and terminal K'atabche'k'ax.

Frequency Table by Phase for Combined Lesion Sub-sample

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	swasey bladen	1	2.2	2.2	95.6
	Bladen	2	4.4	4.4	4.4
	lopez mamom	3	6.7	6.7	93.3
	early cocos Chicanel	5	11.1	11.1	77.8
	cocos Chicanel	28	62.2	62.2	66.7
	late K'atabche'k'ax	4	8.9	8.9	86.7
	terminal K'atabche'k'ax	2	4.4	4.4	100.0
	Total	45	100.0	100.0	

Table 146: Frequencies by phase for combined lesion sub-sample

Grave goods are highly represented (84.4%) compared to none (15.6%).

Frequency Table of Grave Goods Present in Combined Lesion Sub-sample

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	38	84.4	84.4	84.4
	no	7	15.6	15.6	100.0
	Total	45	100.0	100.0	

Table 147: Frequencies of grave goods present for combined lesion sub-sample

Females have a somewhat higher inclusion (84.6%) compared to males (83.9%), despite females being much less represented in the sample overall. The single indeterminate individual has included grave goods (100%).

Grave Goods Present * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			male	female	indeterminate	
Grave Goods Present	Yes	Count	26	11	1	38
		% within Sex	83.9%	84.6%	100.0%	84.4%
	No	Count	5	2	0	7
		% within Sex	16.1%	15.4%	0.0%	15.6%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 148: Crosstabulation of grave goods present and sex for combined sub-sample

All older adults have grave goods included (100%), with a majority of adults (87.5%) and young adults (87.5%) also having them included. Only juveniles have a majority without (66.7%) compared to included (33.3%).

Grave Goods Present * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
Grave Goods Present	yes	Count	1	7	28	2	38
		% within Age Range	33.3%	87.5%	87.5%	100.0%	84.4%
	no	Count	2	1	4	0	7
		% within Age Range	66.7%	12.5%	12.5%	0.0%	15.6%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 149: Crosstabulation of grave goods present and age range for combined sub-sample

Ceramics are more represented in female burials (76.9%) compared to male burials (64.5%), while both sexes show an overall high percentage of ceramic item inclusion compared to not.

Ceramics * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			male	female	indeterminate	
Ceramics	0	Count	11	3	0	14
		% within Sex	35.5%	23.1%	0.0%	31.1%
	1+	Count	20	10	1	31
		% within Sex	64.5%	76.9%	100.0%	68.9%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 150: Crosstabulation of ceramics and sex for combined sub-sample

Older adults have the highest inclusion (100%), followed by adults (75%), and young adults (50%). Only juveniles have a higher percentage of burials without included ceramics (66.7%).

Ceramics * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
ceramics	0	Count	2	4	8	0	14
		% within Age Range	66.7%	50.0%	25.0%	0.0%	31.1%
	1+	Count	1	4	24	2	31
		% within Age Range	33.3%	50.0%	75.0%	100.0%	68.9%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 151: Crosstabulation of ceramics and age range for combined sub-sample

For Cuello, the early time periods of the Swasey-Bladen, Bladen, and Lopez Mamom, all had included ceramics (100%), with somewhat less inclusion in the early Cocos Chicanel (60%) and Cocos Chicanel (60.7%). For K’axob, inclusion was high in both periods, with somewhat less in the late K’atabche’k’ax (75%) compared to the terminal K’atabche’k’ax (100%).

Ceramics * time period Crosstabulation Combined Lesion Sub-sample

			time period							Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabche'k'ax	terminal K'atabche'k'ax	
ceramics	0	Count	0	0	0	2	11	1	0	14
		% within time period	0.0%	0.0%	0.0%	40.0%	39.3%	25.0%	0.0%	31.1%
	1+	Count	1	2	3	3	17	3	2	31
		% within time period	100.0%	100.0%	100.0%	60.0%	60.7%	75.0%	100.0%	68.9%
Total		Count	1	2	3	5	28	4	2	45
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 152: Crosstabulation of ceramics and phase for combined sub-sample

Shell is slightly more likely to be associated with female burials (23.1%) compared to male burials (22.6%) but is still not represented in the majority of burials.

Shell * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			male	female	indeterminate	
Shell	0	Count	24	10	1	35
		% within Sex	77.4%	76.9%	100.0%	77.8%
	1+	Count	7	3	0	10
		% within Sex	22.6%	23.1%	0.0%	22.2%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 153: Crosstabulation of shell items and sex for combined sub-sample

All older adult burials (only 2 cases) have included shell (100%), followed by adults (21.9%), and young adults (12.5%). No juveniles with lesions had included shell items.

Shell * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
shell	0	Count	3	7	25	0	35
		% within Age Range	100.0%	87.5%	78.1%	0.0%	77.8%
	1+	Count	0	1	7	2	10
		% within Age Range	0.0%	12.5%	21.9%	100.0%	22.2%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 154: Crosstabulation of shell items and age range for combined sub-sample

For Cuello, shell is at the highest inclusion in the Lopez Mamom (100%) and the early Cocos Chicanel (60%), while at K’axob shell is present in the late K’atabche’k’ax (50%) but not present in the terminal K’atabche’k’ax.

Shell * time period Crosstabulation

			time period							Total
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabche'k 'ax	terminal K'atabche'k 'ax	
shell	0	Count	1	1	0	2	27	2	2	35
		% within time period	100.0%	50.0%	0.0%	40.0%	96.4%	50.0%	100.0%	77.8%
	1 +	Count	0	1	3	3	1	2	0	10
		% within time period	0.0%	50.0%	100.0%	60.0%	3.6%	50.0%	0.0%	22.2%
Total		Count	1	2	3	5	28	4	2	45
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 155: Crosstabulation of shell items and phase for combined sub-sample

Greenstone is more associated with male burials (25.8%) compared to females (15.4%). While not as rare as expected, it is still not included in the majority of burials within this sub-sample.

Greenstone * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			male	female	indeterminate	
greenstone	0	Count	23	11	1	35
		% within Sex	74.2%	84.6%	100.0%	77.8%
	1+	Count	8	2	0	10
		% within Sex	25.8%	15.4%	0.0%	22.2%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 156: Crosstabulation of greenstone items and sex for combined sub-sample

Greenstone has the highest representation in young adult burials (50%) followed by adults (15.8%). It is not found in burials of any other age category with lesions present.

Greenstone * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
greenstone	0	Count	3	4	26	2	35
		% within Age Range	100.0%	50.0%	81.3%	100.0%	77.8%
	1+	Count	0	4	6	0	10
		% within Age Range	0.0%	50.0%	18.8%	0.0%	22.2%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 157: Crosstabulation of greenstone items and age range for combined sub-sample

At Cuello, greenstone is at the highest inclusion in burials in the Lopez Mamom period (66.7%), the Cocos Chicanel period (25%), and the early Cocos Chicanel period (20%). It is not found in burials from periods earlier than the Lopez Mamom. For K'axob, greenstone is absent in the later periods and so does not overlap with individuals with lesions present, which are only found in later periods at this site. The only obsidian in this sub-sample is found with an adult female from the Cocos Chicanel period.

Greenstone * time period Crosstabulation

			time period							
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabch e'k'ax	terminal K'atabch e'k'ax	Total
greenstone	0	Count	1	2	1	4	21	4	2	35
		% within time period	100.0%	100.0%	33.3%	80.0%	75.0%	100.0%	100.0%	77.8%
	1+	Count	0	0	2	1	7	0	0	10
		% within time period	0.0%	0.0%	66.7%	20.0%	25.0%	0.0%	0.0%	22.2%
Total		Count	1	2	3	5	28	4	2	45
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 158: Crosstabulation of greenstone items and phase for combined sub-sample

For males, burial location is most likely public (54.8%), followed by residential (25.8%), and rubble/fill (19.4%). For females, residential is more common (46.2%), followed by public (38.5%), and rubble/fill (15.4%).

Burial Location * Sex Crosstabulation for Combined Lesion Sub-sample

			Sex			
			male	female	indeterminate	Total
Burial Location	public	Count	17	5	0	22
		% within Sex	54.8%	38.5%	0.0%	48.9%
	residence	Count	8	6	1	15
		% within Sex	25.8%	46.2%	100.0%	33.3%
	rubble / fill	Count	6	2	0	8
		% within Sex	19.4%	15.4%	0.0%	17.8%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 159: Crosstabulation of burial location and sex for combined sub-sample

Juveniles were more likely to be rubble/fill (66.7%) than public (33.3%), with no juveniles with lesions associated with residential burials. Young adults were more likely residential (62.5%), followed by public (25%) and rubble/fill (12.5%). Adults were most represented by public location burials (56.3%), followed by residential (28.1%) and rubble/fill (15.6%). Older adults were evenly split between public and residential locations (50%).

Burial Location * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
Burial Location	public	Count	1	2	18	1	22
		% within Age Range	33.3%	25.0%	56.3%	50.0%	48.9%
	residence	Count	0	5	9	1	15
		% within Age Range	0.0%	62.5%	28.1%	50.0%	33.3%
	rubble / fill	Count	2	1	5	0	8
		% within Age Range	66.7%	12.5%	15.6%	0.0%	17.8%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 160: Crosstabulation of burial location and age range for combined sub-sample

The early time periods at Cuello were exclusively residential burial locations, with the early Cocos Chicanel suddenly seeing a shift in this norm towards public location (100%). The Cocos Chicanel also saw a high percentage of public (60.7%) compared to residential (10.7%), with the inclusion of the third type, rubble/fill (28.6%) also occurring during this time period. The part of the sub-sample from K'axob is entirely represented by residential burials, the norm from that site.

Burial Location * time period Crosstabulation Combined Lesion Sub-sample

		time period							Total
		swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabch e'k'ax	terminal K'atabch e'k'ax	
public	Count	0	0	0	5	17	0	0	22
	% within time period	0.0%	0.0%	0.0%	100.0%	60.7%	0.0%	0.0%	48.9%
residen	Count	1	2	3	0	3	4	2	15
	% within time period	100.0%	100.0 %	100.0%	0.0%	10.7%	100.0%	100.0%	33.3%
rubble / fill	Count	0	0	0	0	8	0	0	8
	% within time period	0.0%	0.0%	0.0%	0.0%	28.6%	0.0%	0.0%	17.8%
Total	Count	1	2	3	5	28	4	2	45
	% within time period	100.0%	100.0 %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %

Table 161: Crosstabulation of burial location and phase for combined sub-sample

Burial position for males is most commonly seated (29%) followed by partial/scattered (25.8%). For females the most common position is flexed (46.2%) followed by seated (30.8%).

Burial Position * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			Male	female	indeterminate	
Burial Position	supine extended	Count	5	1	1	7
		% within Sex	16.1%	7.7%	100.0%	15.6%
	prone	Count	1	0	0	1
		% within Sex	3.2%	0.0%	0.0%	2.2%
	partial	Count	8	0	0	8
		% within Sex	25.8%	0.0%	0.0%	17.8%
	bundle	Count	0	2	0	2
		% within Sex	0.0%	15.4%	0.0%	4.4%
	seated	Count	9	4	0	13
		% within Sex	29.0%	30.8%	0.0%	28.9%
	flexed	Count	7	6	0	13
		% within Sex	22.6%	46.2%	0.0%	28.9%
	Indeterminate	Count	1	0	0	1
		% within Sex	3.2%	0.0%	0.0%	2.2%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 162: Crosstabulation of burial position and sex for combined sub-sample

Seated was most common in older adults (50%), adults (34.4%) and young adults (12.5%). Flexed was also most common in older adults (50%), adults (34.4%) and juveniles (33.3%).

Burial Position * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			Juvenile	ya	adult	older adult	
Burial Position	supine extended	Count	1	2	4	0	7
		% within Age Range	33.3%	25.0%	12.5%	0.0%	15.6%
	prone	Count	1	0	0	0	1
		% within Age Range	33.3%	0.0%	0.0%	0.0%	2.2%
	partial	Count	0	4	4	0	8
		% within Age Range	0.0%	50.0%	12.5%	0.0%	17.8%
	bundle	Count	0	1	1	0	2
		% within Age Range	0.0%	12.5%	3.1%	0.0%	4.4%
	seated	Count	0	1	11	1	13
		% within Age Range	0.0%	12.5%	34.4%	50.0%	28.9%
	flexed	Count	1	0	11	1	13
		% within Age Range	33.3%	0.0%	34.4%	50.0%	28.9%
	Indeterminate	Count	0	0	1	0	1
		% within Age Range	0.0%	0.0%	3.1%	0.0%	2.2%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 163: Crosstabulation of burial position and age range for combined sub-sample

These burial positions become common in the lesion sub-sample at Cuello during the early Cocos Chicanel, and for K'axob seated is most common (50%) during the late K'atabche'k'ax.

Burial Position * time period Crosstabulation Combined Lesion Sub-sample

		time period							
		swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabch e'k'ax	terminal K'atabch e'k'ax	Total
supine extend	Count	0	0	3	0	2	0	2	7
	% within time period	0.0%	0.0%	100.0%	0.0%	7.1%	0.0%	100.0%	15.6%
prone	Count	0	0	0	0	1	0	0	1
	% within time period	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	2.2%
partial	Count	0	0	0	1	7	0	0	8
	% within time period	0.0%	0.0%	0.0%	20.0%	25.0%	0.0%	0.0%	17.8%
bundle	Count	0	1	0	0	0	1	0	2
	% within time period	0.0%	50.0%	0.0%	0.0%	0.0%	25.0%	0.0%	4.4%
seated	Count	0	0	0	2	9	2	0	13
	% within time period	0.0%	0.0%	0.0%	40.0%	32.1%	50.0%	0.0%	28.9%
flexed	Count	0	1	0	2	9	1	0	13
	% within time period	0.0%	50.0%	0.0%	40.0%	32.1%	25.0%	0.0%	28.9%
Indeter	Count	1	0	0	0	0	0	0	1
	% within time period	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%
Total	Count	1	2	3	5	28	4	2	45
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 164: Crosstabulation of burial position and phase for combined sub-sample

Overall, primary is the more common burial type, with females slightly more representative (76.9%) than males (77.4%). Likewise, females have slightly more secondary burials (23.1%) compared to males (22.6%), but this burial type is much less represented in the infection sub-sample, possible due to certain skeletal elements that could be diagnostic of periosteal reactions not being included in secondary burials.

Burial Type * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			Male	female	indeterminate	
Burial Type	primary	Count	24	10	1	35
		% within Sex	77.4%	76.9%	100.0%	77.8%
	secondary	Count	7	3	0	10
		% within Sex	22.6%	23.1%	0.0%	22.2%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 165: Crosstabulation of burial type and sex for combined sub-sample

All juveniles and older adults are primary (100%), with adults also highly represented (84.4%). Young adults are more commonly secondary (62.5%) compared to primary (37.5%) in this sub-sample.

Burial Type * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
Burial Type	primary	Count	3	3	27	2	35
		% within Age Range	100.0%	37.5%	84.4%	100.0%	77.8%
	secondary	Count	0	5	5	0	10
		% within Age Range	0.0%	62.5%	15.6%	0.0%	22.2%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 166: Crosstabulation of burial type and age range for combined sub-sample

Primary is the majority burial type across all time periods covered in this sub-sample, which the exception of the Bladen period at Cuello, which is evenly represented by both burial types in the sub-sample (50%).

Burial Type * time period Crosstabulation Combined Lesion Sub-sample

		time period							Total
		swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabche'k'ax	terminal K'atabche'k'ax	
primary	Count	1	1	3	4	21	3	2	35
	% within time period	100.0%	50.0%	100.0%	80.0%	75.0%	75.0%	100.0%	77.8%
secondary	Count	0	1	0	1	7	1	0	10
	% within time period	0.0%	50.0%	0.0%	20.0%	25.0%	25.0%	0.0%	22.2%
Total	Count	1	2	3	5	28	4	2	45
	% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 167: Crosstabulation of burial type and phase for combined sub-sample

It follows that interment type is most often single, for males (61.3%) compared to multiple (38.7%), and for females (53.8%) compared to multiple (46.2%).

Interment Type * Sex Crosstabulation Combined Lesion Sub-sample

			Sex			Total
			male	female	indeterminate	
Inter Type	single	Count	19	7	1	27
		% within Sex	61.3%	53.8%	100.0%	60.0%
	multiple	Count	12	6	0	18
		% within Sex	38.7%	46.2%	0.0%	40.0%
Total		Count	31	13	1	45
		% within Sex	100.0%	100.0%	100.0%	100.0%

Table 168: Crosstabulation of interment type and sex for combined sub-sample

Older adults are entirely multiple interments (100%) and young adults are evenly represented in both interment types in the sub-sample (50%). Juveniles (66.7%) and adults (65.6%) are more likely to be single interments.

Interment Type * Age Range Crosstabulation Combined Lesion Sub-sample

			Age Range				Total
			juvenile	ya	adult	older adult	
Inter Type	single	Count	2	4	21	0	27
		% within Age Range	66.7%	50.0%	65.6%	0.0%	60.0%
	multiple	Count	1	4	11	2	18
		% within Age Range	33.3%	50.0%	34.4%	100.0%	40.0%
Total		Count	3	8	32	2	45
		% within Age Range	100.0%	100.0%	100.0%	100.0%	100.0%

Table 169: Crosstabulation of interment type and age range for combined sub-sample

The early time periods at Cuello are entirely represented by single interments, with a sudden shift to all interments being multiple in the early Cocos Chicanel (100%). The Cocos Chicanel saw a majority of single interments (64.3%) compared to multiple interments (35.7%). At K'axob, the late K'atabche'k'ax saw a majority of the sub-sample as multiple interments (75%), while the terminal K'atabche'k'ax was only single interments (100%).

Interment Type * time period Crosstabulation Combined Lesion Sub-sample

			time period							
			swasey bladen	bladen	lopez mamom	early cocos Chicanel	cocos Chicanel	late K'atabche'k'ax	terminal K'atabche'k'ax	Total
Inter Type	single	Count	1	2	3	0	18	1	2	27
		% within time period	100.0%	100.0%	100.0%	0.0%	64.3%	25.0%	100.0%	60.0%
	multi	Count	0	0	0	5	10	3	0	18
		% within time period	0.0%	0.0%	0.0%	100.0%	35.7%	75.0%	0.0%	40.0%
Total		Count	1	2	3	5	28	4	2	45
		% within time period	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 170: Crosstabulation of interment type and phase for combined sub-sample

Data Summary Conclusions

As described in Welsh (1988), grave good inclusion is extremely common across sex, age, and time period categories at both sites. The majority of the combined Pre-classic sample have included grave goods (80%) compared to those without any included (20%). This remains just as high in the combined sub-sample of those with lesions present, with a majority having included grave goods (84.4%) compared to those without any included (15.6%). Overall, this is much higher than what was expected despite Welsh's (1988) assertions, which were attributed to the Classic Maya. It would seem some of his "Pan Maya" burial trends do in fact extend back in time and have their origin in the Pre-classic period, as mortuary treatments from both K'axob and Cuello evidently display. From the overall Pre-classic sample, females from both sites showed a stronger trend towards grave good inclusion. Ceramics are the most commonly included grave good item type from both sites, with slightly more inclusion at K'axob than seen at Cuello. There's some evidence that K'axob participated in ceramics production and so this slightly heightened inclusion of ceramic items in burials is not surprising (McAnany, 2004). Adults tend to have the most included ceramic items from both sites, but all age ranges had some level of included ceramics present. This type of grave good is expected to be the most common, as ceramics would qualify as 'utilitarian' items (Goodman, 1998). Ceramic items were also more common in female burials. Shell is the second most common item after ceramics but is not found in a majority of burials from either site, making it potentially an exotica item. The relative closeness of both sites to the New River and the coast, as well as the proximity of K'axob to Pulltrouser Swamp could explain its inclusion as a grave good, as well as its higher inclusion in burials at K'axob compared to Cuello, as K'axob would have had greater natural access via the immediate ecological environment. However, its inclusion in a minority of burials from both sites, as well as its inclusion, although in elaborate form, in the grave of the likely founder of K'axob, a definite individual of substantial importance, suggests the heightened status and potential of shell as an exotica item despite naturally occurring in the nearby environments of each site. Greenstone and obsidian are even rarer, due to being imported from outside the region, and their rarity at both sites is suggestive of their prestige value. However, both greenstone and obsidian are decidedly rarer at K'axob than at Cuello, with Cuello burials possessing overall more exotica type items than found in K'axob burials. Female burials were also more likely to have higher inclusions of shell items at both sites as well as shell being associated with older adult burials, child burials, and juvenile burials. Greenstone is more likely in females and older adults at K'axob and in males and adults at Cuello. Overall, greenstone occurs in more burials than shell does at Cuello, while at K'axob, shell is more commonly found in burials than greenstone. This suggests that K'axob relied more heavily on local resources, like shell, while Cuello participated in more trade outside the immediate region, thus the higher inclusion of greenstone items. However, the excavations at each site were conducted using different approaches with focuses on different locations at each site. More of the overall site of K'axob was excavated compared to Cuello, where inquiry was focused on a particular location. The sample from K'axob may be somewhat more representative of the population of the site as excavations were conducted in several areas.

Patterns in grave good types seem to shift through time at both sites as well. For example, there's a trend towards inclusion of shell items in earlier time periods at both sites and a tapering off in inclusion of this grave good type in later periods. Greenstone is only present at K'axob in later time periods, with the most greenstone associated with the terminal K'atabche'k'ax, while at Cuello it is present in the middle periods of the Pre-classic. Obsidian, although very rare at both sites, only occurs in later time periods, perhaps suggestive of trade network expansion. Later periods also saw an increase in overall population density as shown through the increase in burials associated with these periods, some of which could have been due to migration from areas with more abundant obsidian. As population increases so do trade networks expand and likewise the potential for new infections is amplified due to increased contacts between individuals and far-off villages.

For the Cuello sample, the majority of burial locations were public, while for the K'axob sample the majority were residential. Similarly, all the individuals with lesions present from K'axob were residential burials, and a high percentage of the individuals with lesions present from Cuello were public. This discrepancy suggests, at least for Cuello, that social status does not negatively impact health. However, it is worth noting that a majority of the overall sample of Cuello were public burials and a majority of the overall sample of K'axob were residential burials, so this may not be indicative of the relationship of these variables but rather an example of both sites following their associated norms.

For both sites, multiple interments were more common than single interments, and primary burials more common than secondary burials, an interesting pattern as more multiple interments would seem to suggest more secondary burials due to ancestor veneration behaviors. For K'axob, females are more likely to be primary burials and multiple interments, while for Cuello, females are more likely to be primary burials and single interments. Males from both sites have a more even distribution between primary and secondary burials, with males from both sites being more likely to be multiple interments.

Both burial location and burial position changed through time at both sites. The majority of burials at K'axob were residential throughout the Pre-classic, with a sudden shift occurring in the terminal K'atabche'k'ax to favor public burial locations. K'axob also displays strong evidence for increasing mortuary elaboration through time, as normative burial positions shifted in usage from the early to terminal Pre-classic, and as such new variations emerged. In the early Chaakk'ax periods, supine extended was the norm, with bundled added in the late Chaakk'ax. Population at the site grew during the early K'atabche'k'ax and likewise social complexity would have increased as seen through the advent and adoption of new burial positions from this time, the seated and flexed positions. Cuello also experienced a shift in burial location, with residential being the norm in early time periods and shifting to a majority of public burial locations during the early Cocos

Chicanel. Likewise, common burial positions also shifted in usage at Cuello to include new variations at later times. For K'axob, primary burials were the norm in the early time periods up until the terminal K'atabche'k'ax when secondary burials became more commonplace. Single interments were also more common in early time periods until the late K'atabche'k'ax, when multiple interments became the major type. Similarly, primary burials and single interments were the norm for the early time periods at Cuello until the early Cocos Chicanel when secondary and multiple burials became more common.

For infection markers, utilizing the reduced sample of only those with enough long bone present, the frequency of those with periosteal lesions present is substantially different between the samples, with 39 individuals (35.1%) from Cuello, and 6 individuals (7.7%) from K'axob. Females from both samples were more likely to have lesions present, with females from Cuello more likely to have lesions present than to not, a notable finding and statistically significant. Lesions are present in all age ranges at Cuello except for the child age distinction, while at K'axob lesions were only found in the three adult age distinctions and no subadults. All Pre-classic time periods at Cuello had some level of individuals with periosteal reactions, with the highest representation from the Lopez Mamom period and the Cocos Chicanel period. For K'axob, no lesions are present in the sample until late K'atabche'k'ax. Overwhelmingly, the majority of the population at K'axob from all Pre-classic periods is free from periosteal reactions.

Looking at grave good inclusion and infection markers and utilizing the infection sub-sample of only those individuals with lesions present, the majority of individuals had grave goods present from both sites. For K'axob, grave goods were present in the majority of cases (83.3%) across all sex and age categories associated with this sub-sample. For Cuello, grave goods were also present in a majority of cases (84.6%), with slightly more representation in female burials. No indeterminate sex individuals were included in the infection sub-sample from Cuello. Likewise, all age ranges had a majority of included grave goods, except for the juvenile distinction. Ceramics were common in both samples, and both samples also had some individuals with included shell items. K'axob had no individuals from the infection sub-sample with greenstone or obsidian, but Cuello had some inclusion of greenstone and one case with included obsidian. The pattern of a high inclusion of grave goods including in some cases items considered exotica was not expected to coincide with individuals with periosteal reactions. Using the data from this study, it would seem that mortuary treatment cannot discern health status in any quantifiable way at either of these sites.

Combining both samples, the overall rate for those with long bones present and with visible periosteal lesions present is 45 individuals (23.8%), about a quarter of the Pre-classic sample, compared to those without any signs of periosteal lesions (76.2%). Out of these individuals with lesions present, 38 (84.4%) have included grave goods compared to 7 (15.6%) without any included goods. Chi-square does not support a relationship between the variables of lesion present and grave goods present, and thus the null hypothesis of no relationship is not rejected.

SECTION VIII:

Conclusion

K'axob and Cuello provide an insight into the complex interrelationship between health and socioeconomic status in the Pre-classic period within the New River Complex region of the Maya lowlands. Since both are relatively small agricultural communities within the larger complex of the New River sites, neither was expected to have much internal difference in social status differentiation, with the exception of maybe a family or two showing heightened status via differential mortuary treatment inclusion of higher quality grave goods (Storey, 2004; Sharer & Traxler, 2006). Most individuals were expected to have roughly the same mortuary treatment with few grave goods present and little difference in other mortuary treatment variables. Cuello is noted in the literature as being the higher status of the two villages within the New River Complex, with a likely higher population density at its peak than what was seen at K'axob, but likewise not a center or political power or wealth, and certainly never an urban center (McAnany, 2004; Hammond, 1991). This premise differs quite substantially from what was discovered, both within and between samples.

Goodman's (1998) study on inequality in antiquity found there is not a significant association between stress in the form of linear enamel hypoplasia during development, and status in the form of amount and type of grave goods, either none, utilitarian, or exotica. As Goodman (1998) notes, the use of grave goods as social status indicators and as a classification system by type of grave good present was first used by Rothschild (1979), but admittedly may have issues as an indicator of social status because social status differentiation is complex and as such grave goods alone may not be sufficient for determining it.

For Goodman (1998), several factors could be responsible for the lack of association between frequencies of linear enamel hypoplasia and social status classification, including small sample size as being not representative of the population as a whole, or alternatively that while status does affect health, it does so in a much subtler way and is therefore more difficult to study. Or furthermore, social complexity is patterned, but in such a way that this pattern cannot be distinguished or measured with a single variable such as grave goods present, but rather multiple measures for both social status differentiation as well as health should be applied (Goodman, 1998).

The lower than expected frequency of non-specific infection from both sample sites could partially be resultant from analyzing periosteal reactions alone and not including other skeletal pathology definitive of infectious disease, such as osteomyelitis and treponemal reactions. Other studies have combined infection markers to include a greater array of pathologies (Lallo et al, 1978). For this reason, further inquiry towards an exhaustive study of more inclusive definitions of infection as health status markers at K'axob and Cuello may be necessary to get a clearer picture into the health of the populations during the Pre-classic. Furthermore, the fragmentary condition of the K'axob sample makes accurate analysis difficult because some individuals are represented by only a few small fragments of bone and teeth, not enough skeletal material to completely analyze for the presence or absence of infection markers. Even after adjusting the sample to exclude individuals without adequate long bone or long bone partials the fragmentary nature means most certainly some individuals with periosteal reactions were overlooked, underrepresenting the actual frequency of non-specific infection in the sample. As further described by Wood et al (1992), underrepresenting the prevalence of a condition is inevitable when using bioarchaeological samples as risk cannot be properly assessed. This could be an explanation for why K’axob has such minimal periosteal lesions in comparison to Cuello. Another explanation for the discrepancy could be the alternative excavation approaches utilized at each site.

SECTION IX:

Implications of the Specific Problems to the General Problem

If the skeleton is a biological indicator of social and cultural conditions in life, such as health, infection, and inequality, then evidence of such can be used to make greater inferences about the health and socioeconomic circumstances of the society at a certain point in time, and thus aid in making comparisons between culturally similar societies (Larsen, 2015). Can we infer levels of social status differentiation and biological health of a population overall using bioarchaeological and paleopathological (or paleoepidemiological) methods?

If there was a similarity in rates of infection between culturally and ecologically similar K'axob and Cuello, then that implies the specific problem can be generalized, meaning inferences about health and socioeconomic circumstances can be applied to similar societies. However, the above data does not support this assumption, and instead shows there is not a similarity in rates of infection between K'axob and Cuello. Cuello has a higher frequency of periosteal reactions than seen at K'axob, while K'axob seems to have surprisingly few occurrences of periosteal reactions compared with the expected outcomes. One possible explanation could be the immediate environment of K'axob and the proximity to Pulltrouser Swamp. This location could have been of tremendous benefit due to the abundance of natural resources in this ecosystem. Possibly this could have given the Pre-classic inhabitants of K'axob a dietary advantage and therefore reduced frailty in the population. However, since there is not a similarity in infection rates found between the two sites, the specific questions cannot be generalized, and other socioeconomic, environmental, or cultural factors must be accounted for and studied further, such as differentiated social stratification between the two villages within the regional scope.

Is there a similar extent of discernable social status differentiation within and between the Pre-classic populations represented in the mortuary treatment of skeletal samples from K'axob and Cuello?

The simple answer is 'yes'. Both K'axob and Cuello show a surprising amount of mortuary elaboration in the form of a variety of included grave good item types as well as a myriad assortment of differing burial treatments. This displays that social status differentiation is not a product of divine kingship as seen in the Classic period, but has earlier origins, is rather more nuanced than suspected, and likely based on kin group affiliations rather than institutionalized power. Cuello shows a slightly higher percentage of exotica items in relation to K'axob, as well as a majority of the sample being public burial locations, both signs of Cuello's heightened status compared to K'axob (McAnany, 2004). Exotica items at K'axob were found to occur in fewer mortuary contexts, as well as the majority of the sample occurs in residential burial locations, an expected pattern for the Maya yet considered of a lower ordinal ranking than public location burials. One burial from K'axob, BUR 1-43, possibly an early village founder, shows his likely higher status by both the unique burial position he was discovered in as well as a high number of included exotica (Storey, 2004). Trade can be seen to shift throughout the Pre-classic at both sites, with the type of grave goods inclusions changing from the early to late periods. Minor differences in grave good inclusions are present but do not seem to be a reflection of sex or age-based differentiation. Overall a high percentage of the sample from both sites contained some amount of included grave goods. There is clearly social status differentiation both within as well as between these samples, with a high variation of differentiation within each sample as shown by mortuary treatment variation, and between samples by the contrast in included exotica and normative burial location, with the evidence supporting the hypothesis that Cuello is likely of a slightly higher status in the region than K'axob (McAnany, 2004).

Is there a similar pattern of infection within and between these two societies?

The simple answer is 'no'. While social status differentiation is rather similar between samples, infection measures are not. Although a bigger sample, Cuello has a much higher percentage of the sample with lesions present than seen at K'axob, despite also having a slightly higher regional status. A number of factors could be responsible for this incongruency, included small sample size, of both samples in question as well as of K'axob in comparison to Cuello, preservation issues, and sampling bias from the initial excavations. The demographic makeup of those with lesions present covers both sexes and most age ranges from both sites. Interestingly, females were more likely to have lesions present than other sex categories, and at Cuello females were more likely than not to have lesions present. All adult age ranges have lesions present from both sites, with Cuello also having lesions present in the juvenile age category. No children from either site were found to have lesions, but this age range is not well represented in either sample. While Cuello has some number of lesions present throughout the Pre-classic, K'axob only shows lesions in the two later time periods, perhaps coinciding with both increasing population density at the site as well as increasing regional and long-distance trade, both of which factor into increasing likelihood of infection spread. The difference in frequency of periosteal reactions between the two sites was not hypothesized to be dissimilar and so further factors in the sociocultural environment should be explored to explain this surprising discrepancy. While a very different study in several ways, Holsworth (2013) found that lesion severity differed based on rural or urban core locations, with the rural population having milder reactions compared to the urban core population. Although there are no samples in my study representing an urban core, perhaps the K'axob population, by being of a lower regional status, also avoided some of the severity of lesions associated higher regional status and increased population density, as seen at Cuello, where lesions are both much more common as well as noted as being more commonly severe in grade.

Is there a discernable pattern or relationship between infection frequencies and social status differentiation classifications within and between these two societies?

The answer is a complex 'no'. Looking at the data from both sites, the overall rate for those with long bones present and with visible periosteal lesions present is 45 individuals (23.8%), about a quarter of the Pre-classic sample, compared to those without any signs of periosteal lesions (76.2%). Out of these individuals with lesions present, 38 (84.4%) have included grave goods compared to 7 (15.6%) without any included goods. Grave goods occur in a very high percentage of burials, while lesions occur in only about a quarter of the combined samples. Even looking at the infection sub-sample, a very high percentage still have included grave goods present despite their health status. There's no obvious overlap between the approximately 20% of the combined sample without grave goods and the approximately 20% of the combined sample with lesions present. However, this outcome is a complex 'no' due to the myriad of socioeconomic factors involved, and likely the inability of the chosen study variables to account for all of these, or even identify them. As Goodman (1998) posited, social complexity, while patterned is difficult to discern, and likewise thus difficult to compare with infection markers like non-specific infection. For this reason, using the variables from this study, no discernable relationship can be found within or between the samples. Health status is not related to social status in any discernable way at either Pre-classic K'axob or Cuello.

Future Research Questions

Having completed the study, several additional questions remain unanswered and would be worth exploring in future research. The first consideration is the importance of better preserved skeletal samples when exploring non-specific infection markers or any other skeletal indicators of health. Without adequate preservation it becomes unduly difficult to appropriately analyze the sample as periosteal lesions may be lost or obscured by deterioration, underrepresenting the prevalence in the population. As noted by Weston (2011), "If the skeleton under investigation is incomplete, at best a general pathological category can be assigned to the periosteal lesions, and at worst the lesions can simply be noted without imposing unjustified interpretation" (Weston, 2011, 502). The condition of the K'axob sample leaves much to be desired in this regard. Unfortunately, poor preservation is one of the downfalls of working with skeletal samples from this part of Mesoamerica. The climate simply doesn't support the preservation quality required to do a truly thorough and exhaustive study on non-specific infection markers. Samples from later time periods or from other regions in Mesoamerica could be informative towards this question, however this leaves a gap in knowledge for the Pre-classic lowland Maya. Utilizing multiple health status indicators could partially remedy this, as multiple indictors would have a better chance of being preserved and therefore represented even in a fragmentary sample. While not being specific to the study of periosteal reactions, the use of multiple stress indicators could give a glimpse of the overall health of the Pre-classic population while measuring health in a broader sense (Goodman et al, 1988).

Likewise, looking at social status differentiation from alternative angles or using other and multiple variables could prove more informative. There is clearly evidence from the early time periods at both sites of differential mortuary treatments and this can be correlated to social status differentiation in the living population. Mortuary treatments become more elaborate and varied through time as well and evidence of prolonged display and curation of remains demonstrates the act of ancestor veneration. Increasing social complexity coincides with increasing population growth at both sites, the expansion of trade networks, and the potential for contracting new diseases from increased settlement density as well as long distance trade. However, while social differentiation is clear, quantifying it is not. As noted by Goodman (1998), social complexity is patterned but very difficult to explore without utilizing multiple measurement variables.

Lastly, while keeping in mind the above considerations, explorations into multiple variables for health and for social status differentiation should be explored using comparative skeletal samples from other villages in the New River complex such as Colha, Cerros, Nohmul, San Estevan, and Lamanai, in order to fully explore any potential for finding a relationship between the variables in question within the region during the Pre-classic.

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