

5-3-2017

# A Bioarchaeological Approach to Social Transition in the Pre-Hispanic Andes: A Diachronic Study of Health at Tumilaca la Chimba, Peru

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A BIOARCHAEOLOGICAL APPROACH TO SOCIAL TRANSITION IN THE PRE-  
HISPANIC ANDES: A DIACHRONIC STUDY OF HEALTH AT TUMILACA LA CHIMBA,  
PERU

by

SHANNON A. LOWMAN

Under the Direction of Bethany L. Turner, PhD

ABSTRACT

This thesis investigates the relationship between long-term, macro-scale social change and systemic stress by analyzing osteological data from two occupations at the archaeological site of Tumilaca la Chimba, Peru. The first dates to the terminal Middle Horizon (ca AD 950-1250) and was established as the Tiwanaku state underwent collapse. Despite political fragmentation, this occupation is characterized by substantial cultural continuity in Tiwanaku practices. The second occupation dates to the Late Intermediate Period (LIP) (ca AD 1250-1476) and is associated with significant changes in cultural practice, suggesting a process of population replacement. This study compares skeletal data derived from cemeteries associated with each occupation. Paleopathological analysis of 20 individuals from the terminal Middle Horizon cemeteries and 23 individuals from the LIP cemetery reveals significant differences in age and sex and in skeletal pathologies. These results are a valuable addition to current literature examining the impact major political reorganization has on individuals.

INDEX WORDS: Social transition, Bioarchaeology, Political collapse, Health, Andes, Tiwanaku

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SHANNON A. LOWMAN

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Arts

in the College of Arts and Sciences

Georgia State University

2017

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Shannon Aleen Lowman  
2017

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by

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May 2017

## **DEDICATION**

I would like to dedicate this thesis to my parents: for teaching me the value of education, hard work, and following my dreams no matter how ridiculous they might seem.

## ACKNOWLEDGEMENTS

The excavations of mortuary contexts at Tumulaca la Chimba were funded in part by Dumbarton Oaks, National Science Foundation, Archaeological Institute of America, and the Curtiss T. and Mary G. Brennan Foundation. I would like to thank my thesis committee for taking time out of their hectic schedules to revise my work and helping me throughout this learning process. I want to express my deepest gratitude to Dr. Nicola Sharratt for giving me the opportunity to travel to Peru and trusting me to work with the individuals interred at the site. To Dr. Bethany Turner, thank you for being a great advisor and mentoring me through every step of learning about osteological analysis. I want to thank Dr. Jeffrey Glover for being on my thesis committee during such a busy year and for always being so enthusiastic about his work and archaeology. I would also like to give thanks to Museo Contisuyo for allowing me to use their space and materials to complete my data collection during all hours of the day and to all the Moquegua locals for welcoming me as if I was family and teaching me about their beautiful culture. Special thanks to Ben Schafer for mentoring me and answering endless questions as I collected my data. I also could not have made it through these past two years without my cohort; thank you all for the laughs and friendship when I needed it most.

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## 1 INTRODUCTION

### 1.1 Purpose of the study

The process of the decline or restructuring of a major political entity can have major effects on its citizens (e.g., Faulseit 2016; Kurin 2012; Schwartz 2006; Tung 2016). Over the past several decades, archaeologists have studied these instances of societal collapse and their effect on people in the pre-Columbian Andes of South America (Kurin 2012; Tung 2016). Some of the first examples of the emergence and decline of what can be considered a state can be found in Middle Horizon Period, which lasted from about AD 600-1000 across the Andes (Moseley 2001). During this time, a group called Tiwanaku experienced extensive growth to statehood in southern Peru and northern Bolivia. However, evidence of change begins to appear during the last few centuries of the Middle Horizon that suggests major episodes of civil and social change with the deterioration of the Tiwanaku state (Janusek 2005, 2008; Kolata 1993). Despite increasing political fragmentation following the decline of Tiwanaku and its peripheral colonies, there is archaeological evidence demonstrating a continuation of Tiwanaku cultural influence during this time (Goldstein 2005; Graffam 1992; Sharratt 2010, 2011, 2016; Sharratt et al. 2012). The end of the Middle Horizon is then followed by the Late Intermediate Period (LIP), which lasted from around AD 1000-1476 (Covey 2008; Moseley 2001). Within the Moquegua Valley, this period seems to be more transitional in nature and is marked by changes in domestic and ritual material culture that imply a population replacement (Stanish 1989).

Although distant from the heartland site of Tiwanaku, the Moquegua Valley of Peru contains several archaeological sites that have many material similarities, suggesting that this area was a Tiwanaku peripheral colony (Goldstein 2005). This study is centered specifically on the site of Tumulaca la Chimba, located roughly 15km inland from the modern city of Moquegua

(Bawden 1993, 1989; Sharratt 2011, 2016). Tumulaca la Chimba is characterized by two occupations that fit into the transitional periods following Tiwanaku decline. The first period is associated with the Tumulaca phase within the Moquegua Valley, which dates to the end of Tiwanaku power from AD 950-1200 or later (Sharratt 2011). The Tumulaca phase has also been considered to fall into a category termed the terminal Middle Horizon because this transitional period does not seem to fit neatly into the broader Andean chronologies of Middle Horizon versus Late Intermediate Period. This occupation includes domestic, mortuary, and public ceremonial contexts that continue to share similarities with traditional Tiwanaku iconography and traditions. The second occupation is characterized by Estuquiña phase materials, which are associated with the Late Intermediate Period in Moquegua (AD 1250-1476) and differ starkly from Tiwanaku practices and materials. The origins of Estuquiña are currently unclear; some scholars suggest they represent another wave of migration from the altiplano, (Stanish 1989) while others propose they constitute a local development (Torres Pino and Clara 1990).

When studying how major transitional periods may have affected individuals, especially in the arid Andean regions, it is useful to study mortuary contexts and to utilize the expertise of biological archaeologists. By doing so, it is possible to better understand the lives of individuals within a population and to observe shifts in population demographics, migrations, diet, health, and involvement in warfare. This thesis focuses on four Tumulaca period cemeteries and one Estuquiña period cemetery at Tumulaca la Chimba. It specifically uses a bioarchaeological approach to examine the relationship between cultural change and systemic stress during the terminal Middle Horizon and Late Intermediate Periods. This study utilizes osteological analysis to assess and compare the effects of this cultural transition on health and stress within and between the two populations present on the site. More specifically, did these transitional periods

cause people to be more or less susceptible to disease, infection, or stress as they relocated to the site? Did these changes then cause any shifts in demographics or mortality rates within each population?

To answer these questions, I begin this thesis by explaining the pathological markers that are the focus of this research as well as some of the overarching theoretical and methodological arguments within current literature on paleopathology in Chapter two. Chapter three then presents a brief background on Tiwanaku and its expansion throughout the Andes, specifically into the Moquegua valley, until its period of decline. Chapter four discusses the study design of this project. It begins by explaining the history of excavations at the site. The chapter then moves into the methodology of data collection for this research by explaining the makeup of the skeletal collection and the osteological and statistical methods used to estimate and analyze age at death and sex and record frequencies of stress markers such as: porotic hyperostosis, cribra orbitalia, dental pathological conditions, occupational stress markers, and other major skeletal pathological conditions. Chapter five presents all paleopathological, demographic, and statistical results for each population. The data are then analyzed in Chapters six and seven in conjunction with the existing archaeological literature to better understand this major transitional period and how it may have affected health and demographics in the Andes.

## **1.2 Expected Results**

Although there is a continuation of Tiwanaku culture during the Tumilaca period at Tumilaca la Chimba, past research supports the idea that these inhabitants were refugees from the lower Tiwanaku peripheral sites within the Moquegua valley as the state declined (Sutter and Sharratt 2010). With this analysis, I expect to further support the previous claims with osteological data that suggests higher rates of systemic stress as a result of being forced to



quickly adapt to new lifeways through a period of political turmoil. This should be present through higher levels of osteological stress markers on individuals within Tumilaca period cemeteries. In contrast, I hypothesize that although the Estuquiña inhabitants may have also been a migrant population, the panic of Tiwanaku decline would likely have dissipated, allowing people to be better adapted to their living conditions, resulting in lower levels of systemic stress. Compared to the Tumilaca population, the Estuquiña people should show fewer markers of stress and disease. Overall, it is my aim that my research will be a valuable addition to existing literature on the social and political transition from the Middle Horizon into the Late Intermediate Period within the Moquegua Valley of Peru as well as the broader cultural contexts of state decline within the Andes.

## 2 METHODS AND THEORY

### 2.1 Introduction

Taking a bioarchaeological approach has been especially useful in Andean archaeology. The arid environments in the desert regions of the Andes have led to some excellent preservation of skeletons, giving archaeologists the opportunity to study the remains of individuals that were buried thousands of years ago. This has also been helpful within the more recent theoretical paradigms, which include an increasing popularity of studying the individual to understand the past on a societal scale (Chapman 2003; Korpisaari 2006; Verano 1997). By analyzing human remains, biological anthropologists can gain a better understanding of the age and sex of the person, cause of death, and how healthy they might have been during their lives. While studying pathological markers on skeletons can be problematic at times, it can be useful in reconstructing the lives of people in the past on both individual and group levels (Goodman et al 1984b; Ortner 2003:1-10; Verano 1997). This chapter discusses some of the common stress markers observed in this study, the methodology behind sexing and aging skeletal samples, the theoretical and methodological arguments behind studying these markers, and how paleopathology can be a valuable resource in understanding past cultures.

### 2.2 Common Pathological Stress Markers

Ancient pathology can be studied by using a variety of resources, such as ancient texts, different forms of illustrations or artwork, coprolites, or most commonly, human remains (Ortner 2003:1-10). Working with archaeological remains can often be limiting due to signs of illness disappearing from the human body once healed or post-mortem. However, there are several conditions that can permanently affect bone once they have progressed to a certain stage (Ortner 2003:37-42). Cultural deformation and trauma are usually the most noticeable conditions, but

there are also common bone-altering diseases such as arthritis, chronic infections, and some dietary deficiencies (Verano 1997). Some of the types of ailments that can appear on bones and teeth include, but are not limited to, anemia, degenerative or neoplastic diseases, developmental disorders, dietary deficiencies, infectious disease, malformations, trauma, and tumors (Steele and Bramblett 1988; Verano 1997). Although many visible pathologies were noted within this study, the following conditions are the main focus: porotic hyperostosis, cribra orbitalia, vertebral osteoarthritis, and various dental pathologies.

### ***2.2.1 Anemia***

Anemia is not a specific disease but rather a category that encompasses different irregularities of red blood cells, which are responsible for circulating oxygen within the body (Ortner 2003:359-376). There are both genetic and acquired anemias that people can experience during their lifetime, with thalassemia and sickle cell anemia being the two genetic forms. Thalassemia is a result of a deficiency in the synthesis of hemoglobin, whereas sickle cell is a result of the hemoglobin itself developing with abnormalities. Acquired anemia can have any number of causes, including a lack of iron, abnormal blood loss, infection, and more (Blom et al. 2005; Larsen 1995; Ortner 2003:359-376; Walker et al. 2009). Historically, iron deficiency has been considered the most common form of acquired anemia, and studies have observed the increase in iron deficiency with the transition to agricultural lifestyles as people consumed more maize and grains, shifting their focus away from meat-based diets (Lallo et al. 1977; Larsen 1995; Ortner 2003:359-376).

Porotic hyperostosis is a pathological lesion that affects the cranial bones and has generally been associated with anemia in archaeological populations (Lallo et al. 1977; Naveed 2012; Ortner 2003:359-376). There are three types of porotic hyperostosis: osteoporotic pitting,

spongy hyperostosis, and cribra orbitalia. These lesions form when the lack of blood supply causes the cortical bone to thin and the diplöe to expand, causing the bone to look porous, and they can range anywhere from mild to severe manifestations (Blom et al. 2005; Goodman et al. 1984b; Lallo et al. 1977; Naveed 2012; Ortner 2003:359-376). These lesions are considered as some of the most commonly reported pathological conditions, and bioarchaeologists usually call porosity on the parietal portions of the skull porotic hyperostosis and porosity in the upper eye orbits cribra orbitalia (Walker et al. 2009). Although exact etiologies for the lesions are not known, some anthropologists consider cribra orbitalia to be the first to appear in times of stress, with porotic hyperostosis developing once the stress has reached an extreme case (Blom et al. 2005; Lallo et al. 1977).

Since determining etiologies for the porosity is difficult, there has been much debate surrounding what exactly causes the lesions and during what stage in life they commonly occur. Some of the common potential causes other than anemia are infectious disease, cancer, pressure from the surrounding bone, nutritional disorder, parasites, RH incompatibility between fetus and mother, and trauma (Blom et al. 2005; Lallo et al. 1977; Naveed 2012; Ortner 2003:359-376; Steele and Bramblett 1988; Verano 1997). Since the 1950s, most scientists assumed that the main cause for porotic hyperostosis was iron deficiency; however, many researchers have recently documented that, although it is possible that anemia is a major cause for hyperostosis, it is unlikely that iron deficiency anemia is to blame (Rothschild 2000; Walker et al. 2009). This is because iron deficiency does not seem to affect the red blood cell production in a manner that would cause the marrow expansion present in hyperostosis, and clinically, iron deficiency does not seem to have the same “hair on end” effect as other forms of anemia (Rothschild 2000:86). Walker and colleagues (2009) have evidence to argue that it is more likely to be a hemolytic or

megaloblastic anemia that causes the porosity to occur. They also state that there is no clinical indication to suggest that cribra orbitalia is linked to anemia in any way (Walker et al. 2009).

Other scientists take a more environmental than nutritional approach and argue that parasites are a more likely cause for porotic hyperostosis and cribra orbitalia (Holland and O'Brien 1997; Rothschild 2000; Verano 1997). Many coastal populations are in an ideal environment for parasitic infection because parasites thrive in warm and moist environments, and some species of parasites can even live in the water sources of arid coastal areas. The population would then become a host for the parasites through contamination of drinking water, a marine-based diet, or other means. Once infected with the parasites, either the loss of blood from parasite feeding or the body cutting off iron supply to starve the intruders would cause an anemic reaction and eventually lead to the formation of porous lesions (Blom et al. 2005; Holland and O'Brien 1997; Rothschild 2000; Verano 1997). In contrast, many argue that there is not only one single factor that causes people to develop porotic hyperostosis, but rather a combination of the interdependency of nutrition, environment, and disease (Blom et al. 2005; Holland and O'Brien 1997).

### ***2.2.2 Osteoarthritis***

Osteoarthritis is caused by an inflammation of the joints and is the most common joint disease that medical professionals see in clinical cases today (Ortner 2003:545-559; Steele and Bramblett 1988). Over 50 percent of individuals older than 60 years old have some variation of the disease within Western countries. Extreme cases can cause permanent pathological markers as the articular cartilage starts to break down, leading to bone-on-bone contact. This can then lead to subchondral bone eburnation, development of osteophytes from the growth of new cartilage, and even fusion of the articular surfaces, which is called ankylosis (Ortner 2003:545-

559; Steele and Bramblett 1988). There are two basic groups of osteoarthritis. The first group is primary osteoarthritis, which forms later in life from different types of trauma or biomechanical stress. Secondary osteoarthritis can occur earlier in life from the joints being affected by an unrelated pathology (Ortner 2003:545-559). One of the most common arthritic areas is the spine, with clinical populations showing signs of vertebral arthritis on almost everyone over 40 years old. This is pathologically evident through the degeneration of the vertebral bodies as well as osteophyte growth on the edges of the bodies (Goodman et al. 1984b; Ortner 2003:545-559).

Within the archaeological record, biological anthropologists can observe arthritis in most major joints of the body. Although experienced bioarchaeologists can generally diagnose cases of arthritis, it is difficult to interpret exactly what may have caused arthritis to develop. Different stressors will affect the manifestation of osteoarthritis in varied ways, but they often appear similar. In the case of vertebral arthritis, or vertebral osteophytosis, the major cause is degenerative disc disease (Adams 2006; Goodman et al 1984b). Because intervertebral discs do not have enough blood supply throughout the entire disc, they do not recover from metabolic or mechanical injury very well. Over time, the disc's water content decreases. The nucleus will then begin to bulge into the vertebral body, and the cartilage will flatten out. As this occurs, the spine's resistance to compression becomes uneven, which is when osteoarthritis starts to form (Adams 2006). In both clinical and archaeological contexts, it can be difficult to define the underlying cause, because a number of pressures can lead to the intervertebral discs degenerating such as aging, genetics, nutrition, and mechanical loading. The best way to define degenerative disc disease is as a form of "structural failure" (Adams 2006), but that is not very helpful when trying to reconstruct the lives of past people. The best researchers can do is to attribute cases

found in the archaeological record to age or to specific types of mechanical loading based on comparisons to clinical cases and experimental research.

### ***2.2.3 Oral Pathologies***

Teeth are often the best-preserved part of skeletons in an archaeological setting (Hubbard et al. 2009). Although common pathological conditions typically do not have much of an effect on teeth, certain developmental disturbances, oral infections, and trauma can leave markers for bioarchaeologists to study. Relying on dental information can be tricky because teeth can be lost or broken from taphonomic processes or when the body is removed from its archaeological context. However, in situations where they remain in good condition, they can be very helpful (Ortner 2003:589-606). The most frequent oral pathology is a dental cavity. Dental caries are caused by microbial activity on the tooth surface, which can lead to the destruction of the enamel, dentin, and tooth root. If a cavity continues to worsen, it can lead to abscesses, tooth loss, and alveolar resorption, which is when the bone surrounding the tooth remodels itself to fill in the empty tooth socket. Caries can be helpful to archaeologists because diet has a significant influence on the amount of microbial activity within the mouth. An example of this is within research that has shown that the number of dental caries is lower within hunter gatherer populations than in agricultural populations due to malnutrition during development and the high carbohydrate diet in the latter (Goodman et al. 1984b; Ortner 2003:589-606; Larsen 1995; Lingström and Borrman 1999).

Gingivitis is another oral condition that can indirectly show up in the archaeological record. Gingivitis is the inflammation of the gums caused by a buildup of bacterial dental plaque in the mouth (Ortner 2003:589-606). As gingivitis progresses, it can lead to periodontitis and can cause the alveolar bone and periodontal ligaments to break down. If this occurs, there can be

severe oral infection, tooth loss, and eventually alveolar resorption. Because biological anthropologists cannot see the actual condition of gingivitis on archaeological remains, it is difficult to tell if alveolar resorption was a result of an abscess, periodontal infection, gross attrition, or trauma (Ortner 2003: 589-606; Larsen 1995; Lingström and Borrman 1999). The best way for one to know the possible cause of resorption is to look for other dental caries within the mouth. If there are no caries present, it is highly possible that the resorption was a result of periodontal disease rather than an abscessed tooth (Ortner 2003:589-606).

Dental enamel hypoplasias can be very helpful in understanding a person's quality of life during early childhood. There are three types of hypoplasias: linear, pit, and planar (Hubbard et al. 2009; Ortner 2003:589-606). Linear enamel hypoplasias (LEH) are horizontal lines on the tooth surface, pit hypoplasias are single or multiple well-defined pits, and planar hypoplasias are when entire sections of enamel are missing. All three types are caused by the thinning of the enamel during development of the tooth, but the exact etiology for each type is unknown. Many types of physiological stressors can cause linear hypoplasias to form such as congenital syphilis, tuberculosis, rickets, fluoride level, premature birth, and malnutrition, with planar hypoplasias hypothesized to be an extreme case of LEH (Goodman et al. 1984a; Goodman and Rose 1990; Hubbard et al. 2009; Ortner 2003:589-606). Pit enamel hypoplasias are considered to likely be a result of localized trauma (Griffin and Donlon 2009).

Utilizing hypoplasias in osteological research can be both rewarding and limited. Once a hypoplasia forms on a permanent tooth, it will remain on the tooth throughout adulthood because enamel never regenerates itself. Because of this, surviving teeth within the archaeological record with hypoplasias indicate a period of childhood stress regardless of a given individual's age at death. Biological anthropologists can then use these lines to estimate exactly when the person



may have experienced such stress. However, since hypoplasias are so multifactorial, biological anthropologists cannot know exactly what stressor may have caused the defects to form, and because the lines can only form during development, they only show signs of stress or trauma that occurred in individuals younger than about six years old (Goodman et al. 1984a; Goodman and Rose 1990; Griffin and Donlon 2009; Ortner 2003:589-606). Researchers must also keep in mind that many children may never develop dental defects before they heal or before death.

There is also some debate on the methodology behind using the defects to estimate the timing of the periods of stress. Some archaeologists believe that the best way to measure periods of stress is through measuring the width of the hypoplasias to calculate duration of stress, but many argue that since the width includes the period of recovery, they will overestimate their time periods.

Others say that it is better to count the number of perikymata within the defect to estimate time (Goodman and Rose 1990; Griffin and Donlon 2009; Hubbard et al. 2009).

### **2.3 Sexing and Aging**

As archaeologists have begun to place more focus on the health and stress levels of individuals within past societies, they have also started to look at how gender and sex may have played into identity and daily life in the past. Despite evidence that more than two sexes and genders have consistently existed in many cultures, western biases have caused bioarchaeologists to continue assuming skeletons should always be sexed as male or female (Blackless et al. 2000; Buikstra and Ubelaker 1997; Lang and Kuhnle 2008; Marino 2010). This assumption is reinforced by the fact that skeletally, almost all the bones tend to show signs of dimorphism with some being more reliable than others (Buikstra and Ubelaker 1997; Steele and Bramblett 1988). Generally, teeth tend to be larger and more robust in males than females, although there is usually only a small difference. For the chest and shoulder girdle, scientists can utilize Hyrtl's

law, which states that if the manubrium is half the length of the sternum, the person is likely to be male, but if the manubrium is greater than half the length of the sternum, it is probably female (Steele and Bramblett 1988). Researchers can also examine the length of the scapula to determine possible sex. Not only are the arms and legs typically larger and more robust in men than women, but there are measurement standards in some populations to compare specific diameters of the heads of the humerus and femur. The vertebral column does not seem to be very dimorphic except for in the sacrum, where males tend to have a longer, narrower sacrum with an even curvature while the female sternum is typically short, broad, and curved between the second and third sacral vertebrae. These differences are usually associated with pelvic dimorphism. Measurements can be taken of these notable size differences and used in multivariate statistics and discriminant function analysis to have more accuracy in assigning gender to these skeletal populations (Steele and Bramblett 1988; Buikstra and Ubelaker 1997).

The cranium and pelvic girdle are most commonly used to assign sex of individuals. Because there are several distinct traits on both the pelvis and cranium that help determine sex, biological archaeologists are encouraged to utilize a standard scoring method for each of the traits such as those in Buikstra and Ubelaker's *Standards for Data Collection* (1997). Most of the cranial trait differences are based on robusticity and size with males being larger and more robust, and females being more gracile. Bioarchaeologists look specifically at the Nuchal Crest, mastoid process, supraorbital margin, glabella, and mental eminence and assign each trait a score from one to five. Once all available traits are scored, the osteologist will then assign an average of the scores to determine whether the individual is more likely to be male or female. A score of zero states that there was not enough data to determine sex, one is that it is definitely female, two is probable female, three means the features are ambiguous, four is probable male, and five is a

definite male (Buikstra and Ubelaker 1997; Steele and Bramblett 1988). Scoring pubic morphology is a bit different from cranial scoring because the scores have different ranges depending on the trait. The greater sciatic notch is scored from one to five, and the preauricular sulcus is scored from zero to four. The ventral arc, subpubic concavity, and ischiopubic ramus ridge are all scored from one to three (Buikstra and Ubelaker 1997). This can make finding an average score a bit more difficult. Overall, pelvic sex is based on the female pelvis having a larger canal which appears wider with laterally flaring iliac blades, a broader sacrum, a larger superior aperture, and a broad or rectangular pubic body (Steele and Bramblett 1988).

As seen with cranial and pelvic standards, skeletal sex runs more on a scale than a strict male vs. female dichotomy. Even when using bone size and robusticity of the other bones, male and female standards fluctuate between populations due to environmental and cultural differences affecting overall size. Scientists must also work with obstacles such as cultural modifications during life, bad preservation of bone, interobserver error and intraobserver error, and the fact that subadults do not show signs of skeletal dimorphism before puberty (Buikstra and Ubelaker 1997).

## **2.4 Current Issues in Paleopathology**

### ***2.4.1 Ethical Issues***

Many more problems and debates can arise within the field of paleopathology aside from those already mentioned. One of the first sets of problems to come up is the ethical issues that come with studying the physical remains of past people. When choosing to pursue mortuary research, the researchers are no longer just digging up ancient man-made materials. They are digging up someone's ancestor and loved one that was likely intentionally placed in that mortuary setting. Not only were they purposefully placed in that space, but they were potentially

buried there with spiritual or religious ideologies behind their placement with the possibility that they had no intentions of the individual being removed. Although cultures vary in burial practices, and some may not have strong views against the exhumation of the dead, archaeologists can only ask their distant descendent communities for permission to disturb their burials. Once archaeologists remove the remains from their “final” resting place, much of pathological research can also be destructive for the remains. Destroying human remains is frowned upon in many cultures, and many people believe that it is disrespectful to alter the bodies of ancient people with no consideration of what they may have wanted (Roberts 2016). It should therefore be minimized whenever possible, and should be useful in addressing meaningful questions about individuals’ lives and larger cultural context.

#### ***2.4.2 Methodological Issues***

As with the pathologies discussed, it is very difficult to diagnose a specific disease based only on bony markers. Within an archaeological sample, only about 15 percent of individuals will show signs of disease, and most of those will be non-specific or multifactorial as a general form of trauma, infection, or arthritis (Ortner 2003:110-118). Most diseases do not affect bone, and those that do, either look very similar to one another or taphonomic processes could skew appearances post-mortem (Ortner 2003:37-42; Roberts 2016; Verano 1997). Also, biological archaeologists may not have extensive training in skeletal pathology or epidemiology, and physicians have no archaeological training, so having a standardized methodology can get confusing when deciding the most likely cause for a pathological lesion (Ortner 2003:1-10).

Although many biological anthropologists have attempted to create and use standardized methodology for studying remains (Buikstra and Ubelaker 1994), there is still a need for the improvement and more universal use of such methods (Zuckerman et al. 2016). The most

common method for attempting to accurately diagnose disease is through differential diagnosis. Scientists must first record the basic age, sex, excavation environment, geological age, and more to understand the context surrounding the possible diseases. Then, they should record everything that they notice on the bones, including any abnormal data that could be a pathological marker. After going through the meticulous data collection, the anthropologist should study all available literature to understand what could have caused each lesion, and give their own diagnosis with specific reasons as to why they chose that particular disease over any of the others. If necessary, researchers may need to complete further testing to make final conclusions (Lawler 2016; Ortner 2003:1-10; Zuckerman et al. 2016). Some researchers have also argued that paleopathologists need to take larger strides to incorporate scientific standards from other fields such as clinical medicine and epidemiology into their own work (Zuckerman et al 2016). One of the most critical guidelines that most of those fields abide by, is the requirement to add specific descriptions or images of diagnosed pathologies in peer reviewed research. Including this information would allow for differential diagnosis and help maintain a universal standard for diagnosing different lesions. Biological anthropologists would also benefit from stricter criteria within laboratory settings, which could be improved by collaboration with researchers working in more clinical fields that use the same technology such as with aDNA and isotope analysis (Zuckerman et al. 2016).

### ***2.4.3 Theoretical Issues***

Theoretical issues can also influence how anthropologists interpret their data. Overall, researchers need to develop a better understanding of what the pathological markers they are observing mean in relation to general morbidity within that population. Age, sex, environment, and any other number of factors can skew a population's percentage of disease susceptibility,

and anthropologists must keep that in mind (Ortner 2003:1-10; 110-118). As stated in “The Osteological Paradox” (Wood et al. 1992), anthropologists cannot see how people differ in their sensitivity to disease archaeologically. Some people may get sick, but heal before they show bony lesions. Others may get sick and die before the lesions have a chance to form. The individuals that we see with the disease in the archaeological record could have actually been healthier or less frail since they survived long enough for bony lesions to form. Archaeologists also often forget that their sample is a biased population because those were the people that were not healthy enough to survive. We cannot see a representation of the remainder of the surviving population. With all of this in mind, combined with the fact that sample sizes are generally too small for reliable statistical analysis, it becomes very difficult to utilize data for specific cases within a more comparative cross-population approach (Ortner 2003:110-118; Verano 1997; Wood et al. 1992).

## **2.5 Pathologies in a Broader Cultural Context and Conclusions**

Despite the debates, bioarchaeologists still know significantly more about the populations they are studying than they would otherwise without studying indicators of stress. As long as they attempt to utilize a standardized methodology to minimize biases and interobserver error, and narrow down the possibilities to a broad diagnosis instead of a specific disease, there will be more consistency and accuracy in diagnosis (Ortner 2003:110-118). Then, keeping the Osteological Paradox (Wood et al. 1992) in mind and analyzing all possible factors that can play into a community’s levels of stress, bioarchaeologists can use the signs of infectious disease to provide a perspective on the health of that population. On the societal level, not only can socioeconomic status and environment affect health, but people’s health can also affect their

daily life and how well a society can function. Studying how major epidemics have played out in history is a great example of the relationship between health and society (Roberts 2016).

Overall, paleopathology can be used to study general trends in socioeconomic success in terms of nutrition and overall health of a population, which can then be compared to other populations. Archaeologists can study the geographic distribution of certain diseases (Larsen and Milner 1997), and they can attempt to better understand the effects of subsistence and settlement patterns on the frequencies of skeletal and dental stress. Anthropologists can also utilize concepts of health and stress to study social stratification, population growth, the rise and fall of political power structures, and more (Verano 1997; Roberts 2016). This thesis takes into account all of the arguments listed above and specifically attempts to understand the effects of the fall of Tiwanaku control in the southern Andes over the centuries following its collapse.

### **3 BACKGROUND: TIWANAKU AND ITS PERIPHERY**

#### **3.1 Introduction**

The first era that archaeologists begin to see signs of the emergence of statehood in the Andes is during a period called the Middle Horizon. The Middle Horizon lasted from approximately AD 600-1000 and is characterized by the expansion of two polities known as the Wari in the south-central Andes of Peru and Tiwanaku in southern Peru and northern Bolivia (Moseley 2001). Archaeologically, both populations show signs of statehood through a centralized system of organization and ideology within their respective heartlands. There is also evidence suggesting state control and ideological influences spanning hundreds of kilometers away from the core territories (Moseley 2001). However, beginning around AD 1000, the Wari and Tiwanaku began a process of decline that culminated in a balkanized social landscape. The following period is called the Late Intermediate Period, AD 1000-1476 (Covey 2008; Moseley 2001). This chapter discusses how each state grew and interacted with one another until their decline, with a focus on the state of Tiwanaku and its periphery.

#### **3.2 Tiwanaku**

Around 400 BC, the settlement now known as Tiwanaku was first established east of Lake Titicaca in the highlands of western Bolivia (Moseley 2001). The span of Tiwanaku culture can be split into five phases. During the Formative period, Tiwanaku appears to have remained a smaller, more localized group of people until phase III (AD 100-375), when there are signs of larger scale construction projects on and around the site as well as extensive agricultural projects (Moseley 2001). As the Middle Horizon approached, phase IV can be considered as the height of the Tiwanaku state; it lasted from roughly AD 375-700 and brought further development to the previous construction projects, as well as regional and hierarchical expansion. Regional



expansion then continued through phase V until Tiwanaku decline at approximately AD 1000 (Moseley 2001). Janusek (2008) has also proposed only focusing on Tiwanaku as a state in the later chronological phases. His distinctions consider Tiwanaku Phase IV as Phase 1 and Phase V as Phase 2 (Janusek 2008; Sharratt 2011)

Early archaeologists argued that the site of Tiwanaku was simply a large pilgrimage center (Janusek 2006). It was not until the 1950s that people started to view Tiwanaku as a conquering state, and since the 1980s, there has been considerable amounts of regional scale research completed to better understand just how expansive Tiwanaku control actually was (Vranich and Stanish 2013). Phases IV and V are when many modern archaeologists consider Tiwanaku to have officially developed into a functioning state (Janusek 2006). Competition in the region became limited as neighboring cultural groups such as the Chiripa, Wankarani and Pukara appear to have died out by AD 300 in the Titicaca basin while Tiwanaku continued to thrive and grow. There is evidence of a large urban core with the development of architecture such as the anthropomorphic monoliths and the Akapana and Pumapunku platforms (Janusek 2006; Sharratt 2011). There were also several different residential areas that evolved over time. These neighborhoods ranged from palatial, elite structures to more densely packed, standardized residential compounds. This variation in architectural complexity and cultural goods in the residential components demonstrates vast differences in class as well as a high population density during the height of Tiwanaku.

### ***3.2.1 Archaeological evidence of Tiwanaku expansion***

Archaeologists have studied several surrounding territories to connect them to Tiwanaku. They have observed possible religious or ritual practices, mortuary contexts, domestic space, and more. According to the evidence so far, it does not appear as though Tiwanaku used military

force to control and colonize their periphery. Instead, it looks like Tiwanaku spread through a means by which Goldstein (2005) calls a diasporic archipelago. For Tiwanaku, this was in the form of migrants traveling across territories to develop better agricultural production because the heartland environment is at very high, cold altitudes that are not suitable for many crops. It was through this process that the migrants would have shared their cultural style, burial traditions, and lifestyles (Goldstein 2005). While some argue that Tiwanaku expanded for agricultural gains, many also argue that it expanded as a major religious entity. Janusek (2006) argues that there was an important architectural shift in the heartland from local ritual space to a larger regional center after the Late Formative period. Earlier constructions of sunken courts and smaller scaled platforms were rebuilt into large platforms and monoliths such as the Sun Gate that began to depict deities like the staff god rather than more ancestral artistry. He argues that this could be a result of a growing state that began to integrate outside religious groups into their belief system (Janusek 2006).

Although it is difficult to say whether Tiwanaku expansion was for entirely agricultural or religious motives, the hypotheses concerning the lack of violence during Tiwanaku expansion can be proven by the fact that neither Tiwanaku core settlements nor associated periphery settlements have defensive architecture or extensive skeletal samples of people with evidence of trauma. Archaeological contexts instead allude to a more peaceful incorporation of outside territories (Arkush and Tung 2013). With this peaceful expansion, Karen Anderson (2013) argues that Tiwanaku fits into the corporate state model. This model suggests that the expansion could have included both agricultural and ritualistic components. As Tiwanaku expanded to build connections for agricultural gains, they would have performed inclusive ritual to build relationships with these new people. Archaeologically, we see this corporate statehood through

the widespread distribution of specialty goods and the lack of any imagery of an elite, ruling class (Anderson 2013).

Evidence of Tiwanaku agricultural and ritual connections can be seen outside of the heartland such as in the Moquegua Valley of Peru (Goldstein 2005) and Conchabamba, which is a valley region southwest of Tiwanaku in Bolivia (Anderson 2013). The Moquegua Valley will be discussed in more detail later in this chapter. The central valley of the Conchabamba region has two phases that are linked to Tiwanaku Phases IV and V (Anderson 2013). The first is called Illataco, which is considered to fall into the later years of Tiwanaku IV, and the second is Piñami, which is during the end of Tiwanaku IV and into Tiwanaku V. Throughout these two periods, excavations have revealed a gradual increase in Tiwanaku style artifacts such as camelid mandible scrapers, hallucinogenic bone snuff spoons, and Tiwanaku style pottery. There is also evidence of an increase in maize production and consumption during this time, and Conchabamba varieties of maize have been found in the Tiwanaku heartland. This suggests that the increase in maize production could have been a result of exporting surplus to the Tiwanaku heartland (Anderson 2013).

Burial and osteological data constitute an extremely valuable resource to prove that Tiwanaku locals could have been moving to distant lands. Physical markers such as inherited skeletal traits have proved a probable genetic link between those in the Tiwanaku homeland and peripheral areas such as a study completed by Blom (1999) and colleagues (1998). Blom's study compares osteological samples from the sites of Chen Chen, Omo, and Pampa Huaracane in the Moquegua valley to samples from Tiwanaku, Lukurmata, Chiripa, and Kirawi in the altiplano. The results concluded that the Tiwanaku Phase V population in Moquegua is genetically linked to the altiplano. Because of the long distance between the altiplano and Moquegua as well as the

similarities in material culture, it would be logical for there to be some sort of long-term habitation by Tiwanaku travelers in that area (Blom 1999; Blom et al. 1998). Isotope analysis is also helpful in determining where an individual has spent most of their lives. Results from isotopic research and comparisons to cranial modifications and mortuary contexts conducted at Rio Muerto in the Moquegua valley shows that a majority of the population spent their lives locally. However, a small number of people showed isotopic signatures that were more characteristic of Tiwanaku natives as well as signatures that were in between the Moquegua and Tiwanaku levels. After analyzing the evidence, the authors concluded that second-generation locals probably sustained the site, with the Tiwanaku locals regularly traveling back and forth (Knudson et al. 2014).

There has been some debate as to whether Tiwanaku had control over regions in Northern Chile such as the Azapa Valley and the San Pedro de Atacama (Albarracin-Jordan et al. 2014; Korpisaari et al 2014) Evidence of Tiwanaku reach into the region has been found in a rock shelter in L pez, Bolivia. This site is far from the Tiwanaku heartland, yet archaeologists found a ritual bundle containing two Tiwanaku style snuff tablets, a polychrome textile band, residue of psychoactive plants, as well as other items, that carbon date to AD 905-1175. The archaeologists concluded that L pez could have been on the trade route with colonies in the San Pedro de Atacama and that this bundle could have been buried by travelers that had severed ties with Tiwanaku during its fall (Albarracin-Jordan et al. 2014). These late dates are interesting when considered in the context of recent debates concerning when Tiwanaku influence may have entered the Azapa Valley. Korpisaari and colleagues (2014) completed a study to reassess previous radiocarbon dates that linked the Tiwanaku influenced Cabuza ceramic style to the Middle Horizon and height of the Tiwanaku state. In their research, they collected 14 new

radiocarbon dates with more accurate methodology, and their results show that the contexts containing Cabuza pottery actually had date ranges falling closer to the Late Intermediate Period. With these new dates, Korpisaari et al (2014) argue that although there could have been some earlier interactions, large scale Tiwanaku influence in the Azapa Valley was likely not a result of Tiwanaku migrations into the valley during the Middle Horizon, but rather groups of people that were fleeing from either the Altiplano or the Moquegua Valley as Tiwanaku declined. If this is the case, I argue that the presence of the Tiwanaku ritual bundle found in Lipez at such late dates (Albarracin-Jordan et al. 2014) could also be a result of individuals dispersing as the Tiwanaku state fell.

### **3.3 Wari and Tiwanaku Interactions**

Although scholarship on the Wari is not used in this research, it is important to have some knowledge of its history since the timeline of state rise and decline is roughly contemporaneous with Tiwanaku, yet there is only one region where there seems to be direct interactions between the two states. In northern central Peru, Wari started to develop during the same time that Tiwanaku was expanding in the south. Named after its core site, Wari had spread all the way to the Ica valley by about AD 600 and began to decline around AD 1000. Although the two polities grew and fell at roughly the same time, Wari appears to have had some differences from Tiwanaku. Politically, Wari seems to have been a much more hierarchical state that utilized militaristic strategies to expand. Agriculturally, they specialized in hillside terracing with canals to irrigate their land rather than the low, raised fields of Tiwanaku. Culturally, while there were some shared stylistic elements between the two polities, Wari had different iconography, pottery styles, and burial practices (Moseley 2001).

Evidence of violence has been found within mortuary data contexts, iconography, and the

presence of trophy heads at multiple sites that are considered to be part of the Wari hinterland. Tiffany Tung has completed osteological studies analyzing the possibilities of militaristic expansion throughout the Wari Empire. One of these studies (Tung 2012) focuses on three different sites in both the Wari heartland and the periphery to understand rates of violence and demography. At the heartland site of Conchopata, the remains were mostly of local women and children, some of which had cranial trauma on the posterior sides of their crania, suggesting that they were either raid victims, or that they were subject to some other form of punishment. The lack of men leads Tung (2012) to suggest that they may have been political leaders or soldiers that left to control hinterland locations and died in combat (Tung 2012). In contrast, the hinterland site of Beringa appears to consist of family groups with the women having more postcranial trauma and the men having a lot of healed trauma consistent with face to face combat. These data can be interpreted to support the interpretation that raiding and warfare were common at this site. The hinterland cemetery site of La Real is similar to Beringa, but has much finer mortuary contexts, which could be indicative of a specific burial ground for the elite (Tung 2012).

Mortuary traditions were also quite different from those of Tiwanaku. Although textiles, pottery, and architecture are all similar to the classic Wari tradition, potentially proving that Wari had administrative centers throughout the Central Highlands, there does not appear to have been a standardized mortuary practice as with Tiwanaku. Burials could have been in more domestic contexts such as below residential floors or with cremations, but they could have also been more monumental such as with large mortuary rooms filled with cyst tombs or megalithic chamber tombs. The vast differences in burial contexts has been hypothesized to be a result of a hierarchical separation between elite and non-elite, but others believe that it could also have had

more to do with the concepts of *ayllus* (extended kinship groups), ancestor veneration, sacrifice, or something else (Valdez et al 2006).

Although the Wari and Tiwanaku showed limited signs of integration between their northern and southern territories, there does appear to be some interaction within the Moquegua Valley of Peru for spanning roughly 400 years. As the Tiwanaku inhabitants were practicing raised field agriculture on the lower lands, the Wari moved into the higher Torata valley during the seventh century AD (Williams 2002). There are currently seven known Wari sites in the Moquegua Valley: Cerro Baul, Cerro Mejia, El Paso, Cerro Petroglifo, Cerro Traphiche, Pampa del Arrastrado, and El Tenedor. One of the largest sites is Cerro Baul, which contains several Wari ceremonial structures built over two phases. The first phase was from AD 600-800, and the second phase was from AD 800-1000 (Nash and Williams 2005). Despite the overlap of two major states within sight of one another, there does not appear to have been any open conflict between the two groups. It is possible that the Wari's presence could have either been a tactic to show power and assert dominance over their southern borders. However, it is also possible that it was an act of diplomacy to validate state power through ritual and feasting to keep peace between the two powerful states (Nash and Williams 2005). Although the two states were in the same region, they appear to have maintained separate identities except for a Tiwanaku style temple on the top of Cerro Baul and a close proximity of Tiwanaku villages around the slopes of Cerro Baul and Cerra Mejia (Williams 2013). Overall, the Wari sites show much a higher prevalence of exotic goods in certain contexts, more diversity in material objects, and more palatial residences, suggesting that there were many socioeconomic and cultural differences between groups of people. In contrast, the Tiwanaku sites show lower numbers of exotic goods with less diversity in material objects with more equitable access to these items. They also have

much less monumental temple spaces and only one type of residential structures, suggesting less of a hierarchical divide between the people (Williams 2013).

### **3.4 Moquegua Valley**

The Moquegua Valley is a valuable area for research during the Middle Horizon and later not only because it is the only region where archaeologists see interactions between Wari and Tiwanaku, but because it is also the best known Tiwanaku province (Goldstein 2005; Sharratt 2011) The valley is located on the Pacific side of Southern Peru, roughly 300km from the Tiwanaku heartland. Ecologically, the valley is split into the lower, middle, and upper valleys. Throughout the valley, the aridity can make agriculture difficult, but with irrigation the people can grow crops such as maize and coca, which would have been useful for Tiwanaku. (Sharratt 2011). There are two main Tiwanaku styles seen throughout the middle and upper valley. The first is called the Omo style, and dates roughly to AD 575-700 and was associated with Tiwanaku Phase IV when the Moquegua Valley chronology was first established (Goldstein 1985). The second is called the Chen Chen style, and was initially dated to come into the valley around AD 785 and was linked to Tiwanaku Phase V. Although each style has direct links to Tiwanaku, the sites associated with each are characterized by differences in material styles and daily life. Omo had pottery types that were almost indistinguishable from heartland vessels with red-slipped and black polished fine wares. The style most closely resembles the pottery styles present on the southwestern shore of Lake Titicaca. The inhabitants appear to have been pastoralists due to the sites being located near llama caravanning routes rather than down near the flood plain that would have been used for farming. These sites also had fewer numbers of cemeteries, suggesting that they might have been short term settlements with more temporary housing structures. In contrast, the Chen Chen style does not have any polished blackware and



the red-ware slips are lighter, had lower firing, and are thicker than the Omo vessels (Goldstein 2005). These vessel types are more like those at the capital site of Tiwanaku, with some unique aspects. Unlike Omo, the Chen Chen sites are located closer to irrigation systems with large storage buildings, suggesting that they may have been farmers (Goldstein 2005, 2013; Sharratt 2011).

Since the 1980s, archaeologists have used material assemblages, architecture, and biological data to prove that Moquegua inhabitations were occupied by people that were culturally Tiwanaku. Local styles are absent from the material record and there does not appear to have been any intermarriage between Tiwanaku migrants and the indigenous populations. Since these two occupations have very different manifestations of Tiwanaku styles, and seemed to date to different time periods, the initial hypothesis was that the Chen Chen people were a separate group that migrated from the heartland after the Omo style died off. However, newer radiocarbon dates suggest that there was actually overlap between when the groups were living in the Moquegua Valley. If this is the case, it is more accurate to consider the groups to have been two different ethnic groups that migrated into the valley for separate causes, and they simply kept separate identities throughout the centuries (Goldstein 2005, 2013; Sharratt 2011).

### **3.5 Collapse and the Late Intermediate Period**

Around AD 1000, both Wari and Tiwanaku began a process of political fragmentation. One of the original hypotheses surrounding this collapse is that the states eventually lost the ability to sustain power through the major Pan-Andean drought that lasted until about AD 1500. Others critique this hypothesis and argue that it is more likely that the heartland elites strained the values of reciprocity, causing many to rebel and turn against one another. In the Moquegua Valley, this strain could have been heightened by the Wari hydraulic systems in the upper valley

depleting much of the available water before it could reach the Tiwanaku sites in the middle valley (Kolata and Ortloff 2003; Moseley 2001; Williams 2002; Sharratt 2011). The centuries during which Tiwanaku political fragmentation played out have been termed the terminal Middle Horizon in the Moquegua Valley because they fall into a transitional period that maintains many of the Middle Horizon styles and practices until the radical changes associated with the LIP start to appear around AD 1250 (Sharratt and Williams 2008). During this period (AD 950-1200) citizens began abandoning their larger communities and the refugees moved closer to the coast or to upland areas and created smaller settlements (Owen 2005; Sharratt 2011). In both the heartland and in Moquegua, people destroyed monumental sites such as the Putuni complex in Tiwanaku and the Omo temple in Moquegua. Storage facilities around the periphery were also destroyed (Goldstein 2005; Sharratt 2011). Instead of a larger urban core, there was a rise in rural agricultural colonies (Bermann et al 1989).

Within the Moquegua valley, there were two different stylistic groups, called Tumilaca and Ilo-Tumilaca. The Ilo-Tumilaca people seem to have traveled from mid-valley closer to the coast and had colorful textiles, polychrome ceramics, and depictions of mythical creatures (Owen 2005; Moseley 2001). The Tumilaca people relocated up-Valley and maintained a continuation of many of the Tiwanaku burial practices and pottery types (Figure 1) despite a lack of monumental architecture and depictions of deities (Bermann et al. 1989; Sharratt 2010, 2011, 2016a, 2016b; Sharratt and



**Figure 1** Tumilaca Style *Kero* (Photo courtesy of N. Sharratt)

Williams 2008; Sharratt et al. 2012). Eventually these groups also disappear and the Tumilaca people are replaced by Estuquiña outsiders and Ilo-Tumilaca by the Chiribaya in the Late Intermediate Period, although there may have been some overlap between groups (Owen 2005; Sutter and Sharratt 2010).

The subsequent Late Intermediate Period is characterized by the lack of uniformity that existed in the previous period. The appearance of more defensive settlements suggests an increase in conflict (Moseley 2001). The Estuquiña phase is the dominant manifestation of the LIP in the Tumilaca and Torata Valleys and extends down near to the middle valley. Like the Wari, these people practiced terraced agricultural methods high up on inaccessible hilltops. Their sites were often heavily defended by walls, but there is little evidence for combat in osteological samples (Arkush and Tung 2013; Williams 1990). Culturally, they had a very simple undecorated style of pottery (Figure 2), and according to contexts at the type-site of Estuquiña, they were not as concerned with keeping mortuary and domestic contexts separate as the earlier Tiwanaku and Tumilaca people (Goldstein 2005). Although this was the dominant phase within this region, similar events were occurring throughout the Andes, with several different *señorios* (“kingdoms”) becoming established after the fall of Tiwanaku and Wari (Bermann et al. 1989: 271).



**Figure 2** Estuquiña Style Boot Pot (Photo courtesy of N. Sharratt)

### 3.6 Contemporary Importance of Tiwanaku

Although the state of Tiwanaku was never revived after its demise, some can argue that it never really stopped being politically relevant, especially since many of the heartland ruins still stand today (Vranich 2013). Historically, we first hear of the reemergence of Tiwanaku's story as the Inka discovered its ruins during their expansion. A major point in their justification for ruling was based on the tale that they were the original people created for this earth. Finding evidence of an ancient civilization existing before them would have ruined their claims, so they denied any stories from the local people and made up their own creation myth. In this story, the god Viracocha turned the original inhabitants to stone and recreated the world, with the Inka as the first made. The Inka rulers then refurbished the Pumapunku at Tiwanaku and turned it into a major pilgrimage center. This period represents one of the first examples of a conquering force stealing the native people's history for their own political agenda. After the Spanish arrived, the Catholic priests would destroy the monoliths to prevent Natives from worshiping them, but 200 years later, a general fighting Spanish rule publicly lifted a fallen sculpture and declared the end of foreign rule (Vranich 2013).

The next well known example of the site being used for political gains was in the 1930s after the War of the Chaco (Vranich 2013). During this war, Bolivia lost many of their boundaries. To reclaim control over those boundaries, an archaeologist named Carlos Ponce Sangines worked to reconstruct the site as a symbol of Bolivian National Identity. These attempts led to some very inaccurate and sloppy reconstructions of many of the landmarks and the claim over some pre-war boundaries based on the location of the Akapana. Since the 1980's, there have been strides to use the site to reclaim native Bolivian identity. Tourism has grown both nationally and internationally at the site, and the Aymara people have gradually used the

site as a symbol in their climb to reclaim Bolivian politics from the past colonial and Mestizo rule. During this transitional period, archaeological control over the site and others has been stricter on who is allowed to do work, and pushed out Western and Mestizo control. In 2006, Evo Morales, who is a politician of Aymara descent, used the ruins for his political platform for presidency. During his campaign, he publicly walked up onto the platform in traditional garb and claimed that he was a representative of the indigenous people. This site was once again used for a political agenda to unite the country (Vranich 2013).

### **3.7 Conclusion: Identity and health within major transitions**

As more recent history has demonstrated, the rise and fall of major political entities can have major effects on populations (Kölves et al. 2013). Warfare might increase, methods of producing and acquiring resources can be jeopardized, individuals can be forced to relocate, abandon their ideological background, and adapt to novel cultural and physical environment (Kurin 2012; Schwartz 2006; Tung 2016). Archaeology focusing on the Middle Horizon and Late Intermediate Period in the Andes suggests that these sorts of events occurred after the decline of Wari and Tiwanaku power. The people went through several significant periods of change that dramatically impacted everyone living in these areas of the Andes. Overall, a majority of people migrated to new locations and gradually had to build new lives. Culturally, they shifted away from older religious beliefs, developed new ways of making pottery, textiles, burying their dead, and more. There was such drastic abandonment of their Tiwanaku and Wari ways of life, they felt the need to destroy monumental architecture and their old homes and move away to create a new identity for themselves (Arkush and Tung 2013; Bermann et al 1989; Covey 2008; Moseley 2001; Sutter and Sharratt 2010; Williams 2002). Along with the cultural shifts came economic shifts. Without the regional interactions that a centralized state would

control, people throughout the Andes were forced to adapt to their immediate environment until they could rebuild their lives enough to form new connections. This would have led to people developing new agricultural methods, finding new food sources, and changing overall subsistence patterns. If there was any pre-existing limit of resources before the collapse of the states, it is probable that such a transition would not have been smooth. People likely went through periods of famine, which would have increased bodily stress and levels of disease (Arkush and Tung 2013; Bermann et al 1989; Covey 2008; Moseley 2001; Sutter and Sharratt 2010; Williams 2002). Overall, the centuries spanning the Middle Horizon and the Late Intermediate Period in the Andes present an exceptional opportunity for archaeologists to study both the rise and fall of two large political entities over a relatively short period of time leading up to the Inca Empire and Spanish colonization. Thanks to the arid environment across the coastal and highland regions of the Andes, there has been valuable preservation of these peoples' culture that allows scholars to understand how major shifts in statehood can affect interactions, subsistence, identity, and health for large populations of people.

## 4 STUDY DESIGN

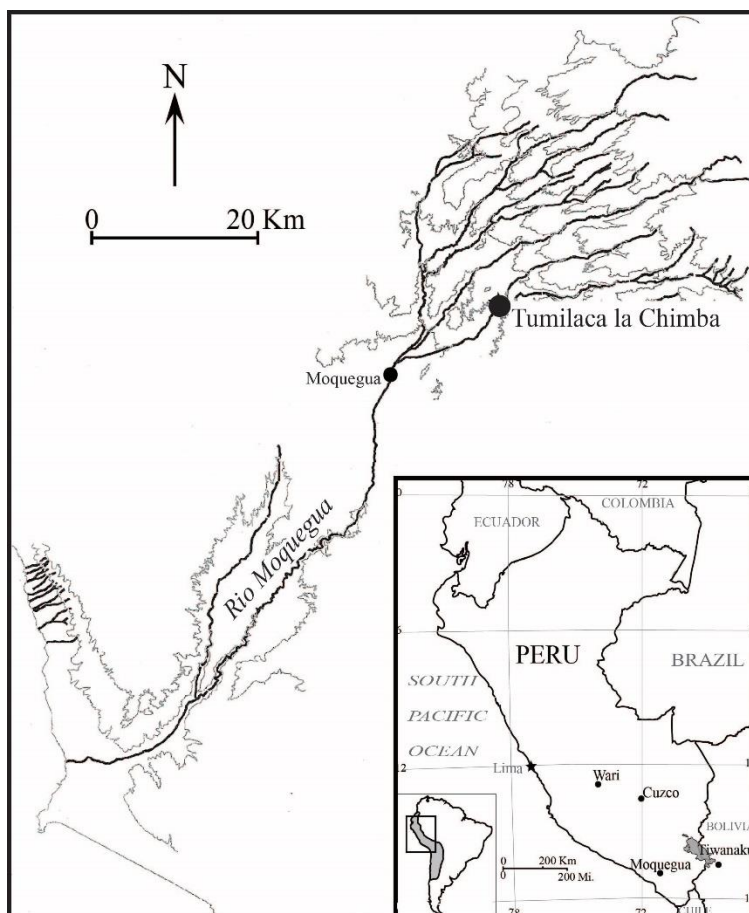
### 4.1 Introduction

Although there has been a lot of archaeological analysis in the Moquegua Valley (Bawden 1989, 1993; Blom et al 1998; Goldstein 2005; Owen 2005; Sharratt 2010, 2011, 2016a; Sharratt and Williams 2008) examining the peripheral regions of Tiwanaku post-collapse, there has not been much thorough bioarchaeological analysis of these periods in the region apart from the collections from the site of Estuquiña (Williams 1990; Williams et al. 1989; Buikstra 1995). Because both samples used in this study are from the same site, they allow for a unique opportunity to study shifts in demographics and health within a single environment over time. Although the sample size is smaller than preferred, this research will add valuable bioarchaeological knowledge to the existing literature. This chapter will describe the history of archaeological research at the site of Tumulaca la Chimba and will explain the sample and methods used for this study.

### 4.2 Tumulaca la Chimba

The site of Tumulaca la Chimba is located about 15km inland from the modern city of Moquegua within the Osmore Valley of Peru (Figure 3). It is located on a bluff north of the Tumulaca River (Bawden 1993, 1989; Sharratt 2011, 2016). There have been multiple

archaeological projects at the site of Tumulaca la Chimba over the last several decades. Romulo Pari Flores performed the first excavations of the site in 1980 for a Bachelor's thesis that focused on the mortuary components of what is now considered to be unit 45 of the site (Pari Flores 1980; Sharratt 2011). After Flores' initial excavations, the Programa Contisuyo completed some brief survey work on the site, which led to Garth Bawden's publications (Bawden 1989, 1993; Sharratt 2011).



**Figure 3** Moquegua Valley (Redrawn from Williams 2006 and Turner et al. 2013)

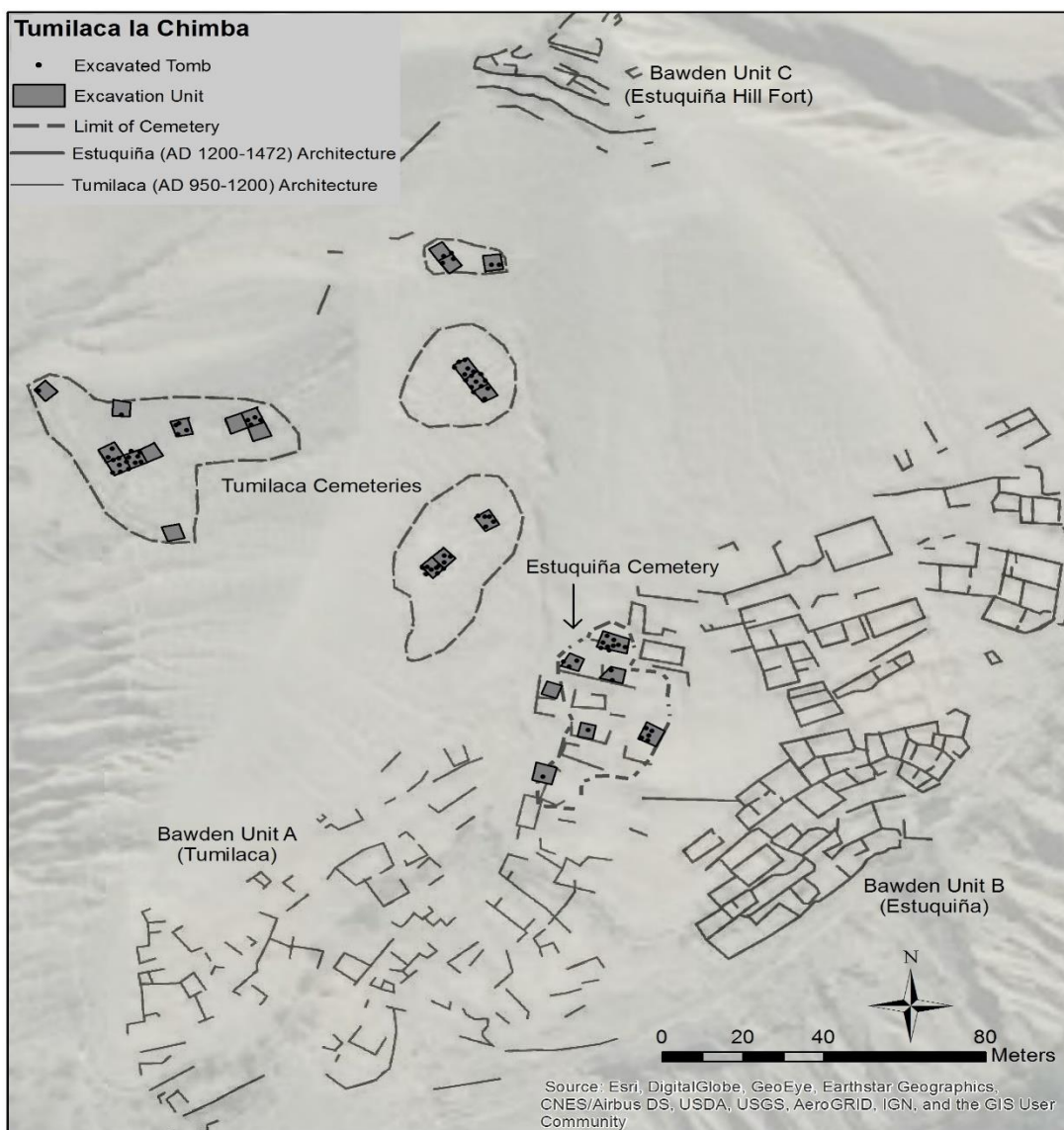
Based on a few days of survey mapping and test pit analysis, Bawden split the site into three distinct architectural components (Figure 4). The first component, called Unit A, consisted of domestic space on low terraces (Bawden 1989, 1993). Bawden (1989, 1993) stated that the constructions appeared to be sets of two to three rooms with specific, compartmentalized spaces. The material from this area included cooking vessels, food refuse, storage pits, hearths, and more. All the items appeared to be very similar to classic Tiwanaku style material culture with some deviations. He also noted a separate cemetery that was made up of cyst-like, stone covered burials, which were similar to Tiwanaku mortuary behavior (Bawden 1989, 1993). Based on the



material evidence, Bawden assigned unit A as a Tumulaca period (or Tiwanaku phase VI) settlement that dates to the end of Tiwanaku power, from AD 950-1200. This is consistent with other research around the Moquegua valley that shows refugees moving to smaller, higher settlements as Tiwanaku power began to diminish. Although people were relocating to new areas and abandoning their original homes, settlements remained fairly large with some traditional Tiwanaku iconography present in their new life, showing that there was probably still some form of centralized power in place to keep conformity between populations (Bawden 1989, 1993).

Bawden (1989, 1993) then argued that the second component (Unit B) stratigraphically dated a bit later than Unit A. Unit B was made up of two clusters of around 35 total rooms. Unlike Unit A, the rooms did not appear to have specialized use, and the material styles were vastly different; most notably within the pottery, which was very plain and crudely fired. There were also burials associated with this space that were more scattered, circular, *chullpa*-like (A *chullpa* is an above-ground burial tower) sunken chambers with stone walls exposed above ground. Bawden's Unit C was located at the top of the slope of Cerro la Chimba. It was a fortified walled enclosure that seemed to also be from the Estuquiña phase. It was hypothesized that this component helped the inhabitants to control who could or could not access the site as well as provide a place of protection from the southern side of the site if needed (Bawden 1989, 1993). Units B and C date to the Estuquiña period. Although there have been no radiocarbon dates for these units of the site, they relatively date from AD 1250-1476 based on regional chronologies. This period was characterized by the smaller, more communal based layout with less uniformity than the previous period. Bawden argued that these inhabitants were an ethnically different group of people that moved down from the highlands and practiced terraced agriculture. Unlike the people of Tumulaca, they did not have any ties to previous statehood to homogenize

their daily cultural practices (Bawden 1989, 1993). Because the initial excavations were limited, some of Bawden's original hypotheses concerning the organization and use of domestic space have since been disproven. However, his preliminary work demonstrated the huge potential of Tumilaca la Chimba as it contains both Tumilaca and Estuquiña phase occupations. Having the two periods in the same geographic area is extremely valuable for addressing the transition from the end of the Middle Horizon to the Late Intermediate Period and how it may have affected people's daily lives.



**Figure 4** Tumilaca la Chimba Excavated Cemetery Units (2006-2016)

Aside from regional survey work completed in 1996 by Bruce Owen that included Tumilaca la Chimba the next major period of excavations at the site began in 2006 as a rescue project from modern irrigation canal construction (Sharratt 2011). These excavations were a collaborative effort by Nicola Sharratt, Ryan Williams, Maria Cecilia Lozada, and colleagues and as of summer 2016, research on the site is still ongoing. These excavations have been much more extensive than those by Flores and Bawden and have led to reevaluation of some of Bawden's original hypotheses. The 2006 and 2007 excavations focused mainly on four Tumilaca phase cemeteries across the site for a comparative dissertation project. Units were excavated within each cemetery to compare the mortuary contexts, burial goods, and remains to one another as well as to those of other sites around the Moquegua Valley to better understand cultural identity during such a major transition period. The dissertation research concluded that the people living at Tumilaca la Chimba during the Tumilaca period continued to practice similar mortuary traditions to the original Tiwanaku colonies in the area with some subtle differences indicating greater factionalism within the community than in the earlier Tiwanaku migrant towns (Sharratt 2010, 2011; Sharratt et al. 2012).

The 2006 and 2007 seasons were followed by excavations in 2010 and 2012 in domestic and public ceremonial contexts associated with the Tumilaca occupation. Several publications about pottery and textile production as well as household and mortuary contexts at Tumilaca la Chimba have been written (Sharratt 2010, 2016a, 2016b; Sharratt et al. 2012; Sharratt et al. 2015; Sutter and Sharratt 2010). Based on pottery analysis, it appears as though Tumilaca pottery styles changed from very standardized forms to having more variation; the previous Tiwanaku Staff God motif is absent from ceramic assemblages, as it is from other Tumilaca phase sites (Goldstein 2005). Along with stylistic changes, there is evidence to suggest that pottery

production shifted from a specialized workshop setting to more local, domestic production that resulted in lower quality pottery (Sharratt 2016b). LA-ICP-MS elemental analysis on the pottery has demonstrated that although the pre-collapse Tiwanaku-affiliated groups and the Tumilaca phase people were using local clays for their pottery, the Tumilaca phase individuals had more variety in paste recipes than did the Tiwanaku colonies and a reduced presence of imported ceramics. These pottery data support the suggestion that regional political fragmentation impacted production and long distance exchange networks (Sharratt et al. 2015). In order to better understand the migration of the Tumilaca phase inhabitants onto the site, bioarchaeologist Richard Sutter used dental traits from the skeletal collection to determine where they may have originated. He first took dental scores and compared them to those from other populations. The results infer that the Tumilaca period individuals being migrants from Chen Chen style settlements (Sutter and Sharratt 2010). Sutter also gathered data from the individuals from the Estuquiña cemetery during the 2016 field season, and the results from that analysis are currently pending.

More recently, Nicola Sharratt has led excavations during the 2015 and 2016 field seasons under Sofia Chacaltana-Cortez's permit to better understand the Estuquiña components of the site. Field crews excavated both residential and mortuary contexts, but due to an unexpected abundance of burials within the cemetery, greater focus has been placed on the mortuary aspect of the area than anticipated. These new skeletal and mortuary data are currently being analyzed by specialists in faunal remains, ceramics, and human remains to add to future interpretations of the site and the Late Intermediate period across the Moquegua Valley of Peru. Although in-depth analysis is currently underway, my own observations during excavation in the summer of 2016 are similar to material descriptions of Estuquiña type burials and artifacts by

Sloan Williams and colleagues (1989; 1990). The tombs observed were circular, rock-lined, and below the surface, with some containing a stone and mortar collar above-ground. A majority of the pottery excavated was plain and was either in the shape of a typical *jarra* (pitcher) or was some sort of plain vessel broken into large sherds, although there was some decorated pottery. Some of the other items found were a boot shaped pot, a wooden spoon, gourds, wooden boxes, and many other artifacts like those found by Williams et al. (1989; 1990) in the Estuquiña type-site burials. Figures 5-8 depict some of the domestic and mortuary components of the site (All photos courtesy of N. Sharratt).



**Figure 5** Estuquiña Rooms (Not Excavated)



**Figure 6** Unit 48 Recinto A: Tumulaca Room



**Figure 8** Tumulaca cemeteries on slope on right, Estuquiña cemetery down on the flat bluff



**Figure 7** Unit 47 Recinto G: Tumulaca Tombs

### **4.3 Skeletal Population**

The skeletal sample for this study included 20 individuals from the Tumilaca cemeteries and 23 individuals from the Estuquiña cemetery. Although the skeletal collection from the Tumilaca component consisted of more than 20 individuals, due to time constraints, any skeletons who were not preserved well enough for useful analysis were not included in this analysis. Individuals were then randomly chosen from the laboratory inventory spreadsheet from each excavation unit and a full osteological analysis of each skeleton was completed. To minimize biases based on previous hypotheses, the data previously recorded by Jennifer Starbird (Sharratt 2010) and Sara Becker (2013) were not studied until analysis was complete. Examination of the Estuquiña component included all the individuals excavated over the 2015 and 2016 field seasons, excluding one adult and one infant who were not preserved well enough for reasonable analysis.

### **4.4 Osteological Methods**

A full osteological survey was conducted of each individual based on the standards set forth by Buikstra and Ubelaker (1994). First, an osteological inventory of each complete skeleton was recorded. Templates were used from Buikstra and Ubelaker (1994) for the inventory of each of the individuals studied from the Estuquiña cemetery since there has not been any previous analysis on the collection. However, the inventory of the Tumilaca skeletons was only recorded within lab notes for more efficient allocation of time and because there were already accurate worksheets previously recorded by Jennifer Starbird. When recording completeness on the template worksheets, the numbers one to three were used to signify how much of each bone was present. The number one indicated that over 75% of the bone was present, two specified that 25%-75% present, and three signified less than 25% present. A rough dental inventory was also

taken for each of the individuals whose dental remains were in situ or preserved well enough to assign original placement. While the inventory was being completed, pictures were taken of any potential pathologies and as many of the bones as possible, because cultural heritage laws will not allow any future access without a separate government permit to the skeletal collection after the end of this study.

After the initial inventory, estimates of age-at-death and sex utilizing the cranial and pelvic elements were recorded as described in Chapter two. The age categories assigned were those suggested by Buikstra and Ubelaker (1994); Fetal is before birth, Infants range from birth to 3 years, children are 3-12 years, adolescents are 12-20 years, young adults are 20-35 years, middle adults are 35-50 years, and old adults are more than 50 years old. For pathological analysis, any observation of what appeared to be minor to severe porotic hyperostosis and cribra orbitalia were noted to compare signs of possible anemia between populations. Visible dental pathological conditions were also documented such as: dental hypoplasias, premortem tooth loss, dental caries, and dental abscess that could be linked to any differences in diet and oral health. During inventory, any obvious occupational stress markers such as vertebral arthritis and other major skeletal pathologies were noted for each individual. I use these data to observe any major differences in demographics, stress, and health between the two populations. Due to the disarray that political collapse causes, I expect that the Tumilaca population would have experienced more stressors of the sort that would produce skeletal lesions than the Estuquiña people.

#### **4.5 Statistical Analyses**

Statistical analyses were completed to see if any known associations existed between those that showed signs of stress and the most prevalent pathologies. Chi-square tests were used to determine if the frequency of porotic hyperostosis and cribra orbitalia was associated to

assigned sex within each population from the Tumilaca and Estuquiña period cemeteries.

Although the sample size was small enough for a Fisher's exact test, the test only allows for two categories. Due to the need for three sex categories to account for those who were not possible to assign possible sex, the Fisher's Exact test was not applicable. A Spearman's rank test was also performed to note any associations between the appearance of porotic hyperostosis to cribra orbitalia within each population as well as any association between the presence of cranial porosities to dental hypoplasia in individuals.



## 5 ANALYSIS AND RESULTS

### 5.1 Tumilaca Period

#### 5.1.1 Sex and Age

As previously stated, the Tumilaca period sample consisted of 20 out of the 54 individuals excavated over the 2006 and 2007 field seasons. Of the 20 individuals, three (15% of the sample) were sexed as probable males, three (15%) as probable females, and fourteen (70%) as unknown due to young age. These percentages were then compared to the full sample that was previously sexed by Jennifer Starbird (Sharratt 2010) to note how representative the sample was of the whole collection. Of the 54 original individuals, nine (16.6%) were probable males, six (11.1%) were probable females, thirty-five (64.8%) were unknown due to age, and four (7.4%) were unknown due to the condition of the remains. Dental and skeletal traits were then examined to find possible ages at death. The sample ranged from infant to middle adult, with most the sample consisting of sub-adults (anyone younger than 20 years old). The ages break down to be six (30%) infants, eight (40%) children, three (15%) young adults, and three (15%) middle adults. Although three of the individual's possible age range fell into more than one category, they were placed into the category that they appeared most likely to fit into. When comparing the age category percentages to the larger sample, one must consider that Starbird's (Sharratt 2010) age ranges and categories did not match up well with those assigned within this study. Out of the full collection of Tumilaca skeletons, two (3.7%) were fetuses, six (11.1%) were infants, eighteen (33.3%) were children (2-5 years), five (9.2%) were juveniles (6-12 years), eight (14.8%) were adolescents, five (9.2%) were young adults, five (9.2%) were middle adults, three (5.5%) were old adults, and two (3.7%) were too fragmentary to age. Table 1 shows a breakdown of sex and age at death for the Tumilaca period cemeteries with skeletal IDs grouped by cemetery unit.

**Table 1** Tumilaca Sex and Age

<b>Skeletal ID</b>	<b>Sex (Score)</b>	<b>Age</b>
CB06-47-0061	N/A	3-5 y
CB06-47-0076	Female (2)	30-34 y
CB06-47-0082	N/A	3-5 y
CB06-47-0083	N/A	1-2 y
CB06-47-0084	Female (1)	18-24 y
CB06-47-0085	N/A	3.5-6.5 y
CB07-44-0019	Male (4)	30-39 y
CB07-44-0020	N/A	birth +/- 2 months
CB07-45-0074	N/A	3-5 y
CB07-45-0076	N/A	3-5 y
CB07-45-0078	N/A	1-2 y
CB07-45-0081	N/A	1-2 y
CB07-45-0085	N/A	2-4 y
CB07-45-0086	N/A	6- 12 months
CB07-45-0095	N/A	9.5- 14.5 y
CB07-46-0059	Male (5)	35-39 y
CB07-46-0067	Male (4)	35-45 y
CB07-46-0069	N/A	3-9 months
CB07-46-0072	N/A	3-5 y
CB07-46-0073	Female (1/2)	20-24 y

### **5.1.2 Pathology**

Although most focus was placed on the prevalence of stress markers such as porotic hyperostosis, cribra orbitalia, dental hypoplasias, and dental caries and abscesses, any other obvious pathological lesions or cultural cranial modifications were also noted. Within this sample of the Tumilaca population, there were seven examples of cribra orbitalia, ranging from active to healed. Five of these individuals were aged as children, but the remaining two were aged as one young adult (active lesions) and one middle adult (healed lesions). However, there were only three skeletons that exhibited signs of porotic hyperostosis. Two individuals were children, one with an active case and one healed, and one individual was a young adult with an

active case. Four skeletons also had small, non-diagnostic endocranial lesions. One of these individuals had an exceptionally bad case that appeared similar to the smaller endocranial markings associated with multiple myeloma; however, she was only a young adult and myeloma tumors typically do not appear until a person is at least 40 years old (Ortner 2003:376-377). Some of the other pathologies noted were: degenerative joint disease (three with vertebral arthritis), one case of severe pitting in vertebrae and sternum (possibly tuberculosis), miscellaneous lesions from infection, one minor case of spina bifida occulta, and three instances of healed fractures. Of the twenty skeletons from these cemeteries, only eight had visible cranial modification. Although several skeletons exhibited signs of cribra orbitalia and porotic hyperostosis, no obvious signs of dental enamel hypoplasias were evident within the Tumilaca sample. However, there were five individuals with possible carious lesions, two of which also had abscesses, one middle adult with maxillary and mandibular alveolar resorption, one instance of possible weathered hypocalcification spots, and three older individuals with significant dental wear. It is also worth noting that one child had left maxillary molars that appeared similar to mulberry molars, which are commonly associated with congenital syphilis (Loannou et al. 2015).

### ***5.1.3 Statistical Results***

To complete the Chi-square tests to determine if there were any associations between assigned sex and cranial porosities, the null hypothesis was set that sex is not associated with the prevalence of porotic hyperostosis or cribra orbitalia. When testing associations between porotic hyperostosis and sex, the results presented a p-value of .995. Because this number is much higher than the standard of .05, there is no statistically significant association between sex and porotic hyperostosis, so the null hypothesis is not rejected. The same test for cribra orbitalia resulted in a p-value of .515. As with porotic hyperostosis, there is no statistically significant association

between sex and cribra orbitalia, and the null hypothesis is not rejected. The null hypotheses for the Spearman's rank tests are that there is no association between cribra orbitalia and porotic hyperostosis as well as the cranial porosities and linear enamel hypoplasias although all three conditions can be associated with childhood malnutrition or illness. The test analyzing association between porotic hyperostosis and cribra orbitalia has a significance value of .008, which is less than the .05 standard, therefore there is a significant association between prevalence of cribra orbitalia and porotic hyperostosis. The hypothesis is rejected as there is a statistically significant relationship between the two. Spearman's rank analyzing association between cranial porosities and linear enamel hypoplasias could not be completed since none of the individuals showed signs of linear enamel hypoplasia, therefore the hypothesis could not be tested. Appendix A contains charts with SPSS results for each test in this study.

## **5.2 Estuquiña Period**

### ***5.2.1 Sex and Age***

The Estuquiña period sample consisted of 23 out of the 25 individuals excavated over the 2015 and 2026 field seasons. Of those skeletons, seven (30.4%) were sexed as probable male, nine (39.1%) were probable females, four (17.4%) were not sexed because of young age, and three (13%) were unknown either due to the fragmentary nature of the remains or ambiguous skeletal traits. Like the Tumilaca group, the ages of these individuals ranged from infant to middle adult; however, there was a much greater ratio of adults to sub-adults within this cemetery than in the Tumilaca cemeteries. Of the 23 individuals, there was one (4.3%) infant, three (13%) children, three (13%) adolescents eight (34.8%) young adults, six (26.1%) middle adults, and two (8.7%) adults of unknown age, although they are likely to be older than twenty-

five based on long bone fusion. Table 2 depicts a breakdown of those excavated from the Estuquiña cemetery.

**Table 2** Estuquiña Sex and Age

<b>Skeletal ID</b>	<b>Sex (Score)</b>	<b>Age</b>
CB15-56-0327	M (4)	30-39 y
CB15-56-0328	N/A	6-10 y
CB15-56-0329	M (4)	25-34 y
CB15-56-0330	F (2)	35-39 y
CB15-56-0331	F (possibly gracile due to age)	17-21 y
CB15-56-0332	N/A	6-10 y
CB15-56-0333	F (2)	25-34 y
CB15-56-0334	N/A	3-5 y
CB15-56-0335	F (1/2)	30-39 y
CB16-56-1806	F (1/2)	35-45 y
CB16-56-1807	N/A	1-2 y
CB16-56-1808	F (possibly gracile due to age)	15-21 y
CB16-56-1809	F (1/2)	25-34 y
CB16-56-1810	M (3/4)	25-34 y
CB16-56-1811	M (4/4)	30-35 y
CB16-56-1812	M (4/3)	21-35 y
CB16-56-1814	U (frag)	U Adult
CB16-56-1815	U	U Adult
CB16-56-1816	M (4/5)	20-29 y
CB16-56-1817	F (1/2)	25-34 y
CB16-56-1818	M (4?Frag/4)	30-39 y
CB16-56-1819	F (possibly gracile due to age)	15-20 y
CB16-56-1820	U (2/3)	30-39 y

### 5.2.2 Pathology

In contrast to the Tumulaca sample, the skeletons from the Estuquiña cemetery showed fewer signs of cribra orbitalia and porotic hyperostosis. Of the 23 individuals, there were no visible markings of active or healed cribra orbitalia and only three instances of porotic hyperostosis. One of the skeletons was aged as a child, while the others were adults. There were also only two individuals, both over 30 years old, who had any non-diagnostic endocranial lesions. Overall, the Estuquiña sample seemed to have fewer pathological markings with the

exception of degenerative joint disease. There were three individuals with possible mild cases of spina bifida occulta, three individuals with miscellaneous infectious lesions, and one healed fracture of the left tibia, and nine individuals appeared to have some cranial modification. Although there seems to be fewer instances of infection and stress on the bones, the oral health of the Estuquiña people seems to be worse than the Tumilaca period inhabitants. Despite the fragmentary nature of many of the teeth in the Estuquiña sample, 19 people exhibited possible dental caries, and two individuals had abscesses. There were also 12 examples of alveolar resorption, four individuals with possible linear hypoplasias, five examples of notable dental wear, one example of possible hypocalcification, and one individual with dental pearls at least three of the teeth.

### ***5.2.3 Statistical Results***

As with the Tumilaca populations, the Chi-square null hypothesis was set that sex is not associated with the prevalence of porotic hyperostosis or cribra orbitalia. When testing associations between porotic hyperostosis and sex, the results presented a p-value of .277. Because this number is higher than the standard of .05, there is no statistically significant association between sex and porotic hyperostosis; the null hypothesis is not rejected. Since no individuals in this population displayed signs of cribra orbitalia, the hypothesis could not be tested. The same is true when using Spearman's rank to test associations between cribra orbitalia and porotic hyperostosis; however, the null hypothesis stating that there is no association between cranial porosities and linear enamel hypoplasias could be tested. This test resulted in a significance value of .380, which is more than the .05 standard. There is no significant association between porosities and hypoplasias, and the hypothesis is not rejected.

## 6 DISCUSSION

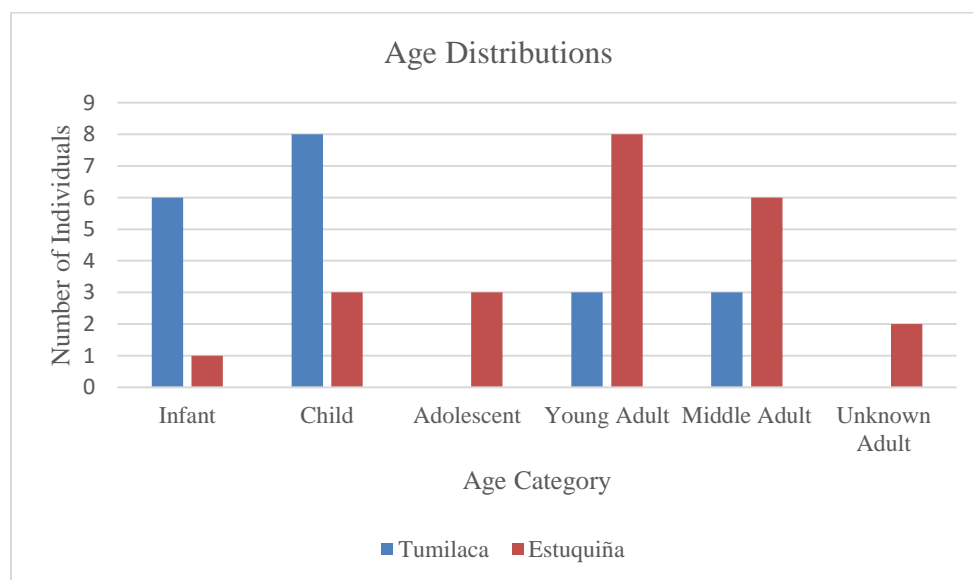
### 6.1 Demographics

As noted above, there are significant differences in distributions of age at death (table 3 and Figure 9), with most of the Tumilaca burials consisting of children and infants. Of those aged within the Tumilaca sample, 70% of the individuals were aged younger than twelve years old, while only 17% of the Estuquiña sample were aged that young. Jennifer Starbird and Nicola Sharratt (2011) previously noted that excavations targeted intact burials to gain a more holistic view of burial practices in each tomb. It is highly likely that these actions skewed the sample toward small tombs of subadults who were less likely to have been affected by looting. However, considering the possibility of more nutritional stress and infection during the Tumilaca period, it is also possible that the greater number of children buried is due to higher childhood mortality during this time. It is also likely that the higher number of child burials is a result of more children being born, suggesting a larger population during the Tumilaca period. When looking at the distributions of sex within the Tumilaca sample, there is an even distribution between males and females, but all the females are younger adults, while the males are all aged as middle adults. In contrast, although the Estuquiña sample contains a fairly even distribution with seven males and six females, their age at death appears to be a bit more sporadic with a majority of males within the young adult age range and the females being evenly dispersed between young and middle adult ranges. Although younger males might be sexed as female based on the gracile nature of their skeleton (Buikstra and Ubelaker 1994), these trends could also allude to differences in mortality rates between sexes in each population. If mortality rates are to blame for variation in sex, it would appear as though the Tumilaca population could have experienced a

higher number of women dying during childbirth, which would prevent them from surviving into their mid-thirties or later (Starbird in Sharratt 2011).

**Table 3** Tumilaca and Estuquiña Sex and Age at Death

<u>Age at Death</u>	<u>Tumilaca</u>			<u>Estuquiña</u>		
	<u>M</u>	<u>F</u>	<u>U</u>	<u>M</u>	<u>F</u>	<u>U</u>
<u>Infant (Birth-3 yrs.)</u>	--	--	6	--	--	1
<u>Child (3-12 yrs.)</u>	--	--	8	--	--	3
<u>Adolescent (12-20 yrs.)</u>	--	--	--	--	--	3
<u>Young Adult (20-35 yrs.)</u>	--	3	--	5	3	--
<u>Middle Adult (35-50 yrs.)</u>	3	--	--	2	3	1
<u>Unknown Age Adult</u>	--	--	--	--	--	2
<b>Total:</b>	<b>3</b>	<b>3</b>	<b>14</b>	<b>7</b>	<b>6</b>	<b>10</b>



**Figure 9** Sex and Age Comparison



## 6.2 Stress and Health

### 6.2.1 *Breakdown by Age Categories*

It is very likely that much of the variation in pathology prevalence between the two populations are a result of the vast differences in age distribution; nevertheless, when looking at pathologies specifically within certain age categories, there are still significant differences within subadults (Table 4) and within adults (Table 5) in the two populations. Within the 14 subadults of the Tumilaca sample, one had healed cribra orbitalia, one was healing, and one was active. There was also one individual with both active cribra orbitalia and porotic hyperostosis and one with healed manifestations of the two pathologies. In contrast, there was only one subadult with active porotic hyperostosis of the seven analyzed in the Estuquiña sample. Because there are twice as many subadults in the Tumilaca sample, it is difficult to say whether this difference is a result of variances in stress between the two populations or if it is simply from the differences in sample size. Comparing infectious lesions and trauma, there were three individuals with subcranial infectious lesions, one with endocranial lesions, and one with a healed depression fracture in the Tumilaca population; however, none of the Estuquiña subadults exhibited any of these signs. Dental pathologies in the subadults were a bit more evenly distributed, with two Tumilaca subadults showing signs of possible hypocalcification, one with a hypoplastic defect of the molars, two Estuquiña subadults with possible hypocalcification, and one with enamel hypoplasias. There were also three Tumilaca and four Estuquiña subadults with possible caries. However, when considering the percentages that those individuals make up within the total numbers of subadults, there is a much smaller percentage of Tumilaca individuals with the dental pathologies. In the Tumilaca subadult sample, most individuals were younger than five years old at death, while most of the Estuquiña individuals were older than five. Because the Tumilaca

subadult sample is so young, I argue that the lack of dental hypoplasias is likely a result of the individuals having not yet reached the stages of dental development that would show hypoplasias.

**Table 4** Tumilaca and Estuquiña Subadult Pathology and Tomb Types

<b>Specimen Number</b>	<b>Age</b>	<b>Pathologies</b>	<b>Tomb Type</b>
<b><u>Tumilaca:</u></b>			Poorly constructed, partially stone-lined cist
<b>CB06-47-0061</b>	3-5 y	No visible pathology	
<b>CB06-47-0082</b>	3-5 y	Healed cribra orbitalia, some porosity on occipital bone	Stone-line cist
<b>CB06-47-0083</b>	1-2 y	Infectious lesion on right eye orbit	Partially stone-lined cist
<b>CB06-47-0085</b>	3.5-6.5 y	Mild active Cribra Orbitalia, Hypoplastic defect on mandibular left molars (looks similar to mulberry molars)	Partially stone-line cist
<b>CB07-44-0020</b>	Birth +/- 2 months	No visible pathology	Stone-lined cist
<b>CB07-45-0074</b>	3-5 y	Mild, active cribra orbitalia, slight, active porotic hyperostosis, possible healed depression fracture, possible cavity on mandibular rm2 (probably developmental)	Stone-lined cist
<b>CB07-45-0076</b>	3-5 y	Moderate, healing cribra orbitalia	Unlined pit
<b>CB07-45-0078</b>	1-2 y	No visible pathology	Stone-lined cist
<b>CB07-45-0081</b>	1-2 y	Possible hypocalcification broken oh weak areas	Stone-lined cist
<b>CB07-45-0085</b>	2-4 y	Possible caries and broken hypocalcification	Stone-lined cist
<b>CB07-45-0086</b>	6-12 months	Possible infection on left zygomatic	Partially stone-lined cist

<b>CB07-45-0095</b>	9.5-14.5 y	Lesion on endocranial parietal, infection on left distal fibula	Stone-lined
<b>CB07-46-0069</b>	3-9 months	No visible pathologies	Unlined pit
<b>CB07-46-0072</b>	3-5 y	Mild, healed cribra orbitalia and porotic hyperostosis, possible cavity on mandibular Im2	Unlined pit
<b><u>Estuquiña:</u></b>			
<b>CB15-56-0328</b>	6-10 y	Hypoplasias on incisors	Stone-lined cist
<b>CB16-56-1807</b>	1-2 y	Active porotic hyperostosis on parietals, possible hypoplasias or hypocalcification that broke on the weaker areas	Unlined pit
<b>CB16-56-1808</b>	15-21 y	Possible hypocalcification	Stone-lined cist
<b>CB15-56-0332</b>	6-10 y	Possible dental caries on maxilla RM1	Stone-lined cist
<b>CB15-56-0331</b>	17-21 y	Has dental caries	Stone-lined cist
<b>CB15-56-0334</b>	3-5 y	Possible caries on mandibular Idm2	Stone-lined cist
<b>CB16-56-1819</b>	15-20 y	Has dental caries	Stone-lined cist

There were also significant differences in prevalence of pathologies within the adults of the two populations. Of the six Tumilaca adults, one had active manifestations of cribra orbitalia and porotic hyperostosis and one had healed cribra orbitalia. There were only two individuals of the 16 Estuquiña adults that had healed porotic hyperostosis. When looking at rates of trauma and infection, there were two Tumilaca adults (one with a healed fracture and infection on the right clavicle and one with possible healed cranial trauma) with trauma, three with miscellaneous endocranial lesions and three with subcranial infectious lesions. Of the Estuquiña adults, there

was only one individual with a healed tibia fracture, two with endocranial lesions, and three with subcranial lesions. As with the subadult distributions, although the numbers of individuals in each population are close, there is more than twice the number of adult individuals in the Estuquiña sample. With that in mind, there is a much higher percentage of individuals in the Tumilaca population with these pathological lesions than in the Estuquiña sample. For dental pathologies, the Estuquiña sample had one individual with enamel hypoplasias, and one with either hypocalcification or hypoplasias that had broken on the lines, while the Tumilaca sample had none. The Estuquiña adults depicted much higher rates of caries, abscess and resorption, with at least 14 individuals having caries and abscesses, and 12 people showing signs of alveolar resorption. These numbers are much higher than in the Tumilaca population, where there were only two individuals with caries or abscess, and one individual with resorption. There were also a lot more cases of vertebral arthritis in the Estuquiña collection (N=7) than in the Tumilaca sample (N=3). The greater number of dental disease as well as the greater prevalence of vertebral arthritis within the Estuquiña sample is likely a reflection of the overall higher average age at death within the group. Although it is possible for younger individuals to develop dental problems, and diet is always a major factor in dental health, older individuals that do not have adequate dental treatment are going to develop more caries over time, which will progress into abscesses and eventual tooth loss and resorption. The same argument can be made for vertebral arthritis since degenerative joint disease takes time and a lot of mechanical stress to form over one's lifetime (Adams and Roughley 2006).

**Table 5** Tumilaca and Estuquiña Adult Pathology and Tomb Types

<b>Specimen Number</b>	<b>Age</b>	<b>Pathologies</b>	<b>Tomb Type</b>
<b><u>Tumilaca:</u></b> <b>CB06-47-0076</b>	30-34 y	Lesion on posterior manubrium, vertebral pitting, and two fused thoracic vertebrae	Unlined pit

		(consistent with tuberculosis), spina bifida occulta	
<b>CB06-47-0084</b>	18-24 y	Moderate active cribra orbitalia and porotic hyperostosis, endocranial lesions throughout the skull, schmorl's nodes on thoracic vertebrae, dental caries	Unlined pit
<b>CB07-44-0019</b>	30-39 y	Vertebral arthritis, possible abscess (taphonomic breakage disrupts diagnosis)	Stone-lined cist
<b>CB07-46-0059</b>	35-39 y	Mild healed cribra orbitalia, pitting on posterior sternum, healed fracture that got infected on right clavicle, endocranial lesions, dental abscess, vertebral arthritis	Poorly constructed partially stone-lined cist
<b>CB07-46-0067</b>	35-45 y	Vertebral arthritis, cranial porosity (not porotic hyperostosis), possible healed cranial trauma, endocranial lesions, dental resorption	Unlined pit
<b>CB07-46-0073</b>	20-24 y	No visible pathology	Partially stone-lined cist
<b><u>Estuquiña:</u></b> <b>CB15-56-0327</b>	30-39 y	Dental resorption and caries	Stone-lined cist
<b>CB16-56-1806</b>	35-45 y	Possible healed porotic hyperostosis, vertebral arthritis, endocranial lesions, resorption, and caries	Stone-lined cist
<b>CB15-56-0329</b>	25-34 y	Vertebral arthritis, dental resorption, abscess, and caries	Stone-lined cist

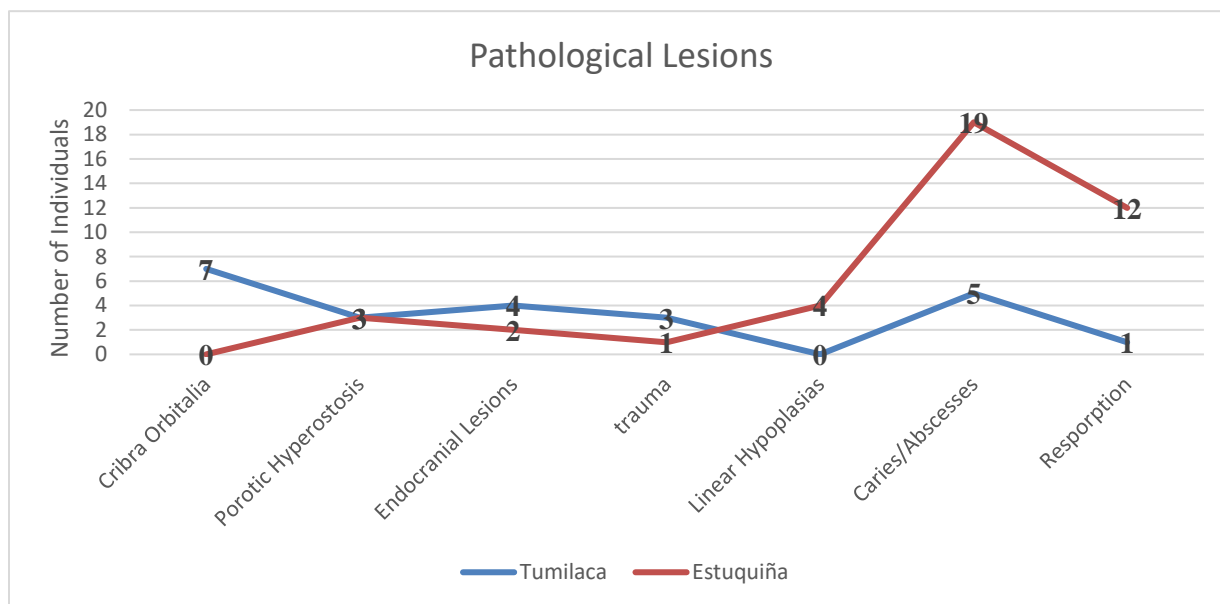
<b>CB15-56-0330</b>	35-39 y	Dental resorption, and caries	Stone-lined cist
<b>CB15-56-0333</b>	25-34 y	Dental resorption, abcess, and caries	Stone-lined cist
<b>CB15-56-0335</b>	30-39 y	Vertebral arthritis, dental resorption, caries	Stone-lined cist
<b>CB16-56-1809</b>	25-34 y	Healed fracture on left tibia, dental resorption and caries	Stone-lined cist
<b>CB16-56-1810</b>	25-34 y	Vertebral arthritis and dental caries	Stone-lined cist
<b>CB16-56-1811</b>	30-35 y	Vertebral arthritis, endocranial lesions and cranial porosity, dental resorption and caries	Stone-lined cist
<b>CB16-56-1812</b>	21-35 y	Vertebral arthritis, extra lumbar vertebra, infection on right humerus, spina bifida occulta, dental caries	Stone-lined cist
<b>CB16-56-1814</b>	Unknown age adult	Spina bifida occulta, possible resorption of 3 M3s or they never erupted, caries	Stone-lined cist
<b>CB16-56-1815</b>	Unknown age adult	Healed porotic hyperostosis, possible resorption	Stone-lined cist
<b>CB16-56-1816</b>	20-29 y	Periosteal reaction on legs, either hypoplasias or hypocalcification, caries	Stone-lined cist
<b>CB16-56-1817</b>	25-34 y	Periosteal reaction on legs, spina bifida occulta, caries	Stone-lined cist
<b>CB16-56-1818</b>	30-39 y	Enamel hypoplasias, caries	Stone-lined cist (noted as being more monumental than others)
<b>CB16-56-1820</b>	30-39 y	Vertebral arthritis, resorption, abcess, and caries	Stone-lined cist

### 6.2.2 *Breakdown by Tomb Type*

Although funerary practices often say more about the living that constructed the tombs than the person buried, they can often say at least a little about the lives of those who died. People might be buried differently based on wealth and status during life, religion, or even health if they had a stigmatized illness before death (Parker-Pearson 1999). For the two populations in this study, grave inclusion styles were different between the Tumilaca and Estuquiña cemeteries; however, their overall tomb form and the types of items present were similar. Most of the people from both periods were buried in below-ground cists, with some variation such as the proto-*chullpas* from the Estuquiña phase (Sharratt 2011). The two tomb types associated with this project's samples are in the form of stone-lined cists or unlined pits, and there does not appear to be a very large difference in tomb type that is indicative of a major status hierarchy on the site. Tables 4 and 5 list the tomb forms for each individual to note if there could be any link between tomb type and the individuals' pathologies. As noted in each table, a majority of tombs for both adults and subadults are stone-lined cists. The Tumilaca sample contained four partially stone-lined cists, seven partially stone-line cists, and three unlined pits for the subadults. For the adults, there were three unlined pits, one stone-lined cist, and two partially stone-lined cists. There does not appear to be any significant link between tomb type and visible pathologies for the Tumilaca subadults, but it is worth noting that two of the unlined pits for the adults are also the two adults with the most severe presence of pathological markings. One of those individuals shows possible signs of having tuberculosis, and the other exhibited an extreme case of endocranial lesions throughout the entire skull. The Estuquiña sample was made of six stone-lined cists and one unlined pit for the subadults, and all 16 adults were buried in stone-lined pits. The one unlined pit was the burial of a child that was between one and two years old that exhibited signs of

porotic hyperostosis as well as a form of hypocalcification or hypoplasia that broke on the weaker areas due to taphonomic processes. Of the stone-lined cists, there was one burial of a male that was between 30 and 39 years old that was noted as being more monumental than the other Estuquiña tombs. This male only showed signs of enamel hypoplasias and dental caries. Overall, there does not seem to be much of a connection between tomb type and pathology within the Estuquiña sample.

### 6.2.3 Overall Trends in Stress Markers



**Figure 10** Pathological Lesions

When comparing health between the two populations, those from the Tumulaca period show signs of more instances of cribra orbitalia, infectious endocranial lesions, and signs of trauma. However, the Estuquiña population demonstrates a higher prevalence of linear enamel hypoplasias, vertebral arthritis, possible mild cases of Spina Bifida Occulta, and dental disease (Figure 10). Although the greater numbers of cribra orbitalia, infectious lesions, and trauma may have resulted from differences in individuals' rates of disease manifestation or healing and



remodeling (Wood 1992), they could also indicate that the people living during the Tumilaca period may have experienced more overall stress during life, whether through infectious disease, periods of anemia, or parasitic infection (Holland and O'Brien 1997; Jacobi and Danforth 2002; Lallo et al. 1977; Naveed et al 2012; Rothschild 2000; Walker et al. 2009). The absence of LEH within the Tumilaca population suggests that those with cribra orbitalia and porotic hyperostosis could have experienced periods of chronic vitamin deficiency that were not related to periods of growth-disrupting illness that generally causes enamel hypoplasia (Goodman et al. 1984b; Goodman and Rose 1990; Griffin and Donlon 2009; Hubbard et al. 2009). Since the rates of dental disease were lower during the Tumilaca phase, I argue that the instances of Cribra Orbitalia and Porotic Hyperostosis are more likely to be related to parasitic infection from marine resources or the local rivers rather than malnutrition from a more starchy, cariogenic diet (Blom et al. 2005; Holland and O'Brien 1997; Rothschild 2000; Verano 1997). When analyzing what these differences might mean archaeologically, the greater prevalence of general stress indicators and trauma within the Tumilaca population implies that they were likely to have suffered during the chaos immediately following collapse. In contrast, while the Estuquiña inhabitants would have also experienced times of physiological stress, as seen in the individuals with LEH, they are likely to have experienced lower levels of disease and malnutrition than those living during the Tumilaca period.

## 7 CONCLUSIONS

### 7.1 Conclusion and Future Research

The site of Tumulaca la Chimba contains two post-Tiwanaku occupations that are associated with the period of turmoil brought about by the decline of the terminal Middle Horizon and the period of rebuilding that occurred into the Late Intermediate period. My study examines these periods of cultural change and compares the overall signs of stress within the two populations that resided and died at the site by using osteological analysis of the preserved remains. By examining the biological remains of the individuals interred at each of the cemeteries at Tumulaca la Chimba, I argue that those living during the Tumulaca period were not only culturally affected as they were forced to relocate during the fall of Tiwanaku, but that they also experienced moments that compromised their health and stress levels. In contrast, by the time that the Estuquiña people were moving onto the site over 200 years later, chaos would have dissipated, and they would not have experienced the same stressors that caused cranial porosities and infection in the Tumulaca population. It is also worth noting that there were no signs of intrapersonal violence within either population. Despite the defensive location of the site and the hill fort that was built during the Estuquiña period, these results support current claims that the LIP was a period of hostilities in this region rather than a time with all out violence (Arkush and Tung 2013).

Although osteological analysis has supported my hypotheses, more data is needed to fully understand how individuals were living during this transitional period. In order to add to these data, a much larger sample size is required from each population that has not been subjected to excavation biases. With a larger sample, analysis of demographics and how they are related to prevalence of pathological lesions will be more informative and representative of the population

during that time period. Methods other than visual osteological analysis are also crucial to understanding the potential causes for some lesions and to better understand where each group would have originated before migrating to the site. Isotope analysis would be extremely helpful to determine whether cribra orbitalia, porotic hyperostosis, and dental decay is more likely to be related to diet, or some other cause. It would also help to determine if the Tumilaca inhabitants were actually migrants from the nearby Chen Chen sites or elsewhere, and aid in settling debates as to whether the Estuquiña people migrated from the highlands or another locale.

## **7.2 Contributions to Andean Archaeology and Future Research**

This study of skeletal and dental indicators presents a preliminary investigation of health and disease among the Tumilaca and Estuquiña occupations at Tumilaca la Chimba. This thesis offers a unique opportunity to study differences between these two groups because of their presence at the same site, without the possible ecological and local subsistence differences implied by studying different sites. Based on existing literature, it appears that very little previous osteological analysis has been completed to help understand Tumilaca and Estuquiña cultures (Williams 1990; Williams et al 1989; Buikstra 1995). My research will contribute to a broader understanding of the migration and possible interactions of people in the post-Tiwanaku era Moquegua valley as well as studying how these shifts may have affected the subsistence and levels of stress of people. If some form of agricultural instability brought about the demise of a political entity, it is important to understand how people would have coped with not only their political cohesion declining in this area, but also how successful they would have been in finding alternative agricultural methods and food sources when relocating to new territories.

Not only will my study add to the current literature specifically on the Moquegua valley, but it will contribute to a larger understanding of how political decline affected indigenous

populations throughout the pre-Inca and pre-Hispanic Andes. The shifts of subsistence and overall health of populations would not have been secluded to just the Moquegua valley during the Late Intermediate period. As stated in chapter three, very similar processes were occurring across the Andes from the most northern borders of previous Wari control in Peru to the southern boundaries of Tiwanaku in Bolivia. While some larger coastal groups appear to have not been affected as much during this time, a majority of the highland populations that were directly under the control of either Wari or Tiwanaku scattered to higher locations in order protect their territories and start anew (Covey 2008). Overall, it is my aim that my research will be a valuable addition to existing literature on the transition into the Late Intermediate Period within the Moquegua Valley of Peru as well as the broader cultural context of the Peruvian Andes.

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## APPENDICES

## Appendix A: SPSS Results

*Appendix A.1: Tumilaca Sex vs. Cribra Orbitalia Crosstabulation*

Sex * CribraOrbitalia Crosstabulation					
			CribraOrbitalia		Total
			No	Yes	
Gender	Female	Count	2	1	3
		% within Sex	66.7%	33.3%	100.0%
		% within CribraOrbitalia	15.4%	14.3%	15.0%
	Male	Count	2	1	3
		% within Sex	66.7%	33.3%	100.0%
		% within CribraOrbitalia	15.4%	14.3%	15.0%
	N/A	Count	9	5	14
		% within Sex	64.3%	35.7%	100.0%
		% within CribraOrbitalia	69.2%	71.4%	70.0%
Total		Count	13	7	20
		% within Sex	65.0%	35.0%	100.0%
		% within CribraOrbitalia	100.0%	100.0%	100.0%

**Appendix A.2: Tumilaca Sex to Cribra Orbitalia Chi-Square Values**

<b>Chi-Square Tests</b>			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.010 <sup>a</sup>	2	.995
Likelihood Ratio	.011	2	.995
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is 1.05.

**Appendix A.3: Tumilaca Sex vs. PH Crosstabulation**

<b>Sex * PoroticHyperostosis Crosstabulation</b>					
			PoroticHyperostosis		Total
			No	Yes	
Gender	Female	Count	2	1	3
		% within Sex	66.7%	33.3%	100.0%
		% within PoroticHyperostosis	11.8%	33.3%	15.0%
	Male	Count	3	0	3
		% within Sex	100.0%	0.0%	100.0%
		% within PoroticHyperostosis	17.6%	0.0%	15.0%
	N/A	Count	12	2	14
		% within Sex	85.7%	14.3%	100.0%
		% within PoroticHyperostosis	70.6%	66.7%	70.0%
Total		Count	17	3	20
		% within Sex	85.0%	15.0%	100.0%
		% within PoroticHyperostosis	100.0%	100.0%	100.0%

**Appendix A.4: Tumilaca Sex to PH Chi-Square Values**

<b>Chi-Square Tests</b>			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.326 <sup>a</sup>	2	.515
Likelihood Ratio	1.606	2	.448
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .45.

**Appendix A.5: Estuquiña Sex to Porotic Hyperostosis Crosstabulation**

<b>Sex * PoroticHyperostosis Crosstabulation</b>					
			PoroticHyperostosis		Total
			No	Yes	
Gender	F	Count	8	1	9
		% within Sex	88.9%	11.1%	100.0%
		% within PoroticHyperostosis	40.0%	33.3%	39.1%
	M	Count	7	0	7
		% within Sex	100.0%	0.0%	100.0%
		% within PoroticHyperostosis	35.0%	0.0%	30.4%
	N/A	Count	5	2	7
		% within Sex	71.4%	28.6%	100.0%
		% within PoroticHyperostosis	25.0%	66.7%	30.4%
Total		Count	20	3	23
		% within Sex	87.0%	13.0%	100.0%
		% within PoroticHyperostosis	100.0%	100.0%	100.0%



*Appendix A.6: Estuquiña Sex to Porotic Hyperostosis Chi-Square Values*

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.568 <sup>a</sup>	2	.277
Likelihood Ratio	3.157	2	.206
N of Valid Cases	23		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is .91.

*Appendix A.7: Tumilaca Spearman's Rank: Cribra Orbitalia to Porotic Hyperostosis*

Nonmetric Correlations				
			CribraOrbitalia	PoroticHyperostosis
Spearman's rho	CribraOrbitalia	Correlation Coefficient	1.000	.576**
		Sig. (2-tailed)	.	.008
		N	20	20
	PoroticHyperostosis	Correlation Coefficient	.576**	1.000
		Sig. (2-tailed)	.008	.
		N	20	20

\*\* . Correlation is significant at the 0.01 level (2-tailed).

*Appendix A.8: Estuquiña Spearman's Rank: Cranial Porosities to LEH*

Nonparametric Correlations				
			CranialPorosities	Hypoplasias
Spearman's rho	CranialPorosities	Correlation Coefficient	1.000	.192
		Sig. (2-tailed)	.	.380
		N	23	23
	Hypoplasias	Correlation Coefficient	.192	1.000
		Sig. (2-tailed)	.380	.
		N	23	23

**Appendix B: Pictures of Pathological Lesions**

*Appendix B.1: Tumilaca*

CB06-47-0076



CB06-47-0082



CB06-47-0083





CB06-47-0084



CB06-47-0085

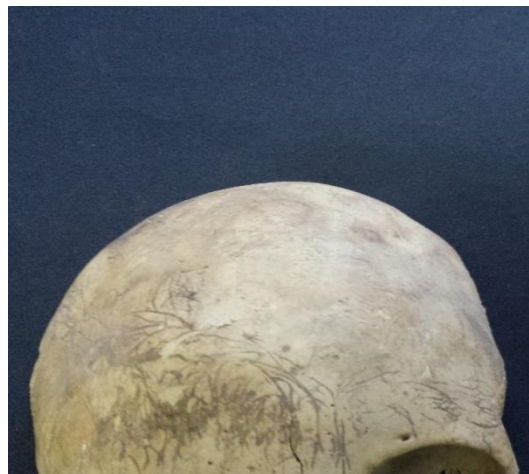
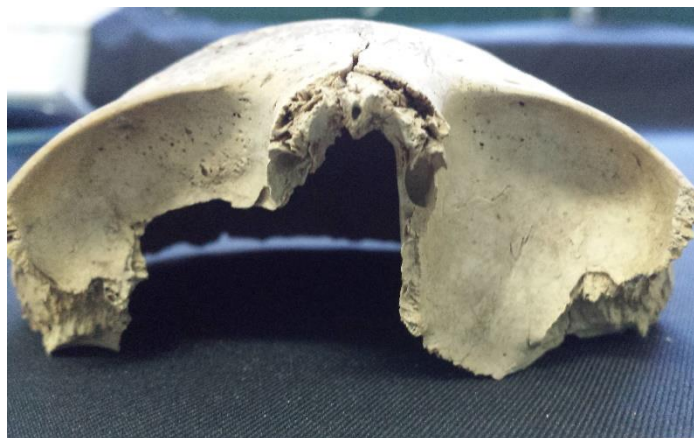


CB07-44-0019





CB07-45-0074



CB07-45-0076



CB07-45-0081



CB07-45-0085





CB07-45-0086



CB07-45-0095



CB07-46-0059





CB07-46-0067



CB07-46-0072



*Appendix B.2: Estuquiña*

CB15-56-0327



CB15-56-0328





CB16-56-1806



CB16-56-1807



CB16-56-1808



CB15-56-0329





CB15-56-0330



CB15-56-0333



CB15-56-0335





CB16-56-1809



CB16-56-1810



CB16-56-1811



CB16-56-1814



CB16-56-1812



CB16-56-1815





CB16-56-1816



CB16-56-1818



CB16-56-1817



CB16-56-1819





CB16-56-1820

