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Oral Health in the Inka Heartland During the Late Horizon: A Tale of Two Sites

Macie Orrand

ORAL HEALTH IN THE INKA HEARTLAND DURING THE LATE HORIZON: A TALE OF TWO SITES

by

MACIE LOGAN ORRAND

Under the Direction of Bethany L. Turner-Livermore, Ph.D.

ABSTRACT

This study is a comparative dental analysis of two sites in the Inka heartland during the Late Horizon (1476-1532 CE), where residents were likely servants. Reconstructing the life histories of servant groups is critical to understanding Inka statecraft and the lived experiences of Inka subjects. Oral pathological conditions compared from two contemporaneous sites (N=34, N=65) to infer diet and activity-related stress. The first site, Salapunku, is 15km southeast of Machu Picchu and was likely an administrative outpost. The second site, Saqsahuaman, overlooks the capital of Cusco and functioned as a ceremonial center. Results identify a greater number of antemortem tooth loss and edentulous individuals at Saqsahuaman compared to Salapunku. In addition, Sacsayhuaman exhibits heavy wear that suggests a variety of habitual activity and may reflect different subsistence or economic backgrounds prior to living at the site. The results point to varied diets and activity patterns between the two sites that may reflect their differing functions.

INDEX WORDS: Peru, Biological identity, Life histories, Diet, Dental pathology, Inka, Habitual activity, Statecraft

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MACIE LOGAN ORRAND

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MACIE LOGAN ORRAND

Committee Chair: Bethany L. Turner-Livermore

Committee: Nicola O. Sharratt

Molly K. Zuckerman

Frank L'Engle Williams

Electronic Version Approved:

Office of Graduate Services

College of Arts and Sciences

Georgia State University

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DEDICATION

This thesis is dedicated to my grandmother, Gladys Marie Phy, the strongest woman I know.

Thank you for all of your support and love over the years.

You are loved and missed.

Rest in Peace.

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I want to thank the loves of my life: my partner and daughter. I am forever grateful for your love and support. I know these last two years have been insane, but both of you have been the light at the end of this tunnel. Thank you for shining brightly for me to find my way out. Christian, you motivate me to be my very best self, and I love you more than a thousand galaxies.

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LIST OF ABBREVIATIONS

SOD – *Standards of Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994)

AMTL – Antemortem Tooth Loss

CE – Common Era

SPSS – Statistical Package for the Social Sciences

EDITOR'S NOTE

This thesis contains images of human remains to show examples of pathological conditions observed during the duration of this study. Readers please use ethical practices sharing this material. Thank you for your cooperation to ensure the integrity of the individuals displayed here is kept intact.

Mortui Vivos Docent - The Dead Teach The Living

CHAPTER 1: INTRODUCTION

1.1 Introduction

The Inka imperial heartland stretched thousands of miles across the Andean highlands. Archaeologists have long been intrigued by the study of ancient empires (Covey 2018). Through investigating how social and political control was obtained and maintained by the Inka, archaeologists expand what we actually know about this famous imperial state. Ethnohistory offers one version of social history and organization of daily life of both elite and non-elite members of the Inka (Covey 2008). Bioarchaeological studies can provide a lens on unknown Inka histories and shed light on the lived experiences of servant class groups that are not highlighted in ethnohistorical accounts. One of the ways that bioarchaeologists are reconstructing lived experiences is through studies of how populations respond to changes in their social, physical, and cultural lives through major events. Health, status, labor, and mobility can be analyzed through a variety of archaeological analysis to build up the human experience and story.

Oral health studies can give insight to overall health and quality of life. A study published in 2010 by the Surgeon General for the United States Public Health Service highlights the connection between oral health with diabetes, pregnancy and birthing complications, pneumonia, HIV/AIDS, osteoporosis, Alzheimer's, heart and lung disease. Poverty and inequality contribute to why some groups suffer from oral pathologies and studies show that health disparities can be accessed in past populations all the way through to modern day. I am interested in understanding how oral pathological frequencies reflect on the life histories of past populations. As a bio-archaeologist my goal is to interpret oral pathologies observed in skeletal remains by noting the presence of cavities (called caries), infections (like abscesses), tooth loss and wear that can indicate possible diets, social inequality, overall health, and the use of teeth as tools.

I have conducted a comparative dental analysis through documenting the frequencies of oral pathologies between two sites in the heartland of an ancient empire, the Inka, where the full-time residents were likely servants. My thesis research took place in Cuzco, Peru, in the Andes Mountains of South America. I analyzed the teeth of Inka servants from two sites that date to the 1400s through early 1500s CE, Saqsahuaman and Salapunku. The groups at each site appear to have served different functions in the empire and were probably from different servant classes. Reconstructing the life histories of these different servant groups is critical to understanding Inka statecraft and the lived experiences of Inka subjects. This research therefore contributes to the study of Inka imperialism from the bottom up, rather than top-down narratives from Spanish chronicles.

My central hypothesis is that there are higher frequencies of oral pathologies observed in Saqsahuman because the site was more densely populated and involved brewing of maize beer that is associated with cavities and oral decay. The other site, Salapunku, was likely an administrative center near the famous site of Machu Picchu. My results identified heavy tooth loss at Saqsahuman compared to Salapunku, with some individuals having lost all their teeth to decay. In addition, Saqsahuaman exhibits heavy wear that suggests a variety of habitual activity and may reflect different subsistence or economic backgrounds prior to living at the site. For example, one of the individuals from Saqsahuaman expressed heavy wear on the lower molars which is consistent with patterning seen among fishers along the Pacific coast, caused by the pulling of cords from fishing nets along the distal surfaces of their molar teeth. In comparison, individuals from Salapunku exhibit fewer oral pathologies, which may indicate differentiating diets or overall better oral health. These findings support my hypothesis that the individuals from Saqsahuman would present higher frequencies than would those from Salapunku and point to varied diets and activity due to the

migration into the imperial city. So, why does this bioarchaeological comparative dental analysis of the dead matter? Modern dental research, discussed below, underscores the ways in which the health of the oral cavity is significantly associated with larger systemic respiratory and cardiovascular issues, many of which do not manifest any signs on the skeleton and therefore would be invisible in the archaeological record. Moreover, oral health can be influenced by diet and nutritional status, overall disease burden, and other factors that are shaped by different environmental contexts and by systemic inequality. By studying oral health among the different communities living in ancient complex societies like the Inka, we can explore our understanding of how similar processes have shaped health and well-being in antiquity.

1.2 Oral Health, Identity, & Lived Experience in an Ancient State

Tawantinsuyu, or "land of the four corners" in Quechua, was the name of the Inka Empire, which expanded out of the southern central Peruvian highlands starting in the 14th century. After a meteoric rise to power in the late 14th and early 15th centuries CE, the empire conquered and/or incorporated some 12 million people spanning parts of Ecuador, Peru, Bolivia, Chile, and Argentina by the 1530s CE (Bauer and Covey 2002, D'Altroy 2000). The heartland of the Inka Empire was located in the city of Cuzco (which remains a prominent city in modern Peru), and the surrounding region boasts some of the most remarkable archaeological sites in the Americas. Massive stone estates, ceremonial centers, and monumental structures are found throughout the highlands and attract tourists year-round; this includes but is certainly not limited to the royal estate of Machu Picchu, named one of the seven wonders of the modern world.

Our understanding of these sites and Inka culture, in general, came from ethnohistorical analyses of Spanish Chronicles until the 1980s, when archaeologists began systematic surveys of

the Cusco region (Bauer 1992). This archaeological research is extremely important, as historical records are not always accurate representations of past peoples. Spanish Chroniclers recorded what they observed, but their perception of the events was inherently shaped by their own ethnocentric lens; mestizo (mixed Spanish and indigenous) Chroniclers such as Guaman Poma de Ayala (1980 [1615]) also recorded many observations, but often with an aim of advocacy or recalling events that happened decades or even centuries earlier.

The Inka themselves did not have written records; instead, they recorded information using a patterned knotted cord system called quipu, to record dates, events, inventory, genealogies, and relationships; Spanish conquistadors destroyed many of these quipu, and many of the specialists who could read them (quipucamayoc) either died or hid their knowledge along with their quipu (Niles 1999). Therefore, there is still much we do not know about Inka society and culture, especially its localized variation within the imperial heartland and between the heartland and its provinces. Archaeologists and bioarchaeologists are well poised to address these gaps using systematic analysis of material culture, landscape features, and human remains throughout Peru and neighboring countries, thereby piecing together a more accurate representation of Inka peoples.

Andean bioarchaeology has expanded dramatically over the past few decades, providing invaluable knowledge of past peoples through skeletal data analysis. While much of this research has centered on earlier Andean empires and complex polities such as the Wari (Andrushko et al. 2011), Tiwanaku (Blom 1999; Torres Rouff 2008), Moche (Gagnon 2019), Sicán (Klaus 2014), Chachapoya (Toyne et al. 2017), and others, a growing body of research has focused on the Inka (Andrushko et al. 2006 [Saqsahuaman], Williams and Murphy 2013 [Puruchuco-Huaquerones], Turner et al. 2009, 2010 [Machu Picchu]) and their predecessors in the Cusco region (Andrushko

2008, Turner et al. 2018). These data provide a narrative that enrich colonial accounts, and even contradict them (Murphy 2004 [Puruchuco-Huaquerones]), giving a more accurate representation of how the empire functioned from the perspectives of their subjects. This research has increasingly focused on reconstructing social identity, health, disease, disability, gender identity, and life courses within the last two decades, contextualizing analyses of age, sex, stature, pathology, and ancestry of individuals within larger social theory. Across these themes, the study of diet and disease is a continuous focus for bioarchaeologists to gain insight on the life histories and lived experiences of past populations and how events throughout an individual's life course affects the health status not only of individuals but also generalize to group-level and even population-level trends (Khudaverdyan et al. 2017).

The discussion of non-elite members of Inka society and how their life histories differ from those of the aristocracy has been a central part of in Inka archaeology, exemplified by work in the Cuzco heartland (Bauer 1992, Bauer 2004, Bauer and Covey 2002, Quave 2018, Quave 2019, Kosiba 2014) and different Inka provinces (Baca Marroquin 2017, Chacaltana Cortez 2017, Wernke 2006, Malpass 1993). However, with the exception of studies in the Upper Mantaro Valley (Earle et al. 1987) and more recent work discussed below, there is comparatively little explicitly bioarchaeological research focused on non-elite subjects, even though they make up most of the empire. Further, while there are ethnohistorical analyses of Spanish Chronicles that provide significant insights into Inka subjects, particularly those in the imperial heartland (Silverblatt 1987, Niles 1999, Julien 2009, Rostworowski de Diez Canseco 1999), the original Chronicles inherently reflected the perspectives of their Spanish and mestizo authors, and were often written decades after the Spanish conquest, such as Guaman Poma de Ayala's (1980 [1615]) famous work El Primer Nuevo Crónico y Buen Gobierno. Bioarchaeologists therefore have much

to contribute in reconstructing the lives and life histories of non-elite members of Inka society, using direct methods and employing both a "bottom-up" perspective (Erickson 1993) that focuses on individuals and a population approach that examines larger-scale patterns among and between groups.

1.3 Overview of the Thesis

1.3.1 Study Objectives

This study focuses on the oral health of the Inka by examining the dentition of archaeological human remains from two sites constructed and used during the Late Horizon (1476 - 1532 CE). The first site is in a rural area along the Inka trail to the royal estate of Machu Picchu in Peru's Sacred Valley. This site, Salapunku, served as an agricultural center and travel stop for Inka elites traveling to and from Machu Picchu. The other site, Sacsayhuaman, is in an urban setting overlooking the Inka capital of Cusco. Archaeologists originally thought that Sacsayhuaman served as a military fortress due to its vantage point; however, more recent research indicates that the site was more likely a ceremonial center that included ritual spaces and an aqllawasi ("House of the Chosen Women," special servants to the nobility). Mortuary contexts indicate that the people who were interred at each site were non-elites, and likely workers who served different functions in the empire.

This study centers on a comparison of oral health and likely factors influencing oral health--such as diet, infectious and noninfectious diseases, and other life history variables-- between Salapunku and Saqsahuaman, and among the different sectors of Saqsahuaman. In this study, I present the results of a systematic survey of oral decay (carious lesions, abscesses, and antemortem tooth loss) and oral wear (cumulative attrition, asymmetric wear, and atypical wear) from

individuals interred at Salapunku (N=18) and Saqsahuaman (N=52). Oral health can be a source for interpreting biological life histories within populations related to cultural factors including subsistence, social and/or resource inequality, and divergent life histories (such as different residential origins). Reconstructing the life histories of these different servant groups is critical to understanding Inka statecraft, through understanding the lived experiences of Inka subjects upon whose labor the empire functioned. This research, therefore, contributes to the study of Inka imperialism from within the imperial heartland.

1.3.2 Central Hypothesis: Comparing Two Sites

My central hypothesis is that (H1) the cohort of individuals from Saqsahuaman will exhibit higher frequencies and crude prevalence of oral decay than the cohort from Salapunku. There are two main premises informing this hypothesis: first, Sacsayhuaman was a larger and more densely populated site on the immediate outskirts of a major urban capital, making it more susceptible to infectious diseases that could influence the prevalence of oral decay (see Chapter 2). Second, one of the functions of the aqllakuna (Chosen Women) at Saqsahuaman appeared to have been brewing chicha de jora/maíz (maize beer); this likely involved masticating maize, a highly cariogenic food, regardless of how much maize was actually part of their diets. In contrast, Salapunku was a smaller site in a more rural setting, likely serving as an administrative outpost near Machu Picchu; however, the extent to which this difference in site setting and function equated to different diets or other stressors on the dentition is unclear.

1.3.3 Overview of Chapters

In this thesis, I ground my analysis in a larger context of oral paleopathology, Central Andean culture history, and Inka statecraft. In chapters 2 and 3, I lay out the theoretical approaches to bioarchaeological studies and how to utilize a variety of methods to interpret skeletal data. I pay

particular attention to perspectives from social bioarchaeology, immigration and emigration, social status, ethnic identity, and imperialism (Agarwal and Glencross 2011). I then narrow my discussion to dental paleopathology and discuss the conditions that I focus on in my analysis

Chapter 4 discusses the geographical and environmental zones of the Andes and provides a brief overview of Peruvian cultural history. In the chapter, I introduce the Wari and other earlier states using case studies published by scholars who explored similar research questions within these pre-Inka populations. This discussion is important to understanding the Inka Empire in a broader Andean context, because Tawantinsuyu was a secondary state, modeled in some respects on the earlier Wari and Tiwanaku. Chapter 5 discusses the social structure of the empire and some key aspects of Inka imperialism including social stratification, agricultural practices, military expansion, and their system of labor taxation. This chapter provides critical context for situating the two sites of this thesis. The understanding of how imperialism influenced the daily lives of the people adds substance to the life histories of the individuals examined in this study.

In Chapter 6, I describe the design, study samples, and methods employed in this study. I explain the research question in detail and why they hold an essential role in this study. Where data collection took place and methods utilized for the study are stated. I explain complications that arose during the research and provide unexpected observations of oral health observed from the two sites. I describe rare and unique oral or cranial pathologies in detail. I present the results of my analysis in Chapter 7. I then interpret these findings in Chapter 8, discussing their larger implications for understanding aspects of lived experience in the Inka imperial heartland.

1.4 A Note on Terminology

Throughout the thesis, Inka is spelled with a “k” instead of a “c” to respect the primary language of the Inka, which was Quechua. Quechua remains a commonly-spoken language today in Peru, but did not have a written form until after the Spanish conquest. The revitalization of the Quechua language in the 20th and 21st centuries (Coronel-Molina 2008) has included both scholarly and public discourse surrounding the nature of its revitalization and the decolonization of its linguistic components, especially in the modern Cuzco (or Cusco, or Qosqo) region. This extends to the written forms of Quechua, from the early versions transliterated with significant influence of romance languages. Concepts around this topic focus on linguistic cultures and ideologies, which relate to notions of pan-Andean indigenous nationalism. The revitalization serves as a focal point of activism for the Quechua speaking community (Coronel-Molina 2008). Therefore, I employ spellings (such as Inka, aqllakuna, Tawantinsuyu, Saqsahuaman, and Salapunku) that reflect these decolonization efforts.

CHAPTER 2: THEORETICAL APPROACHES

2.1 Introduction

Bioarchaeological approaches to investigating stress mechanisms in skeletal biology provide avenues for examining lived experiences on a population and individual level (Temple 2016). Earlier researchers were critiqued for their methods for investigating stress and relating it to "health." Understanding the mechanisms of the stress observed in skeletal remains provides a more accurate assessment for skeletal studies rather than a focus on the prevalence of stress indicators (Temple 2016). Stress, health, and biocultural approaches should be intertwined in bioarchaeological analysis of social organization (Temple 2016). In this chapter I discuss the importance of identifying appropriate methodology and constructive theoretical frames for conducting bioarchaeological analysis on skeletal remains in order to assess the relationship with social and hierarchical shifts in society and how specific groups are affected by this change.

Practitioners and researchers from the United States Public Health Service highlight the role that identifying the presence of oral pathological conditions has in understanding human physiology's response to further related health problems (Benjamin 2010). Thus, bioarchaeological studies utilize dental pathology to pay attention to other factors that may be happening in the body that results in poor oral health. The study of stress markers can assist in identifying indicators of potential causal factors. However, individual variation and human genotypes expressions can also contribute to how individuals are affected by cultural, social, and climate stress (Temple 2016). Therefore, population studies can serve as a method for studying lived experiences of people from various classes. This chapter ties in these key concepts and theoretical perspective in bioarchaeological scholarship to highlight the importance of how the methods and questions addressed in this thesis were constructed.

2.2 Theorizing Stress in Antiquity

The study of stress serves as documentation for impactful events over the course of an individual's life. Analyzing stress in skeletal remains provides insight to not only events in individual lives but also populations (Larsen 2002). Patterson (2005) discusses the importance of reconstructing stress by paying close attention to economic activities in groups and how occupational labor may factor into the interpretations of stress. Through examining archaeological material culture and skeletal remains, researchers observe specific patterning that can lead to understanding aspects of social reproduction (Patterson 2005). Finding signs of stress on the skeleton provides context to the life history of an individual and how often the stress occurred. Studies understanding stress and its context are prominent in current bioarchaeological research. Stress refers to a period in which an individual experienced malnutrition, poor health, or extreme labor, which affected the overall health of the individual. In order to describe and interpret stress on skeletal remains, bioarchaeologists must incorporate cultural context and histories (Cohen 1984). Through written records and archaeological evidence, researchers can suggest interpretations of what caused the stress, how it was treated, and who it affected (Larsen 2002). Stress is assessed in bones and dentition. Although ethnohistorical records for colonalized areas are subjective, they can be useful when studying major events that contributed to stress on the health and lifestyles of past populations.

The study of stress is critical to identifying the state and process of physiological well-being of humans (Temple 2016). Different types of stress can be studied in humans: emotional, climatic, disease, and nutritional (Temple 2016). Stress consists of three factors: environmental strains, cultural systems, and host resistance (Goodman et al. 1984). Deciphering which type of stress is

occurring is important in skeletal studies, because stress can manifest in distinct ways with different types of visibility on the skeleton. Stress can be general or specific, chronic or episodic, mild or severe. Different types of stress will manifest in bones and teeth in different ways, and some stressors are unlikely to manifest on these hard tissues at all (Temple 2016). Moreover, some pathological conditions, such as enamel hypoplasia, are highly sensitive (will manifest more easily or more quickly in the face of a stressor), while others, such as osteomyelitis, are unlikely to manifest unless a stressor is severe and/or prolonged (Goodman and Rose 1990, osteomyelitis (Tilley 2012). Some pathological conditions are highly specific; for example, caries sicca is highly diagnostic for venereal syphilis (Zuckerman and Harper 2016). Other pathological conditions have low specificity and are diagnostic only in a general sense; for example, porotic hyperostosis is indicative of anemia stemming from a number of possible nutritional, inherited, and infectious factors (Blom et al. 2005, Walker et al. 2009).

Bioarchaeologists researching pathological expressions in large skeletal populations therefore situate their analyses and interpretation within studies of modern epidemiology and clinical research, allowing them to expand interpretations and come to newly developed hypotheses (Roberts 2005). Importantly, paleopathology research also relies on integrated biocultural frameworks to examine the likely stressors present in different cultural and temporal contexts (Zuckerman et al. 2006). Researchers also utilize sophisticated radiologic, immunologic, microscopic techniques, and computerized tomography (CT), to assist in skeletal imaging (Mann and Hunt 2012). Imaging such as computer-assisted tomography (CAT) and magnetic resonance imaging (MRI) help in the reconstruction of pathological evidence for further study. Other modes of analysis like stable isotope characterization, scanning electron microscopy (SEM), and radiology assist in reconstructing health in populations. Biological anthropologists have created

an assortment of communal dental inventory forms and detailed typology of oral health to assist with individual and population studies.

2.3 Oral Paleopathology in Biocultural Perspective

As noted above, poor oral health is associated with a multitude of factors including diabetes, pregnancy and birthing complications, pneumonia, HIV/AIDS, osteoporosis, Alzheimer's, heart, and lung disease. Putting these proximate factors in a larger context, poverty and inequality often frame health disparities, including those manifesting as oral decay and inflammation, can be observed in past populations through modern-day (Sheiham 2005). Studies of both modern and ancient populations have underscore the significant associations between lifestyle, diet, and caries (Marklein et al. 2019). Therefore, multifactorial analyses are necessary to understand patterns of carious lesions and indicate broad subsidence patterns (Marklein et al. 2019).

Multifactorial analysis and careful consideration of different causal factors is particularly important when examining oral pathological conditions. For example, when interpreting patterns of oral decay--especially caries--between males and females, higher frequencies in females could suggest gendered diets or unequal exposures to stresses that could tax the immune system; alternatively, they could be due to endocrine differences related to pregnancy. Boggess and Edelstein's (2006) study highlights the high frequency of poor oral health during and after pregnancy due to endogenous hormone levels across the stages of fetal development. Therefore, women are highly likely to experience oral health issues such as pregnancy gingivitis throughout each pregnancy over their life course. Clinical research highlights hormonal and vascular changes that happen to inflammatory responses and contributes to oral health (Watson et al. 2010). Menopause results in a loss in bone mineral density, and this can lead to tooth loss (Watson et al.

2010). Therefore, females' hormonal changes over their lives, shaped by puberty, menstrual cycles, pregnancy and menopause (Marklein et al. 2019).

Diet and health can be interpreted from oral pathology studies and used as a tool to reconstruct life histories and population behaviors that contribute to those factors (Gagnon 2019). Higher frequencies of oral pathological conditions (caries, periodontal disease, and abscess) are associated with the shifts to agriculture (Lanfranco and Eggers 2010). Paleobotany studies assess the starchy grains discovered at archaeological sites to examine whether this is evidence of early cultivation or wild plant growth (Piperno and Dillehay 2008). These types of studies can enlighten archaeologists about the types of foods past peoples were consuming early on and how they began modification of wild plants. Farming increases the carbohydrate frequency in the diet and therefore leads to a higher chance of dental decay and carious lesions (Lanfranco and Eggers 2010). Early populations in northern Peru show the presence of high starchy grains (possibly wild beans) in their diets (Piperno and Dillehay 2008). Starches make up the majority of the human diet and are a primary source for calories, proteins, minerals, and vitamins in foods with high starch content (Lingstrom et al. 2000). However, sugars and starches make up dietary carbohydrates and support dental plaque buildup (Lingstrom et al. 2000). This eventually leads to bacteria and carious lesions. Other forms of negative effects of agriculture can be observed in oral pathological conditions like enamel hypoplasia. Evidence of stress concerning nutrition is observable through transverse lines, pits, and grooves on the crown surface of the tooth (White 2005). These defects appear on the permanent dentition while in development and signify periods of malnutrition. The reason the defects are present on developing permanent dentition is because enamel grows in layers, and therefore when there is a disruption with the enamel growth, it is noted (Mays 1998). Malnutrition is common during periods of famine and contributed to the rise of dental caries due to salivary

flow rate, which leads to plaque formation (Walter et al. 2016). However, malnutrition is not the only factor when it comes to the presence of these types of enamel defects. Disease during development can also cause defects in the enamel. By identifying enamel defects with consistent expressions of hypoplasia, researchers can examine frequencies of malnutrition in individuals and populations. Therefore, defects can provide insight into dietary practices and nutritional health over an individual's life course.

Dental caries are indicative of chronic disease that is commonly observed in modern populations worldwide (DeWitte and Bekvalac 2010). Dental caries are related to high exposure to sugars and carbs (Gagnon 2019). Carious can spread to other areas in the mouth soft tissue and bone, which can become life-threatening (DeWitte and Bekvalac 2010). Dental caries that are severe enough to manipulate the dental pulp can cause systemic inflammatory responses (DeWitte and Bekvalac 2010). They can affect development in subadults due to symptoms induced by the caries that make it hard to eat and sleep (DeWitte and Bekvalac 2010). This can cause stunted growth in children and in extreme cases mortality (Dewitte and Bekvalac 2010). Therefore, caries can result from biological, cultural, and environmental factors (Walter et al. 2016).

Oral pathological studies are a standard element of bioarchaeological investigations (DeWitte and Bekvalac 2010). Since many diseases do not reflect on the skeleton, researching how the oral health of past peoples can contribute to understanding of oral health in unequal, stratified societies affects us today (Benjamin 2010). Studying past civilizations like the Inka, can contribute to our understanding of how social stratification and distribution of power affect people's lived experience, not only in the past but also in the present. Paleopathological analysis can provide context to the lives of individuals and deceased populations. Bioarchaeologists often utilize various methodologies for studying osteological interpretations of health among the

contemporary populations. These contemporary interpretations contribute to their interpretations of archaeological skeletal populations. How a disease presents today most likely is different from its past manifestations (Roberts 2005). Thus, it is crucial to proceed with caution when comparing disease manifestation across populations. Researchers must know the context in which the disease presents and how the disease modifies over the years (Roberts 2005).

Despite the limitations of pathological analyses, researchers can make concluding interpretations of frequent expressions for overall health in individuals or populations. Through the use of stable isotopic analysis paired with osteological and dental data – diet, disease, mobility and nutrition can contribute to the life course of individuals and population studies (Williams and Murphy 2013). Biological interpretations of health and disease can lead to further research questions with a focus on mobility, diet, social organization, economy, and lived experiences of past peoples (Larsen 1997). Mobility can provide insight into the movement of peoples and the effects of living in new environments.

Wood et al. (1992) discuss the considerations that bioarchaeologists should take when analyzing prehistoric health and how discussing findings of population studies can be problematic. However, by examining groups, bioarchaeologists can theorize possible interpretations for status and occupations by providing consistent patterning observed in the remains that signify such explanations through descriptive statistical analysis. Observing how many individuals have oral pathologies and wear with consideration of the frequencies between age and sex provide continual information on the past peoples from a site (DeWitte 2012). Consideration of the burial context is imperative to the study of human remains. Not only should burial settings be taken into account, but also the social context in which the individual lived.

Social status can contribute to the burial conditions of individuals. Health and disease reflect one's status within the population. If an individual appears to have high concentrations of oral cavities, this can imply access to subsistence resources. Research can lead to other observations about status within the society concerning labor or occupation. Dental wear patterning can offer insight into the types of habitual behaviors an individual may have had during their lifetime. Therefore, pathological investigations of oral health can not only speak to individual life histories but to the large-scale dynamics of societies.

2.4 Life History Perspectives in Paleopathology

The focus of much archaeological research has expanded outside the individual case studies and broader population approaches to apply a "life course" perspective examining different *in vivo* periods, and to explore more theoretical questions leading to social and political identities. One example is looking at the effects of early-life stress across the lifespan, similar to studies in human biology that explore the Fetal Origins of Adult Disease (FOAD), or Barker Hypothesis (Calkins and Devaskar 2011). Armelagos et al. (2009), Garland et al. (2016) and others have compared frequencies of enamel defects and other conditions that manifest in childhood to age at death to examine the downstream effects of stress episodes during infancy and childhood on overall longevity. Researchers can also examine survival and endurance in documenting healed lesions, such those resulting from oral decay and tooth loss, alongside those that manifest later in life or are the result of a cumulative burden of stress over many years, to reconstruct aspects of suffering and lived experience (DeWitte and Stojanowski 2015).

In the Andes, a life history perspective can be particularly critical to assessing patterns of pathology in ancient groups, for two reasons. First, people moved about the Central Andes for

many reasons prior to the expansion of the Inka Empire, and were moved about the empire during the Late Horizon as part of Inka state dictates (Turner 2008), meaning that demographic nonstationarity (per Wood et al. 1992) likely describes Late Horizon skeletal samples. Second, the Central Andes has incredible ecological complexity, which means that individuals and communities could vary significantly in their diets and the different forms of stress--infectious, climatic, and otherwise--that they were exposed to in their early lives. Examining pathological conditions in Andean samples benefits from also studying aspects of life history that might provide insights into the different factors shaping those conditions at both individual and group levels. Bioarchaeological approaches can help in this endeavor, utilizing genetic/genomic (Shinoda et al. 2006, Lindo et al. 2017), geochemical (Turner et al. 2009, Turner et al. 2013, Tung and Knudson 2011, Knudson and Price 2007), mortuary (Andrushko et al. 2011), and osteological analyses (Sutter and Sharratt, Klaus 2008, Torres-Rouff 2002) to reconstruct aspects of peoples' biological and cultural backgrounds.

Knudson and Stojanowski (2009) explain that one issue with analyzing "identity" is the fact that it is defined in many different ways. The purpose of exploring identity is not to determine who the person was but to interpret human experiences with the social and political environment (Knudson and Stojanowski 2009). Through biological identity research, bioarchaeologists can explore individual life histories that can, in return, provide large scale understandings of group dynamics within a society. Knudson and Stojanowski (2009) further discuss how, through the investigation of identity, researchers can expand on multigenerational perspectives to explore the ongoing dynamics of complex societies and the peoples who lived in them. Increasingly, archaeological including bioarchaeological perspectives on ethnicity emphasize ethnicity as an ongoing process of identity negotiation rather than a fixed set of affiliations and differences (Diaz-

Andreu 2005). Material objects and everyday practices participate in this process of negotiation, and people both consciously and unconsciously redefine their ethnicity, an identity that intersects with other modalities such as age, sex, and class (Diaz-Andreu 2005). One is often taught their ethnicity in early childhood and this process expands their understanding and belonging to the group through their lifetime (Diaz-Andreu 2005).

Scholars of the late pre-Hispanic Andes have contextualized their studies of human remains and their mortuary contexts within ethnography, ethnohistory, and social theory (Pearson 1999). Cranial modification is a deliberate and permanent aesthetic that reflects identity within a social group in the Andes (Torres-Rouff 2005). Torres-Rouff and Yablonsky (2005:2) explain the importance of interpreting the purpose of cranial modification within its "local social context." Ethnohistorians document the cranial shape of the Inka drawing on Spanish accounts of how cranial modification styles assisted in distinguishing groups from one another (Blom 2005). This modification is different from racial grouping and more associated with ethnic identity because one is not born with the modification like someone is with skin color (Blom 2005). Scholars highlight that ethnicity is a cultural construct and is utilized in the Andes as an identifiable group marker (Torres-Rouff 2005). By altering the shape of the head, it serves as a durable declaration of group membership (Torres-Rouff 2005). This action is a choice made by one's kin when one is an infant that is then carried out over the duration of early childhood, similar (but more inalterable) as an outward expression of identity. Scholars have thought in the past that these modifications indicate probable status or social class to distinguish themselves from non-elites (Torres-Rouff 2005). Cranial modification in the Andes also correlates with stratification of past populations and what role they played in Inka society. There are two main forms of cranial modification observed in the Andes; circular (annular) and tabular which both involve manipulation of the frontal and

occipital bones in the skull (Torres-Rouff 2005). Both forms of modification were achieved using boards, straps, cords, tablets and pads on young infants' heads until the age of 3-5 (Blom 2005). Therefore, this indicates that for parents this is an investment of both time and effort for their children (Torres-Rouff 2005). Case studies that focus on cranial modification and diversity in Tiwanaku, a pre-Inka polity, demonstrate both annular and tabular modification was present in the skeletal remains of individuals excavated from the Tiwanaku capital. These results could indicate differentiation in economic and occupational backgrounds. The Inka utilized the appearance of the head as a way to spot the elite and to differentiate the non-elite members (Torres-Rouff 2005). Thus, cranial modification style likely served as a group identifier in different ways at different times in the pre-Hispanic Andes.

2.4 Conclusions

Data collection must be undertaken by trained researchers. Familiarity with deciduous and permanent dentition is imperative, because fragmentary and mixed dentition raise additional challenges particularly if (as is common and is the case for this study), the paleopathologist was not present during the excavation of the skeletal remains. For example, a researcher should ask whether mixed dentition reflects a young child with permanent teeth in different stages of development or instead reflects commingled remains. This is where osteological experience with fragmentary remains is highly useful. Postmortem taphonomic damage is another factor that should be expected to be observed in dental analysis. Breakage could have happened during excavation, transport, or during the analysis. It is important to be familiar with the various taphonomic processes and not confuse pathological conditions for postmortem conditions.

Appropriate methodology for accessing remains and how types of pathological conditions are documented should be familiar to practitioners.

However, it is important to reflect on not only methods but also theoretical perspectives when conducting bioarchaeological analysis, including paleopathology. Wider social theory can drive research design, the process of data collection can also generate new questions and contribute important case studies to comparative research in the social sciences. Therefore, this thesis adopts the perspective that bioarchaeological analysis and interpretation must be grounded in and contribute to wider anthropological perspectives. Through research on oral health in the Inka Empire, this thesis participates in discourse on relations of power and lived experience under conditions of political dominance.

CHAPTER 3: METHODS IN DENTAL ANALYSIS

3.1 Introduction

Bioarchaeological methods for assessing oral health rely heavily on the use of clinical research and modern studies on physiological response to stress. To assess factors of stress scholars analyze skeletal elements through a variety of methods. Non-metric observations are commonly utilized in understanding visible conditions. For dental observations there are numerous ways to document what is seen on the dental surfaces and associated alveolar bone to describe and determine what is present and what the presence of these conditions means. These conditions are micro and developmental defects that can provide a wealth of information about people's lives; in combination with other lines of evidence of identity, ancestries, and nutrition, these data can be used to create richer portrayals of ancient lives.

3.2 Oral Health & Disease

3.2.1 Caries

Dental caries are frequently observed in pathological studies, which is not surprising given how easily cavities can form. Cavities are associated with diet and lack of oral care. Observing cavities on human remains from archaeological contexts can provide insight into the diet and nutrition of past peoples. White (2005) describes dental caries as a disease process defined by the advanced decalcification of enamel or dentin. Caries are uncomfortable and can cause pain. Caries grow and spread due to the bacteria destroying dental surfaces. Caries can develop on any part of the tooth where food and plaque builds up (Roberts and Manchester 2005). The destructive

processes and pyogenic infection resulting from severe caries can further develop abscesses, which cause extensive destruction to the tooth, root, and alveolar bone.

Plaque buildup is a significant contributor to cavities due to bacteria exposure on the enamel surfaces. Consumption of fermentable carbohydrates can lead to carious lesions (White 2005). By recording the presence and location of caries, bioarchaeologists can interpret the oral health of an individual. The scoring system in *Standards of Data Collection* by Buikstra and Ubelaker (1994) provides an easily adaptable form for recording the dental presence of caries. The book contains scoring systems for dentition and provides a visual recording form to illustrate the pathology or wear on the occlusal, buccal, lingual, and labial surfaces. However, when recording, analyzing, and interpreting dental caries, practitioners must consider the multifactorial etiological nature of caries within a population before making assumptions about the cause of caries (Roberts and Manchester 2005). Lack of oral hygiene, diet, and disease can all contribute to caries developing. Therefore, researchers must consider all potential causal factors when interpreting caries in a dental pathological study.

3.2.2 Periodontal Disease

Periodontal disease is a result of inflammation of soft tissue in the mouth. Gums or the internal walls of the cheeks can become infected. Any infected area in contact with a tooth can result in spread of infection to the tooth, potentially leading to loss of the tooth, and even to the alveolar bone. Infections like this can become deadly in severe cases.

Severe caries can result in advanced infection, referred to as an abscess. An abscess is a confined gathering of pus in a cavity formed by tissue breakdown (White 2005). An abscess destroys enamel, root, and alveolar bone. Commonly, a tooth with an abscess will be pulled, or the

infection will eat through most of the tooth to the extent that the tooth falls out of the gum. As today, periodontal disease was a significant factor in tooth loss in the past (White 2005).

3.2.3 Antemortem Tooth Loss

Antemortem tooth loss refers to the loss of a tooth during a person's life time. The tooth may have been extracted or have fallen out. The absence of the tooth will initiate the resorption process. Resorption results from the annihilation of bone by osteoclasts (White 2005). Recording resorption in an individual documents the stage of healing; stages are active or complete resorption. Active resorption is when the alveolar bone undergoes reformation but remains in incomplete stages of healing. Complete resorption is when the bone has finished reconstruction and been modified to support the healing process. Complete resorption is often represented in oral pathological analysis by closed root pockets to signify the healing of the loss or infection.

3.3 Dental Wear

All dental inventories record dental attrition, or wear. Attrition is the dental wear on the occlusal surface that results from contact between upper and lower dentition. Attrition is often a result of heavy grit in the diet (Bass 1987). Wear can be recorded based on the degree of its presence; minimal, moderate, and significant. When observing molars, each quadrant of a molar should be recorded independently. *Standards of Data Collection* by Buikstra and Ubelaker (1994) provides a comprehensive scoring system for the incisors, canines, premolars, and molars and informative visual representations of where the wear is present.

Each tooth should be examined independently, and the practitioner should be attentive to asymmetrical patterning. Patterning signifies possible habitual behaviors using one's teeth as tools.

Fishing, weaving, meal preparation, and other tool use are activities commonly referenced when researchers interpret patterning. Attrition is often associated with periodontal disease and caries due to the exposure of dentine and even the pulp cavity to bacteria. Paradoxically, wear can also smooth out grooves and facets, especially in molars and premolars, and can reduce the number of caries (Ritter et al. 2009).

3.3.1 Common Causes of Attrition

The etiology of attrition has been explored both in archaeological and clinical contexts (Grippo et al. 2004). Attrition is tooth-to-tooth friction that compromises the occlusal, incisal, buccal, labial, and lingual surfaces of teeth (Grippo et al. 2004). Macrowear destruction of enamel or dentin is observed mostly on occlusal surfaces but can show patterning to indicate favoring one side of the mouth, occupational activity, and/or diet (Gagnon 2019). Cultural modification on anterior vs posterior teeth could be related to food processing (Gagnon 2019). Alveolar abscesses can be caused by infection of the pulp chamber, often in conjunction with caries or macrowear. The process of the abscess destroys bone (Gagnon 2019). Periodontal disease is the destruction of the alveolar bone along the gumline near the tooth and root related to gum disease where inflammation of the soft tissue has been compromised and spread to the bone (Gagnon 2019).

Occupational wear is a result of a performance or task being completed with the use of teeth. Clinical studies note that occupations like tailors, seamstresses, shoemakers, upholsterers, glassblowers, and musicians all utilize their teeth daily for tasks related to their profession (Grippo et al. 2004). Patterned wear may suggest occupational induced attrition. Bioarchaeologists pay close attention to asymmetrical and atypical wear patterns because they could indicate that the individual underwent habitual behavior during their life course which caused the patterning being observed. Given that labor is frequently associated with class identity, this pattern can reflect not

only possible occupation but maybe even status. People have continuously utilized their teeth as tools, and analysis of occupational wear on the dentition can highlight lived experiences of past peoples.

Abrasion or grit in the diet is another form of dental attrition observed in living and skeletal populations. The mechanics of chewing soft vs rough foods often principally affect the posterior teeth (Gagnon 2019). The posterior dentition is known as our grinding and food processing teeth. This type of macrowear analysis can provide insight on the types of food people were eating and suggest connections between diet and health (Gagnon 2019). Bruxism happens as a result of teeth clenching or grinding habits that cause excessive wear on the occlusal surface of teeth; mostly on the anterior teeth (Khan et al. 1998). The behavior is a non-functional movement of the mandible that can occur during the day or the night (Khan et al. 1998). Individuals are often unaware that they are performing this behavior. Conditions observed in association with bruxism include tongue thrusting and cheek-biting (Khan et al. 1998). It should be noted that both bruxism and abrasion are cumulative. Because of this, they are often used as aging criteria if demographic stationarity is assumed. In this study, however, stationarity is not assumed.

3.4 Inferences & Context: Diet & Nutrition

A multidisciplinary approach is important for interpreting the dietary patterns suggested by dentition analyses of individuals and populations. Archaeologists who specialize in botany, floral, faunal, and human remains generate data on how humans utilized and consumed their resources. Evolutionary studies of diet document the effects of agriculture on human beings and its correlation with disease. Once people were relying on agriculture as the main source of nutrition, they were vulnerable to unreliable growing seasons and natural disasters, which can wipe

out resources quickly. Skeletal and dental pathology provides a new understanding of food consumption patterns and the impacts of subsistence strategies on human health (Scherer, Wright, and Yoder 2007). Caries are more frequent in individuals with agricultural practices than hunter and gathers (White 2005). Moreover, agricultural practices can be strenuous. Habitual behaviors among agriculturalists can be observed through markers of degenerative stress on the skeleton. Agriculture is also associated with sedentism and over time, increased population concentration which facilitates the rapid spread of disease.

Bioarchaeological analyses of diet in humans also contributes to comparative understandings of the relationship between subsistence strategies and social organization. Food distribution and access to resources is frequently associated with social status. Documenting indicators of malnutrition in archaeological remains also offers insight into periods of stress within a population or in an individual's life course. In sum, investigating diet and health within populations offers an opportunity to explore not only prehistoric and historic diets but also the ways in which diet contributed to stress and was embedded in the wider social context (Goodman 1993).

3.5 Limitations of Interpreting Oral Health

Lukas's (1989) article in the volume *Reconstruction of Life from the Skeleton* provides an exciting interpretation of the methods and resources used to diagnose pathological conditions in the skeleton. According to this scholar, the many textbooks on paleopathology reveal widely varying perspectives concerning dental pathology. Additionally, scholars have not sufficiently explored the correlation between dental disease, dietary changes, and societal transformation.

Societal changes can affect the distribution or production of resources and these changes may have affected the life courses of past peoples.

Misdiagnosis could be due to the similar ways in which different oral pathologies present. For example, resorption can be interpreted in many ways but could be a factor of many different pathologies acting at once. The occurrence of caries is not always linked to plaque buildup or diet. There is a high frequency of caries in pregnant women because her body will draw on natural minerals that are stored in bones and teeth to support the developing fetus. Calcium is usually pulled from the teeth to help with the production of the fetus, and the loss of calcium makes the mother's teeth vulnerable to infection. Therefore, close consideration should be given as to whether the frequency in caries is related to diet or fetal development in pregnant women.

Sample size also limits what archaeologists can say about populations through the analyses of oral pathologies. In order to draw conclusions about a population, the analyzed sample must be sufficiently large. Scholars have been calling for standardizing the recording of pathological expressions for some time. While the *Standards of Data Collection* by Buikstra and Ubelaker (1994) is primarily utilized in the field, researchers often create their own format for recording and documenting pathological occurrences. The problem with standardizing is that it may limit the ability to document the presence of oral health to the extent the researcher intends, and may also obscure debates among researchers about what classifies as oral health. The expressions of unique dental anomalies may or may not have been caused by pathology. Therefore, classifying these expressions using the same pathological recording form can be confusing and problematic.

CHAPTER 4: CULTURAL CONTEXTS OF THE CENTRAL ANDES

4.1 Introduction

All anthropological research, including lab based bioarchaeological studies, must be situated in a comprehensive understanding of the relevant cultural context. Additionally, an understanding of ecology and environment is also relevant to any study examining health and diet. Contextualizing a study in its particular social and environmental context as well as comparative theory facilitates contributing to cross-cultural studies of social identity, human/environment interactions, political shifts, subsistence strategies, and health (Martin et al. 2013). Reconstructing lived experiences requires grounding bioarchaeological data in their particular cultural and ecological context. Therefore, this chapter introduces readers to the prehistoric landscape of the central Andes. It pays close attention to pre-Inka states that may have laid the foundation for the rise of Inka imperialism (Moseley 2001).

4.1 The Geography and Ecology of the Andes

The Andean mountain range flows down the southwestern aspect of South America through Venezuela, Colombia, Ecuador, Peru, Bolivia, Chile, and Argentina. This geographical region is characterized by a variety of ecological zones from glaciers, coasts, deserts, forests, to grasslands. Temperatures and annual rainfall vary significantly depending on the altitude and exposure to wind and sun. The Amazon rainforest meets the eastern aspect of the mountain range, which provides a plethora of resources. Although there are distinct traditions of archaeological scholarship in the Andean and Amazonian regions and although this thesis focuses on the Andes, it is likely that resources and cultural traditions have been exchanged between the two for thousands of years.

The dramatic terrain and extreme degree of ecological diversity in the Andean region is in part due to the high levels of tectonic activity. The Nazca plate has been shifting under the South American plate for millions of years, and resulted in the creation of two prominent mountain ranges that run parallel to each other. Intermontane valleys lie between these two ranges (the Cordillera Negra and the Cordillera Blanca) (D'Altroy 2002).

Natural disaster and environmental challenges are endemic in Andean South America. Given the tectonic volatility, the Andean region experiences frequent earthquakes whose impact ranges from minimal to significant, even catastrophic. There are three active volcanic zones within the two mountain ranges, and tectonic movement means they risk being activated at any time. Additionally, extreme rainfalls brought about by El Niño Southern Oscillation (ENSO) conditions can devastate agricultural crops while shifts in Pacific currents disrupt the region's marine resources (D'Altroy 2002). Even without devastating rainfall and mudslides, farming in the Andes presents challenges and requires skills and infrastructure such as irrigation canals, reservoirs, and terracing (D'Altroy 2002).

Populations in high altitude environments in the Andes evidence biological as well as cultural adaptations. The hypoxic conditions of the montane regions can cause dizziness, nausea, headaches, fatigue, and shortness of breath (Moran 2007, Beall 2014). Present and prehistoric populations in the highlands have deep barrel chests to accommodate their large lungs, which is an adaptation to low oxygen levels (Lanning 1967). Other adaptations include a higher number of blood cells that allow individuals to efficiently and rapidly distribute oxygen throughout their bodies. Lowland people can acclimatize to highland altitude but frequently experience short-term altitude sickness (D'Altroy 2002).

Despite these challenges, human populations have been making use of Andean South America's natural resources that include obsidian, copper, and tin as well as diverse comestibles for at least 12,000 years (D'Altroy 2002; Mosely 2001). Importantly, over millennia, Andean communities have developed social strategies to facilitate access to resources from diverse ecological zones. The Central Andean region (the focus of this thesis) includes coastal deserts and highland valleys. Large concentrations of plankton reside along the western coastline due to deep-ocean currents and nutrient upwelling and they draw in a variety of marine life. Marine food resources include anchovies, sardines, tuna, salmon, sea bass, sea lions, and seals (D'Altroy 2002). Coastal deserts are arid but with irrigation, the river valleys that empty into the Pacific Ocean are highly productive and suited to the cultivation of maize, cotton, and fruits (Lanning 1967). Altitudinal ranges increase further inland, and higher terrains, those above 2500 meters above sea level, are better suited to potatoes and quinoa while camelids (including the domesticated alpaca and llama) thrive in the highest plains, above 4000 meters above sea level (Lanning 1967). On the eastern slope of the mountains, some areas are tropical due to the adjacent Amazonian rainforest and sustain yet other resources (Lanning 1967). As articulated in John Murra's Vertical Archipelago model (Moseley 2001), ethnohistorical and archaeological as well as ethnographic data reveal that relations of kinship and reciprocal obligations have structured and enabled peoples' access to resources from these diverse zones for thousands of years.

4.2 Andean Cultures before Expansive States

Archaeological evidence from an extremely well preserved site at Monte Verde in southern Chile supports the claim that humans have been living in South America for at least 18,000 years (Dillehay 2011) (*Table 4.1*). Early occupants at Monte Verde were hunters and gatherers who

likely relied on small game and plant resources. However, as discussed, Andean South America is characterized by high levels of ecological diversity. Preceramic Period sites (ca. 16,000 BCE - 1800 BCE) are found in diverse locations and altitudes and thus subsistence practices and diets of the first Andean populations also varied (Moseley 2001). Around 3,000 BCE (the Late Preceramic Period), Andean communities began to cultivate crops (D'Altroy 2002). The gradual shift to agriculture began with quinoa, gourds, and squash. Later cotton, lucuma, maize, potatoes, and beans were domesticated (Moseley, 2001). The domestication of camelids and other animals such as guinea pigs and the emergence of pastoral life ways were also critical transitions with long lasting impacts on Andean cultural practices (Kendall 1973). Watson conducted a study on diet transition during the formative period at a site in Chile (Watson 2010). His study focuses on transitions in sustenance activities, nutritional range, and diet structure that instigated new dental disease and formed dietary inadequacies related to cultivation (Watson 2010). He notes a higher frequency of oral pathologies emerging when the shift from foragers to cultivators is made (Watson 2010). He suggested substance strategies were being inconsistent due to unpredictability in the seasons (Watson 2010).

Beginning in the Initial Period (ca 1800-800 BCE), intensification of agriculture required landscape modifications and well-designed irrigation systems made distributing water easier than before (D'Altroy 2002). Terracing was another modification people developed, allowing people to farm on steep slopes. Both projects helped the success of cultivation in the highlands, but later Inka (14th and 15th century) irrigation and terracing systems were more extensive than the ones created by the first peoples and remain visible on the landscape today (Lanning 1967). (*Figures: 4.1 and 4.2)* below showcase a beautiful example of an irrigation and terracing at Tipón exquisitely designed by the Inka, which is located southeast of the city of Cusco, Peru.

Figure 4.1 Inka Terracing at Tipón

Figure 4.2 Inka Irrigation at Tipón

The Initial Period (1800–800 BCE) also witnessed marked population growth, increasing sedentism, and increasingly complex sociopolitical organization, evidenced by religious iconography, ceramic production, and residential and ceremonial complexes (Moseley 2001). During the subsequent Early Horizon Period (800 BCE- 200 BCE) the presence of diverse social and cultural traditions in the Andes is indicated by architecture and material culture, most commonly ceramic styles but also by the adoption of increasingly complex iconographic traditions

expressed in textile arts (Kendall 1973). The Early Intermediate Period (200 BCE - 600 CE) was characterized by urbanism, pronounced social stratification, and state political organization as the Moche state expanded across 600 km of what is now the northern Peruvian coast. On the south coast, a confederacy of communities shared religious traditions and artistic styles referred to today as Nazca (Moseley 2001). In the following Middle Horizon (600 - 1000 CE), political organization was established on an entirely new scale with the emergence of two expansive states; Tiwanaku and Wari (Moseley 2001). Given the scholarly suggestion that these states provided important models for the later Inka Empire (McEwan 2001), I discuss the Middle Horizon in more depth.

4.3 Wari and Tiwanaku Empires

The Wari Empire of the central Peruvian highlands reigned during the Middle Horizon (600–1100 CE) during the same time as the Tiwanaku polity expanded from its core in the Titicaca Basin to establish outposts in strategic locations across the south central Andes (550–1000 CE). There are shared elements in the iconographic repertoires of Wari and Tiwanaku that may suggest common religious ideologies (Tung 2012). In fact, similarities in ceramic and other portable material styles contributed to a conflation of Wari and Tiwanaku by early scholars, with Wari referred to as Coastal Tiahuanaco as recently as the mid-20th century. Archaeologists did not all recognize them as separate groups until the late 1960s to early 1970s (McEwan 1996). Despite this, although there is evidence for direct interaction in the Moquegua Valley, Peru, the nature of relations between the two states remains debated (Moseley 2001). Wari influence extended across large swathes of the northern highlands and coast of the Central Andes while Tiwanaku influence was in the south in parts of what are today Peru, Bolivia, and Chile. Both exerted considerable political, economic, and cultural influence in their respective territories for as much as 500 years.

The Wari are particularly well known for their architectural styles and political organization (McEwan 1996) and possibly served as a model for the Inka Empire. The Wari empire spanned across large parts of what is today Peru. Wari presence is indicated by a number of large administrative sites as well as smaller sites across the landscape (Jennings 2006). Although the earlier Moche state was characterized by elite authority, urbanism, and pronounced sociopolitical hierarchy, the Wari is considered one of the first expansive states in the Andes (along with Tiwanaku) (McEwan 1996). The power dynamics of the Wari include a monopoly of force, stratifying political and territorial lines along with social class systems, and state sponsored production (McEwan 1996).

The capital of the Wari state was located in the Ayacucho Basin. Called Huari, the site is about three to five kilometers squared in size (Tung 2012). Large structures and complexes, including multi-story buildings and the classic D-Shaped Wari temples, are present at Huari and provide insight into the life histories of the elite, artisans, priests, and farmers who live there (Tung 2012). Another significant Wari site is an elite residential and ceremonial site called Pikillacta (McEwan 1996). Pikillacta is located at the southern end of the valley of Cusco on the north side of the Lucre Basin (McEwan 1996). Pikillacta is one of the administrative sites that are distributed across Wari territory (Jennings 2006) that were strategically positioned to govern the empire (Tung 2012).

Analysis of the distribution of resources and goods throughout the empire provides researchers with significant insights as to the organization of the Wari state in Cuzco and its forms of statecraft in the region that would centuries later become the heart of the Inka Empire (Covey, Bauer, Belisle, and Tsesmeli 2013). Research indicates that the Wari state controlled the region directly rather than through local infrastructures (Covey, Bauer, Belisle, and Tsesmeli 2013).

Although debates about the nature of Wari statecraft are ongoing, a number of scholars propose that the polity constituted an empire and possibly influenced later Inka political organization.

Table 4.1 Dates and Periods for Pre-Hispanic Andean Complex Polities (after Tung 2012)

Dates	**Time Periods**	**Empires/Polities**
800 BCE – 1 CE	Early Horizon	Chavin
1-550/600 CE	Early Intermediate Period	Regional Polities
600-1000/1100 CE	Middle Horizon	Wari and Tiwanaku
1000/1100-1476 CE	Late Intermediate Period	Regional Polities incl. Inka
1476 - 1532 CE	Late Horizon	Inka

CHAPTER 5: THE INKA EMPIRE

5.1 Introduction

The prehistoric archaeological work in the Central Andes has largely contributed to understanding the foundation for which the Inka Empire rose. Previous studies track shifts in the diets of transitional agriculturalists to review the biological effects of this change. The transitions are studied not only through bioarchaeological analysis but through material culture. Inka statecraft was complex and multifaceted, allowing the Inka to expand rapidly and control a vast territory. Previous studies on imperialism through biological evidence that resulted due to events relative to the rise, expansion, and fall of imperial states are consistent themes in the region (Andrushko et al. 2006). Therefore, the archaeological investigations of the Inka attempt to fill in the gaps that will hopefully speak to the approaches made in Inka statecraft to maintain and monitor rule in a massive and aggressively expansionist empire.

5.2 The Rise of Tawantinsuyu

The transition from the Late Intermediate Period (LIP) to the Late Horizon (1300–1476 CE) in Andean South America is defined by Inka imperialism. The Inka were one of a number of groups inhabiting the Cuzco region during the LIP (ca. CE 1000-1300) who enacted diverse strategies including conquest, marriage alliances, and indirect rule through local elites to establish political dominance in the Cuzco heartland and eventually over six million people distributed across a territory that spans parts of modern Peru, Bolivia, Argentina, Chile, and Ecuador (Bauer & Covey 2002; Bauer & Kellett 2010). Below (*Figure 5.1*) shows the map of the Inka Empire.

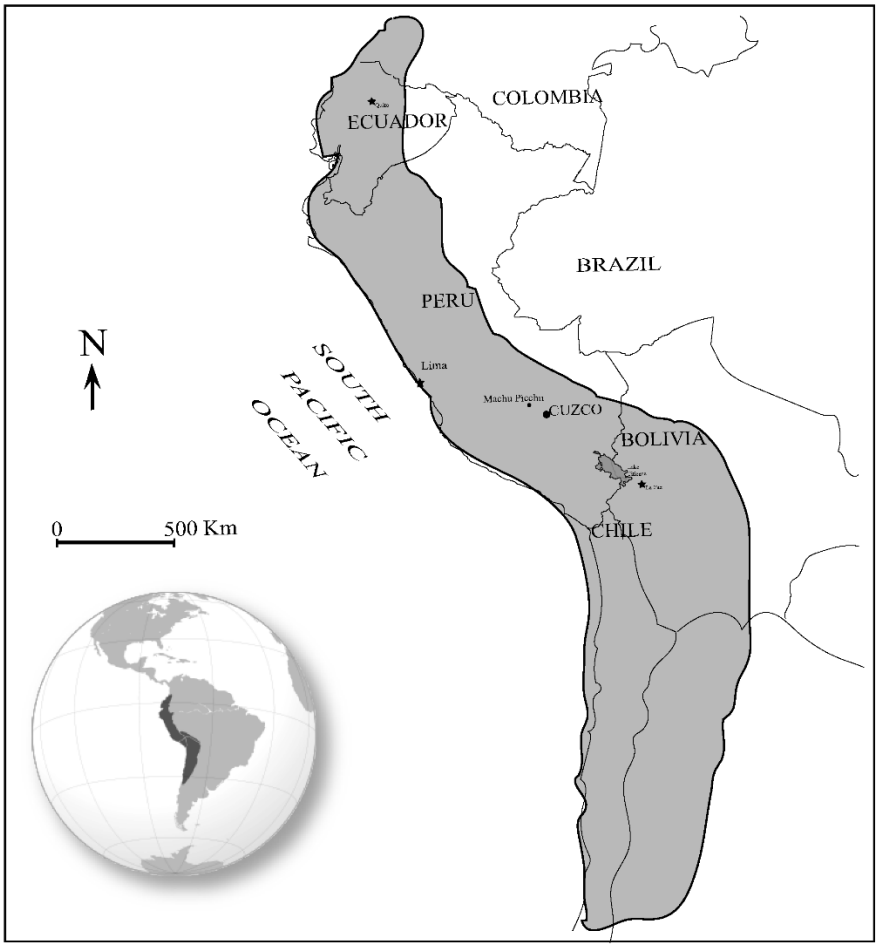


Figure 5.1 Map of Inka Empire

5.3 The Inka Capital at Cuzco/Cusco/Qosqo

The Inka referred to the Empire as Tawantinsuyu, or "Land of the Four Quarters," the center of which was the city of Cusco, considered by the Inka to be the "navel" of the universe. The modern city of Cuzco sits in what was the Inka heartland - a region located around 3,353 meters above sea level (masl) and extends from the Urubamba through Lucre Valleys (Turner et al. 2018). Cusco had a population in the tens of thousands during the Late Horizon (Covey 2008). As the heart of the Empire, the city was both an administrative and ceremonial center (Andrushko et al. 2006). Imperial elites, craft specialists, and religious officials lived in the city. In addition to

permanent residents, migrants came in and out of the city for political or religious reasons. European arrivals to the city in the Colonial Period commented on the location of the city along with its architecture and immense wealth. In particular, colonists described the temples, palaces, as well as the ceremonial center of Sacsayhuaman (Covey 2008). People also lived around the edges of the city in suburban communities and rural farming settlements. Cusco housed storage facilities for metals, textiles, and non-staples that were used to craft goods, ritual objects, and weaponry (Covey 2008). Vast amounts of goods were brought into Cusco daily for ceremonial and utilitarian use.

5.4 Inka Expansion

Inka expansion out of the Cuzco basin was motivated in part by access to resources, which included raw materials, wealth, and labor. For example, from lowland areas, the Inka sought wood, gold, and brilliant feathers (D'Altroy 2002). Although military leadership played a role in this pursuit, expansion also relied on complex and variable forms of statecraft along what D'Altroy (2002) describes as a continuum of territorial (direct) and hegemonic (indirect) control, as well as religious ideology and the control and redistribution of goods.

Religious ideology legitimized Inka authority through the relationship between religion and royalty (Lockard 2008). The King or Sapa Inka was conceptualized as an offspring of the Sun and therefore was the most holy person in the Empire (Lockard 2008). However, Inka rule also involved complex negotiations between local and imperial actors, interests, and power structures (Wernke 2006). Wernke (2006) states that the growth of the Empire should also be attributed to the emerging wealth economy that relied on specialists including potters, metalsmiths, and weavers (Wernke 2006). Craft goods indicated social status (Bray 2003) and were used to reward

loyalty to the empire. Textiles, in particular, played an important role in this system of state sponsored production and exchange. Textiles held a high place in Inka society, as in many earlier Andean societies, and were used to demonstrate social identities including gender, age, ethnicity, and social status (Costin 2008). The Inka authorities distributed precise quantities of raw fiber, cotton, and wool throughout the Empire and also directly controlled the production of the highest quality textiles (Moseley 2001). Textiles were used as a reward or payment for services. Loans or trades could be negotiated through food, textiles, or the promise of future labor (Moseley 2001).

5.5 Social Organization and Imperial Rule

This thesis examines oral health in individuals buried at two different sites in the Sacred Valley of the Inka imperial heartland. These individuals are thought to be from different social classes. The Inka elite included the lords, administrators and religious specialists (Rostworowski 1999). At the social pinnacle of elites were Inkas by blood, those who claimed ancestry from early Inka. The purer blood, the higher of nobility one came from (Kolata 2013). In order to maintain the purity of bloodlines, Inka emperors married their sisters (Kolata 2013).

Inka social organization played a role in the state's (short-lived) success. The Empire was divided into four "suyus" or lands, which were then further subdivided into smaller territorial units. Administration of the Empire was undertaken by a hierarchy of governors and nested levels of administrators who were responsible for specific groups of the population. These leaders were also responsible for communicating with administrators and enacting the emperor's rule (Kendall 1973). The governor and administrators were both responsible for making sure the collection of taxes and laws were upheld. Regional administrators maintained other laws regarding interpersonal disputes or crime. However, crimes were given different punishments based on the

context and these were decided upon by administrators. Sentencing people to death was under the rule of the Inca governor of a province (Kendall 1973). The elderly and disabled were also protected with specific laws and provided for.

The military assisted in providing stability to the provinces. The Inkas had a network of barracks, forts, and most famously an immense road system (the Qhapaq Nan) along which support sites and storage facilities were located (D'Altroy 2002). Military strength was one component of Inka statecraft and the threat of violence was utilized in some regions, for example the northern border of the empire in what is now Ecuador. The military was hierarchically organized. The emperor was the commander. However, officers held certain ranks, which gave them power depending on their position. The Inka armies were extensive, according to European accounts (Moseley 2001). As many as 100,000 were on the field at a time. Warriors could only be male and were often on the road due to campaigning or missions. However, families could accompany their loved ones on their journey to assist in caring for them when needed (D'Altroy 2002). The Inka had many weapons but preferred a stone mace or double-edged club when faced with conflict missions (D'Altroy 2002). Despite this, Inka imperial strategies were varied, and militarism was not uniformly used to subjugate the entire Inka territory.

Craft specialists and artisans were valuable to the Inka elite (D'Altroy 2005). These workers were responsible for the mass production of goods that served as a symbolism for power. Textiles, metallurgy, ceramics, and stonework were especially significant media (D'Altroy 2005). Artisans contributed greatly to Inka cultural expression and included entire communities of potters but also the aqlla or chosen women who wove the most valuable and socially restricted cloth (D'Altroy 2005). Although it was rare, some rulers and nobles had personal craft specialists (D'Altroy 2005). However, even though these artisans were highly valued by the Inka and utilized

by the state, some craft specialists often also had other productive responsibilities like farming and herding (D'Altroy 2005).

The elite, military, and craft specialists all relied on the rest of the population, the commoners: the taxpayers whose work provided the products and goods in which the administration was supported (Kendall 1973). Commoners were at the bottom of the Inka hierarchical system but were critical to the stability of the Empire. Not only did commoners support the land of the emperors, but they also worked the lands of the suns and other religions (Kendall 1973). Besides farming and herding, commoners also included fishers, some craftspeople, servants, and prisoners of war (Rostworowski 1999).

The importance of maize to the Inka was significant because it was used for ceremonial and political feasting as well as for subsistence (Murra 1980). The Inka claimed to have brought maize into the highland area and therefore it was considered a sacred food. The Inka had innovative agricultural practices, which included irrigation and terracing. Terracing was utilized in Andean South America long before the Inka (Olszewski 2016). The Wari, in particular, constructed vast terracing systems. The development of roads and irrigation infrastructure made enormous impacts for Andean civilizations, and the Inka Empire benefited from these inventions. The Inka state relied on agriculture to provide beyond the subsistence levels of the peasantry (Murra 1980). Therefore, much work and maintenance were put into ensuring successful seasons. Spanish accounts say the Inka ate twice a day, once in the morning and afternoon (Cobo 1990). Consumption patterns were different on days of celebration or for ceremonial feasts (Cobo 1990). Reciprocal exchange and hospitality were important elements of Inka statecraft and these practices are archaeologically visible in the distribution of supplies; ceramics, nourishments, and beverages (Bray 2003).

Men and women held different roles within Inka society (Olszewski 2016). The roles were decided upon at birth and differ with class. High nobility men would be allowed to marry many wives; however, it had to be approved by the administrators because wives were considered luxury items (Kendall 1973). Elite children would be allowed to obtain an education to learn the ins and outs of the state culture. First sons were considered heirs to noblemen and would inherit their responsibilities (Kendall 1973). Commoner gender roles were distinctive and the most consistent throughout the Empire. However, men and women could both participate in the production of pottery, textiles, and labor in the fields but had differing responsibilities within these professions (Lockard 2008). Male children began to gain responsibility for helping care for the animals, while female children cared for the other children, cooked, cleaned, and performed other household responsibilities. Some young girls were handpicked to be taken to the capital to learn about religion and household crafting. The girls deemed most beautiful became servants to Inca himself or were distributed to others by him to show honor or reward the people for the services they provide (Kendall 1973) while other girls became priestesses or even sacrifices in religious ceremonies.

Adult women married much earlier than adult men. Women married around 16-20 years of age, while men were around 25 before they were married. Once pregnant, women still maintained their household duties but cut back on strenuous activities (D'Altroy 2002). Europeans documented the relationship with mother and infant when they first arrived. They noted unusual methods for breastfeeding. Women often stood over the infants during feedings to keep from holding them ([Garcilaso 1966] D'Altroy 2002). They did not want to create needy children who would want to be nursed all the time as a result of being held ([Garcilaso 1966] D'Altroy 2002). The Europeans also noted feeding patterns, which were only observed three times a day. Infants did not feed beyond the three feedings even if they were upset (Kendall 1973). Other accounts of

birthing discuss the favored “children of Thunder”, who were born during thundering and played an important role when they were older assisting in sacrificial rituals (Silverblatt 1987). Having “extraordinary” births (twins, cleft-lipped, breech-births) were connected to the supernatural world and the children became native deities (Silverblatt 1987).

Early Colonial period sources also document Inka medicinal practices. These included the use of herbal medicines, smoking tobacco, purging and bleeding, and sacrifices. Often more than one technique was utilized. Doctors, surgeons, and sorcerers were paid with food, gold, silver, or llamas (Kendall 1973). The state economic resources acted as a material reward in some cases (Collier 1982). Written Spanish accounts of coca chewing in the Cusco region and archaeological material culture confirm that coca leaves played an essential part in Inka's lives as it has done since it was domesticated 7000 years ago (Murphy and Boza 2012; Sharratt 2014).

Coca chewing is a long-time practice in the Central Andes and serves not only cultural and religious but also medicinal purposes (Gagnon 2019). Some scholars thought that coca was a delicacy only allowed Inca royals, however, sixteenth-century documents contradict this, revealing that even non-elite households were able to access it (Sharratt 2014). Murphy and Boza conducted a study on the impacts on dental health as a result of coca leaf chewing (Murphy and Boza 2012). Their study was of Late Horizon individuals from the central coast of Peru; therefore, I had an interest in the results and how they might be related to what I was observing in the highlands where they were also active coca chewers. This confirms that no correlation could be made between oral pathologies and coca chewing (Murphy and Boza 2012). Their results permitted me to rule out any possibilities that habitual coca chewing could explain any oral pathologies I observed during my study. Recent studies on coca chewing effects on skeletal oral health confirm that there was no indication that coca creates oral pathological conditions, calculus and caries, however previous

scholars have documented mandibular root caries as a possible result of coca (Indriati and Buikstra 2001, Gagnon 2019).

Ethnohistoric sources describe funerary practices, many of which are also attested to by archaeological data. When an individual died, the body was buried in a seated position wrapped in beautiful clothing (Kendall 1973). Mourning periods were long, and items were placed with the dead that were associated with that individual. Any other belongings of the individuals were burned or given away (Kendall 1973). The naturally mummified bodies of elite individuals, particularly Inka emperors, continued to play active roles in the world of the living, and were consulted, feted, and publicly paraded around Cuzco during ceremonial events (Moseley 2001).

5.6 The Spanish Invasion and Conquest of the Inka Empires

Spanish arrival in the Andes in 1532 ultimately resulted in the fall of the Inka Empire, which was recovering from a civil war during the time of colonial contact. Spanish conquerors were astounded by the Empire's sophisticated political, economic, and monumental structures (McEwan 1996). The Inka did not have a writing system, and therefore the only written accounts of the culture are by Spanish and mestizo/criollo chroniclers. Atahualpa was ruler over the Empire during the contact with the Spanish and at war with his brother Huascar (Kendall 1973). The Spanish took advantage of these fractures in the empire. Inka Cusco was virtually destroyed during the "native" uprising of 1535; the colonial Spanish city went through profound changes in layout and population in the following century (Covey 2008). The official end of the Inka rule happened in 1572. For some time, Cusco was co-ruled by the Spanish and Inka (D'Altroy 2002). The Spanish wanted to ensure control and spread colonial governing practices across the Empire. The Spanish worked with some of the Inka to keep an eye out for rebellions and the return of Inka religious

ideologies (D'Altroy 2002). In addition to anti-idolatry movements that sought to stamp out Andean rituals, including funerary practices, Catholicism was introduced to the Andes.

CHAPTER 6: RESEARCH DESIGN, MATERIALS AND METHODS

6.1 Introduction

This thesis project is a comparative dental analysis from sites in Peru dating to the Late Horizon (1476-1532 CE). The project is a component of a larger regional bioarchaeological study funded by an NSF grant awarded to Dr. Bethany Turner. The focus of Dr. Turner's project is on her research of how the Inka's process of integration as a method of political control affected different groups within the Sacred Valley (Turner 2014). As one of Dr. Turner's students I was interested in assisting on the project and expanding it through my oral pathological study to assess if there were any patterns that could be related to changes in diet or mobility. During the project I recorded data from human remains that were previously excavated in the middle to late 1990s and stored in Cusco, Peru, at the Gabinete de Antropología Física in the Dirección Regional--Cusco of Peru's Ministry of Culture. The dental inventories require immense detail and therefore took much time to complete. During the recording process, I noticed visible signs of heavy wear and oral pathology that would be useful in investigating the overall health and lifestyles of these past peoples. Notes were made of any cranial pathologies or trauma that could reflect the general quality of life. The overarching objective of this study, as introduced in Chapter 1 and detailed below, is to explore what oral pathology can tell us about the overall health and life histories of the individuals from the two sites.

The remains are all associated with the Late Horizon (1476 – 1532 CE) when Inka imperialism was prominent throughout the west coast of South America. The remains were excavated in the late 1990s and curated at the Gabinete de Antropología Física of the Dirección Regional de Cultura - Cusco de la Ministerio de Cultura, i.e. the regional office of Peru's national Ministry of Culture. Unfortunately, the printed archive copies of the site and demographic reports

were lost while moving facilities a few years back. During the time of collection, it was thought that the reports were available; therefore, when the demographic data was confirmed not accessible, the focus of the project shifted slightly. Instead of comparing the collected oral pathological data to the age and sex, I focus on showcasing the data frequencies of the occurrence of specific conditions. I had planned to receive the demographic data in late March but was unfortunately stymied when the Coronavirus pandemic began. This stalled efforts to locate additional documents or copies in both Cuzco's and Lima's Ministry of Culture archives due to mandatory social distancing requirements that kept curatorial facilities closed.

6.2 Research Questions and Hypotheses

As stated above, the overhanging research question this project centers around is what oral pathology can tell us about the overall health of individuals who likely served different functions in the imperial heartland of the Inka Empire. More specifically, the questions forming the core of this study are as follows:

A: ***Are there significant differences in the oral health of the individuals from Salapunku and Saqsahuaman?*** This can be observed through the dental inventories and frequencies of caries, abscesses, or antemortem tooth loss from each site. After recording the data, it is possible to draw some conclusions on which site shows higher frequencies for each oral observation, and what might this mean for each site? Another observation is recorded in the dental inventories is dental wear; wear is essential to understanding habitual activity in populations.

B: ***How does dental wear differ at each site? What might this tell us about the lived experiences of these individuals?*** Dental wear may suggest habitual behaviors that result in

a distinctive wear patterning on the teeth utilized for activities. Can the pattern of wear suggest the activity which caused the alteration of the dental surfaces? If so, this adds insightful information about the lifestyles of the individuals who lived at Salapunku and Saqsahuaman. Is there a similar patterning for each site, or do the sites differ in patterns or severity of dental wear? If so, this can show distinct habitual activities that may provide narratives for the sites. These findings can contribute to the understanding occupational wear that can be indicative of particular activities. Thus, elements like social identity and class can be drawn upon and expand the knowledge of how people were utilized throughout the empire.

C: ***How can all the results contribute to the life histories of the individuals? Are there any common themes that can be related to social stratification linked to Inka imperialism?***

I hypothesize that **(H_1)**: The study sample from Saqsahuaman will show higher frequencies of dental pathologies than that from Salapunku due to the urbanized landscape in which individuals lived and the greater likelihood of maize in their diets. The increased possibility of disease and poor health conditions would likely be higher in an urbanized area opposed to a rural region like Salapunku. Given the fact that Cusco is the imperial capital for the Inka, it would have been densely populated with migrants flowing in and through the city. Health can reflect poorly due to the movement of people as new diseases are presented.

Access to resources influences oral decay; therefore, even within sites, there may be variation in oral health. While there are not distinct sectors at Salapunku, there are at Saqsahuaman; consequently, I hypothesize that **(H_2)** there will be significant variation in the frequencies and prevalence of oral pathological conditions between sectors at Saqsahuaman. However, residents

may have had limited access to resources at both sites; thus, aspects of social status as they relate to differential consumption of resources may be more complex in their patterning. Paradoxically, however, one of the highest-status foods in Tawantinsuyu was maize, which is highly cariogenic. The presence of an *aqllawasi* at Saqsahuaman (Andrushko et al. 2006) suggests brewing of *chicha de jora* (maize beer), and part of the preparation of *chicha* involves the mastication of sprouted maize to catalyze fermentation by adding amylase from saliva. Therefore, even if residents at Saqsahuaman were not consuming maize per se, they may have experienced the oral decay associated with maize consumption nonetheless (Gagnon and Jeungst 2018).

6.3 Site Histories and Contexts

6.3.1 The Sacred Valley

The Sacred Valley is considered a highly significant landscape in the Inka Empire, bookended by the imperial capital of Cuzco in the southeast and Machu Picchu in the northwest. Regional surveys by Kendall (1988) and ethnohistorical analyses (Rostworowski de Diez Canseco 1999) have identified a number a constellation of sites with distinct functions and cosmological significance. The only bioarchaeological studies of the Sacred Valley are Andrushko's (2008) regional diachronic osteological survey and Turner and colleagues' multi-isotopic study on human remains from Machu Picchu (Turner et al. 2009, Turner et al. 2010). One focus of the latter focuses on the development of pathological conditions and potential associations with diets or residential backgrounds (Turner et al. 2012). More recent isotopic work by Turner and Nuñez Flores (2019) at the Sacred Valley site of Patallaqta, roughly 15km southwest of Salapunku, has identified distinct demographic subgroups among the resident population that do not mirror those at nearby Machu Picchu. These early results suggest that different sites in the Sacred Valley were inhabited

by distinct groups of non-elite workers with differing functions in the Empire (Turner n.d.) Below (*Figure 6.1*), represents a map of sacred valley sites discussed in this thesis study.

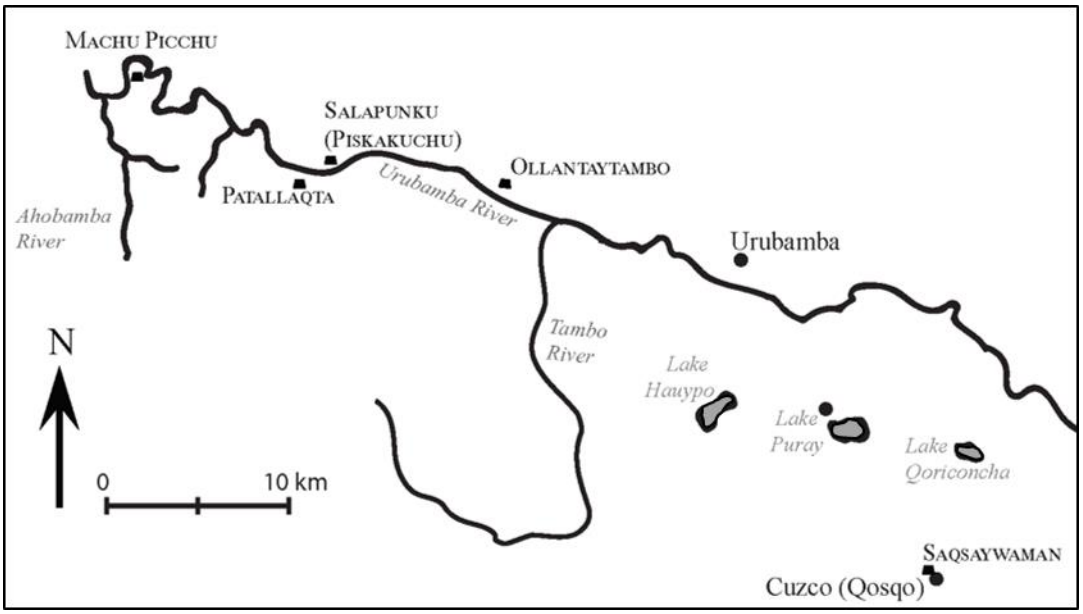


Figure 6.1 Map of Sacred Valley Sites

A recent analysis by Turner (2013) focused on the skeletal remains from Machu Picchu *(Figure 6.2),* and the frequencies of oral caries and dental attrition. This thesis study follows similar research goals and will tie into the understanding of Inka life of non-elite groups in the imperial heartland. In Turner's (2013) study there were a number of high frequencies of caries present on the enamel surfaces and can be connected to the consumption of a cariogenic diet. This association is not shocking considering that one of the core foods the Inka incorporated into their diet was maize, which is highly cariogenic. Dental wear can provide insight into possible foods being consumed and how foods are processed. Wear observed from the individuals in Turner's (2013) study show habitual patterning that could be associated with the use of teeth as tools for processing food.

Figure 6.2 Machu Picchu

6.3.2 Salapunku

Salapunku is a site located close to Machu Picchu and likely served as an outpost and waystation for travellers headed to and from Machu Picchu. The site is associated with agricultural activities; therefore, most of the individuals there most likely were non-elite farmers and herders. Unfortunately, few publications that briefly mention the site, and of few that are accessible are not available in English. Luckily, I had a colleague and friend in the Master's program with me at Georgia State University in Atlanta, GA, who generously offered to translate what little material I could find. Even with her translation, it seemed that Salapunku was only mentioned briefly to discuss its location in relation to Machu Picchu, roughly 30 km away or about 10 hours walking distance. Below, (*Figure 6.3)* shows the beautiful site of Salapunku located along the Inka Trail. Salapunku is roughly 75km to Saqsahuaman by modern roads.

Figure 6.3 Salapunku

6.3.3 Saqsahuaman

Saqsahuaman rests in the heart of the Inka Empire, Cusco. The city of Cusco was densely populated and supported a more urbanized lifestyle. The Spanish mistook Saqsahuaman as a fortress but is actually a sacred ceremonial site to the Inka (Andrushko et al. 2006). From Spanish accounts, the city was designed by the Sapa Inka (emperor) Pachacuti to appear to be a snake; Saqsahuaman is the head of the serpent (Andrushko et al. 2006). The site is rather large and contains many features that suggest large festivals and gatherings occurred here. Below, (*Figure 6.4)* shows the massive stone walls at Saqsahuaman. There are plazas, residences, temples, storerooms, roads, strongholds, lookout towers, and canals at Saqsahuaman (Andrushko et al. 2006). A temple of the Sun is at the highest point of the site and suggests that this would have been a sacred place (Andrushko et al. 2006). Articles published on the site, are the only sources that give helpful insight into the possible lifestyles of people who would have lived there. Andrushko analyzed Saqsahuaman and Chokepukio skeletal populations to note differences in social status for each site through burial and skeletal analysis (Andrushko et al. 2006). It should be noted that the skeletons utilized in the Andrushko study are included in the sample size for Saqsahuaman.

However, I have analyzed skeletons from other sectors located at the site that are not mentioned in his study.

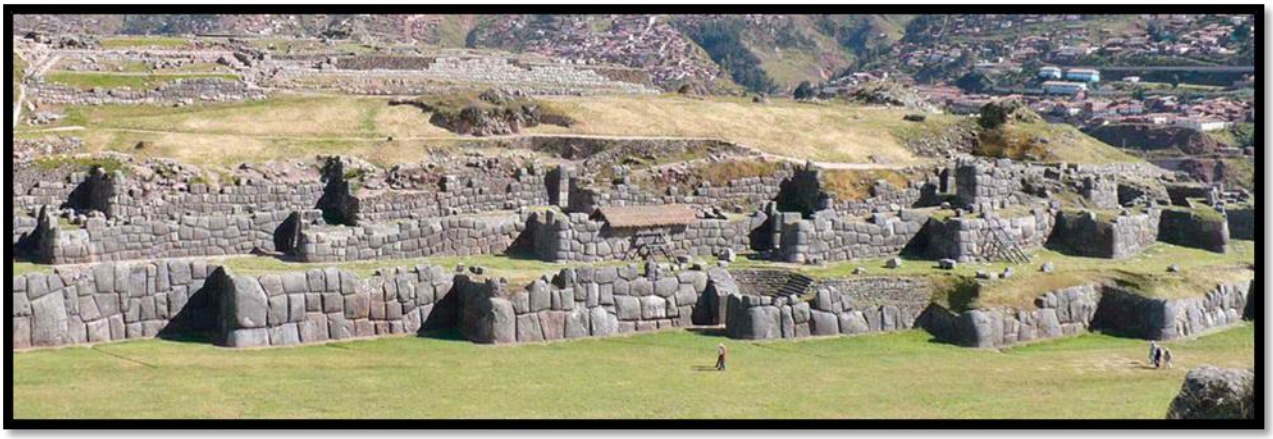


Figure 6.4 Saqsahuaman

The skeletons from Saqsahuaman were mostly from primary inhumations. Skeletons were in a seated position with the limbs flexed (Andrushko et al. 2006). Saqsahuaman was clearly defined by sectors but the 2020 pandemic stalled efforts to locate site and osteological reports. Therefore, we are unfortunately lacking the clarification of what the context is for each sector and the typology of the internments. We do know however, is that burials were randomly sampled using a grid system. The reason for the random sample is due to the numerous sectors at the site. Some individuals were excavated from tombs and thought to have been of high status (Andrushko et al. 2006), though these individuals are from different sectors than those included in this study. Elite cemeteries included tombs while non-elites were in flexed seated internments. Mortuary archaeology in the sacred valley is unfortunately compromised due the continuous destruction of burial context and looting of above-ground tombs (Covey 2018). Burials are usually based on kinship and tombs serve as ancestral ventilation (Moore 2004). Burial goods can also be a helpful insight into social status. The goods discovered in the tombs contained a variety of carbonized vegetables but mostly maize (Andrushko et al. 2006). The high concentration of carbonized plant

material found outside of the tombs indicates that they were likely offerings for the dead (Andrushko et al. 2006).

The overall results of Andrushko's study show that there is a high frequency of women at the site; about 75% of the skeletons were estimated females (Andrushko et al. 2006). This data suggest that the site possibly included sectors associated with an *aqllakuna* or house of the "chosen women" (Andrushko et al. 2006). High frequencies of caries were noted from Andrushko's study and indicated possible differing social status or could be related to unhygienic crowded environments of urban life (Andrushko at el. 2006).

Dental wear was noted in the study and shown that there was an interesting lingual patterning observed on the anterior enamel surface that suggests a possible result of weaving or other activities that require the use of teeth as tools (Andrushko et al. 2006). Spanish accounts of the lives of *aqllakuna* state that they engaged in cooking, rituals, weaving, spinning, and brewing maize beer (Andrushko et al. 2006). Therefore, the predictions that the women were likely the wives of the Inka or chosen women are high considering the other probable evidence relating to regular dental wear. Several sectors from Saqsahuaman were utilized in my study. Below, (*Table 6.1)* shows the number of individuals from each sector that I observed significant oral pathologies. The sectors are different sections of cemeteries were utilized for long periods by the Inka. (*Figures 6.5, 6.6, and 6.7)* show the signs at Saqsahuaman that direct tourists to the different sectors around the site. I visited the site on the weekend and was astounded by how large the stone walls and doorways were. The stones at Saqsahuaman stand about 3 meters high and weigh around 220,000 lbs (Protzen 1986). The masonry behind the type of design observed at Saqsahuaman was intended to withstand environmental factors like earthquakes, which are common in the area. They also serve as statement pieces for Inka power (Protzen 1997). The Inka had well-thought-out designs

for the structure of their cities and this is observed with their innovative inventions like their well-designed irrigation systems and straw bridges.

Table 6.1 Number of Individuals Observed with Pathological Conditions from Sectors at Saqsahuaman

Saqsahuaman Sectors	**# of Individuals Observed**
Suchuna	36
Muyukmarka	13
Chincana Grande	3
Cruz Moqo	1
Qochapata	1

Figure 6.5 Sign Directing Tourist to Sectors at Saqsahuaman

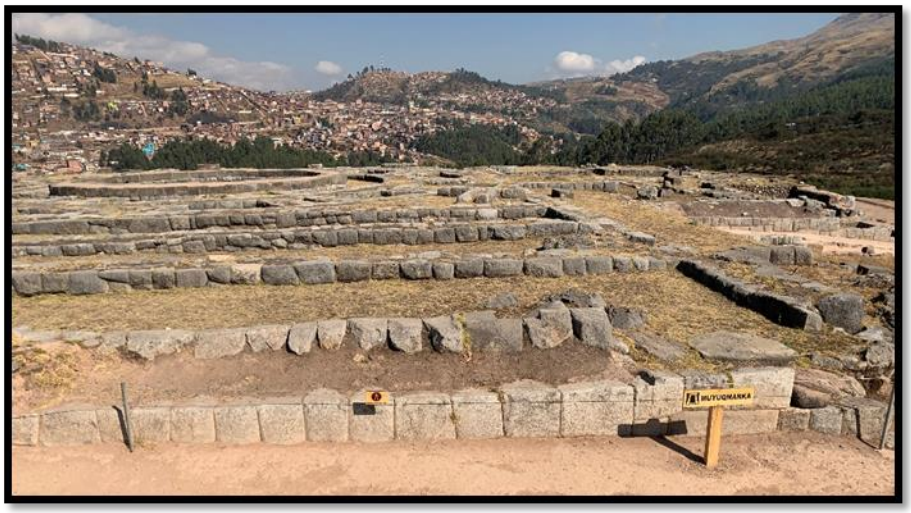


Figure 6.6 Muyukmarka Sector at Saqsahuaman

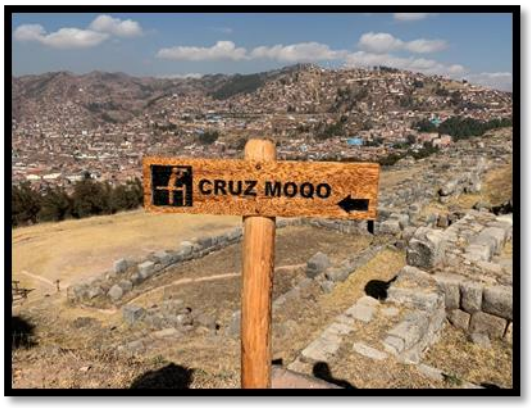


Figure 6.7 Sector Cruz Moqo at Saqsahuaman

6.4 Study Samples and Methods

Data collection was conducted from August 20th to September 5th of 2019 with the approval of the Peru's national Ministry of Culture (Resolución Directoral No D000046-2019-DGM/MC). All data were collected at the Gabinete de Antropología Física at the Dirección Regional de Cultura - Cusco (regional offices of Peru's Ministry of Culture) in Cuzco, Peru *(see Figure 6.8 below).* Inventories were conducted with the use of Buikstra and Ubelaker's (1994) *Standards of Data*

Collection from Human Remains, or SOD. This book is predominantly utilized for skeletal inventories in the field for biological anthropologists, for it contains widely-adopted forms that come with detailed instructions for scoring dental wear and pathological expressions. While inventories were being conducted, photographs of significant pathological observations were taken. After the inventories are completed, the data were then transcribed into an excel spreadsheet to help with further analysis. The sample size between Salapunku and Saqsahuaman is vastly differentiating; however, the percentages of the pathological conditions recorded are interpretatively significant. Due to the considerable amount of variation of teeth present in individuals from both sites, I pay close attention to the percentages of the oral conditions between sites and sectors.

Figure 6.8 Data Collection in Cuzco, Peru

I completed dental inventories following Buikstra and Ubelaker's (1994) data collection standards for 34 individuals from Salapunku and 64 individuals from Saqsahuaman. Of the thirty-four individuals from Salapunku, eighteen exhibited oral pathologies. Of the sixty-four individuals from Saqsahuaman, fifty-two exhibited oral pathologies. Therefore, the total number of individuals observed for this study from both sites is 70. Even though there are more individuals represented in Saqsahuaman, there still should be interpretative results to analyze between the two sites. The biological profiles for both sites were previously recorded but since we do not have any documentation currently, analyses that include estimated sex and age-at-death will be undertaken in the future. Upon receiving the remains, I began opening the boxes to get an idea of the number of individuals, the preservation of the remains, and whether there were any teeth present to be observed. Individuals who did not have a cranium or cranial fragments were excluded from my study.

For this study, I completed the dental inventories along with noting any cranial modification or trauma (See *Appendix A.2*). The data collected on the crania were strategically and intentionally done, for I have plans to utilize that data with the demographic information in future publications. Below *(Table 6.2)* lists the five elements of data that were recorded and thoroughly documented (See *Appendix A.1*).

Table 6.2 Oral Pathological Conditions Recorded

Observable Dental Conditions of Interest
Caries
Abscess
Resorption
Attrition
Modification

The methodology I utilized in analyzing the five elements above was to record them and create a numerical coding system to easily transport the data into SPSS version 25 to determine frequencies and the pathological conditions for each site. I expected to see significant differences between the two sites due to the context of their locations. Below is (*Table 6.3*) showcasing the enormous number of teeth and pathological conditions observed from each site (See *Appendix A.3*). I also include the breakdown of the two largest sectors from Saqsahuaman (Muyukmarka and Suchuna) hoping I might spot any differences in prevalence of the variables assessed here. The last column serves as a reference for the overall total of the teeth and pathologies observed in this study.

Table 6.3 Number of teeth observed, number of teeth with the specified pathological for each site and two sectors from Saqsahuaman

SITES/SECTORS/ PATHOLOGIES RECORDED	# OF TEETH INVENTORIED	CARIES	ABSCESS	AMTL	WEAR
SITEA: SALAPUNKU	267	27	22	87	156
SITEB: SAQSAHUAMAN	806	113	91	97	480
SECTOR: SUCHUNA	525	94	71	92	374
SECTOR: MUYUKMARKA	187	10	8	10	45
TOTAL:	1785	244	192	286	1055

After recording the frequencies of oral pathology I wanted to focus specifically on attrition. With the guidance of my advisor, I utilized the scores that I recorded following the (Buikstra and Ubelaker 1994) recommended system to investigate possible differentiating wear patterns. Building on the scoring system detailed in Buikstra and Ubelaker (1994: Ch. 5), I created a single aggregate wear score for each individual I observed (n=70) (See *Appendix A.4*). The anterior teeth make up the maxillary and mandibular premolar, incisors, and canines. In the Buikstra and

Ubelaker (1994) manual, the anterior teeth are accessed for wear through a 1-10 scoring system. A score 1 reflects little to no wear, while score 10 the enamel and dentin are destroyed. The posterior teeth make up the maxillary and mandibular molar dentition. In the Buikstra and Ubelaker (1994) manual, the molars are accessed for wear on the occlusal surface for each of the four quadrants independently. Each quadrant is scored on a 1-10 system that rates the severity of the wear. The four-quadrant scores are then added up and reported together as a total wear score. The overall wear score is #/40.

To create a composite wear score, I scored anterior wear for each present, intact and erupted tooth with mostly or fully-developed root using the 1-10 score system. I then took the average wear score of the teeth that are present by adding up each score and dividing by the number of teeth. The posterior dental scores were calculated by recording the wear score for each molar observed and divide that score by four since there are four quadrants. I then took the scaled (/10) score and divided it by the total number of molars present and recorded the number as the overall posterior wear score for each individual. The overall dental composite score is calculated by summing all of the anterior and scaled posterior scores, adding them and then dividing by the total number of teeth observed in that individual.

CHAPTER 7: RESULTS

7.1 Introduction

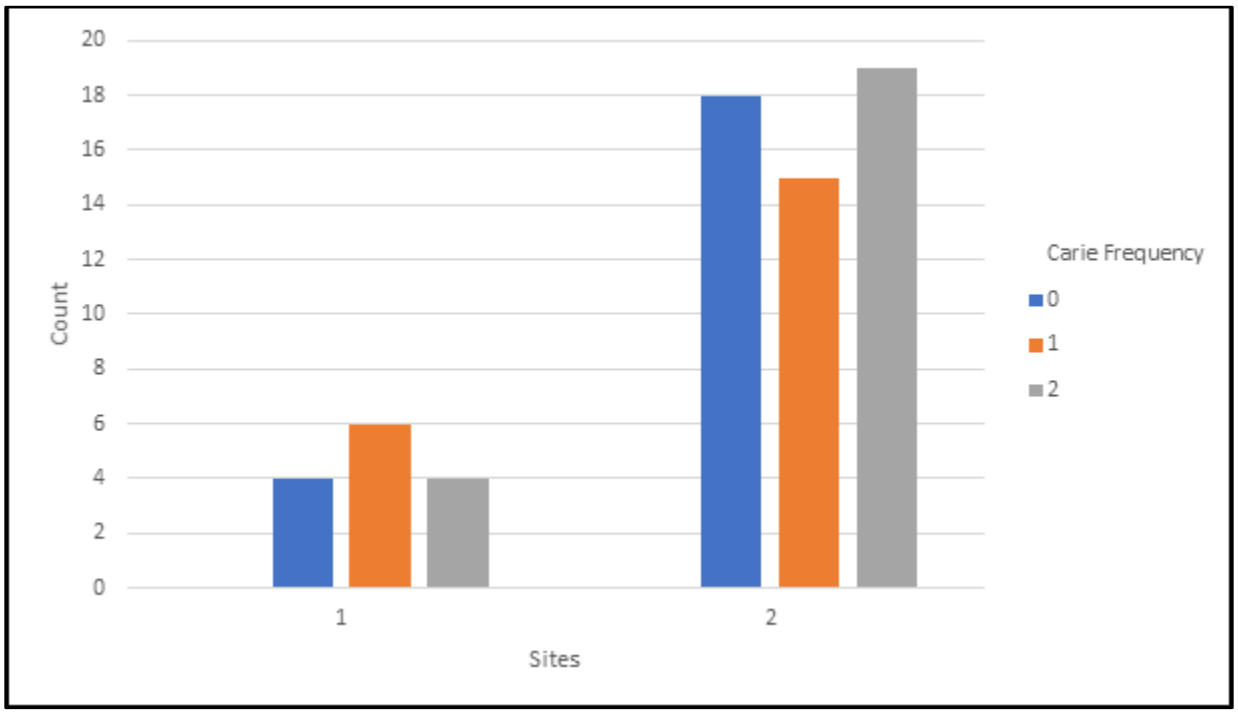
The findings presented here are produced by non-metric observations, frequency studies, and statistical analysis. Other elements that provide potentially useful contextual information are presented here. The results are presented in broad categories because of the high frequency of fragmentary remains and perimortem/postmortem tooth loss. The dental arcade is not always intact and therefore it is an often occurrence that individuals are missing several teeth. The significance of cranial modification and trauma are briefly mentioned but are not compared with any of the oral pathological conditions reported, rather this data is recorded and stored for future publications. All discussions and interpretations are found in Chapter 8.

7.2 Oral Health Findings

7.2.1 Carie and Abscess Frequencies

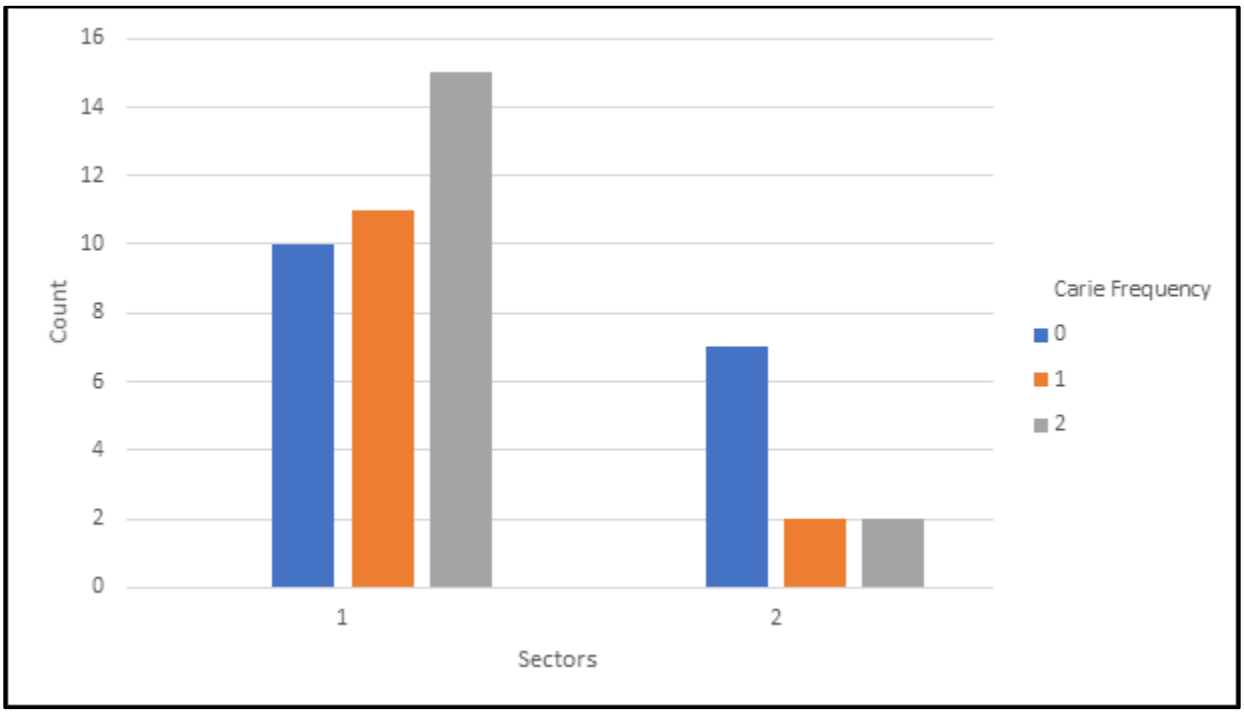
The presence of dental caries are frequently observed in both sites. Salapunku has eleven individuals while Saqsahuaman has thirty-three individuals who showed the presence of carious lesions. The presence of abscesses are frequently recorded on dentition and alveolar bone. Of the eighteen individuals with oral pathology from Salapunku, thirteen of them exhibit abscesses. At Saqsahuaman, thirty-five of the fifty-two individuals exhibit abscesses. There are several cases between caries and abscess presenting within the same individual; highlighting the correlation these two conditions have with one another. It was common for individuals to have more than one carie. All the individuals observed with these types of oral pathologies were adults.

Table 7.1 Carie Frequencies: Salapunku and Muyukmarka



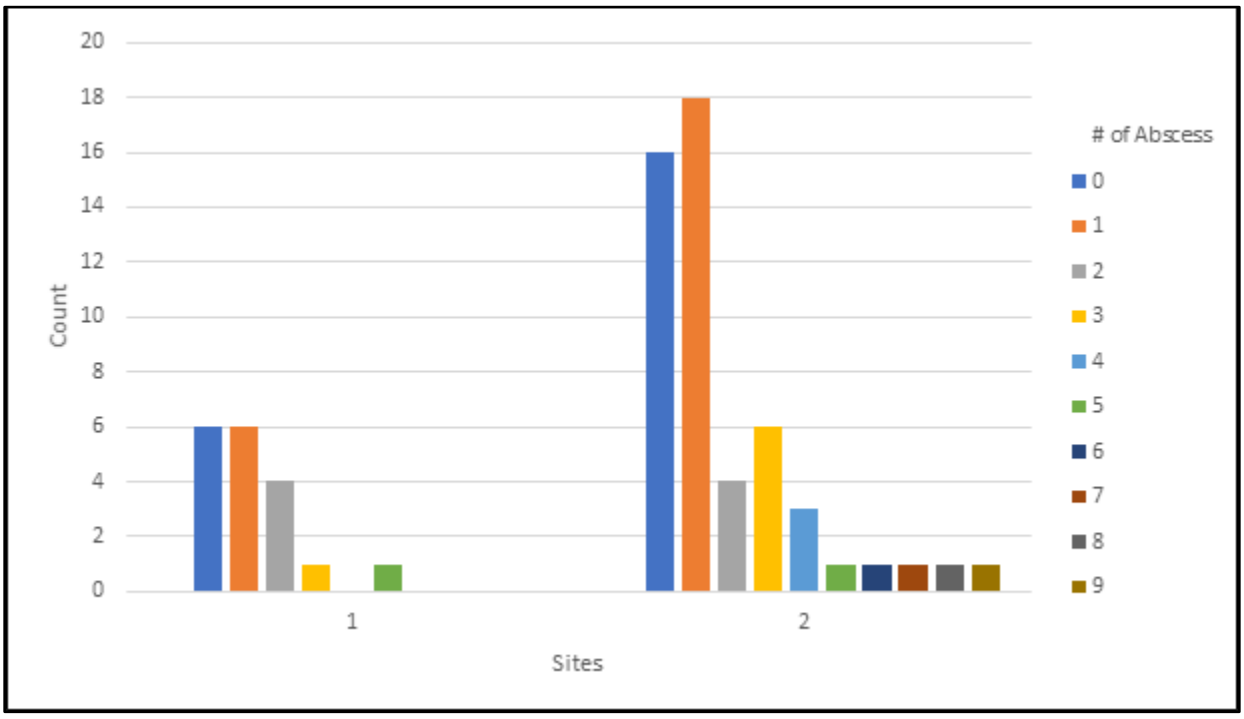
The bar graph above presents the frequency of caries at both Salapunku (1) and Saqsahuaman (2). The results show that there are four individuals that had no caries (0), 6 individuals that had >3 (1) less than three caries and four individuals that had <3 (2) three or more caries from Salapunku (1). There are eighteen individuals that had no caries (0), fifteen individuals that had >3 (1) less than three caries and nineteen individuals that had <3 (2) three or more caries from Saqsahuaman (2). Therefore, Saqsahuaman (2) exhibited higher frequencies of caries than Salapunku, however, sample size must be considered.

Table 7.2 Carie Frequencies: Suchuna and Muyukmarka



The bar graph above shows the comparison of carie frequencies observed in two sectors at Saqsahuaman, Suchuna (1) and Muyukmarka (2). The results show that at Suchuna there are ten individuals with (0) zero caries, eleven individuals with (1) >3 caries, and fifteen individuals with (2) <3 caries at Suchuna. From Muyukmarka there are seven individuals with (0) zero caries, one individual with (1) >3 caries, and one individual with (2) <3 caries. This shows that there are more caries observed at Suchuna than at Muyukmarka, however sample size must be taken into account.

Table 7.3 Abscess Frequencies: Salapunku and Saqsahuaman



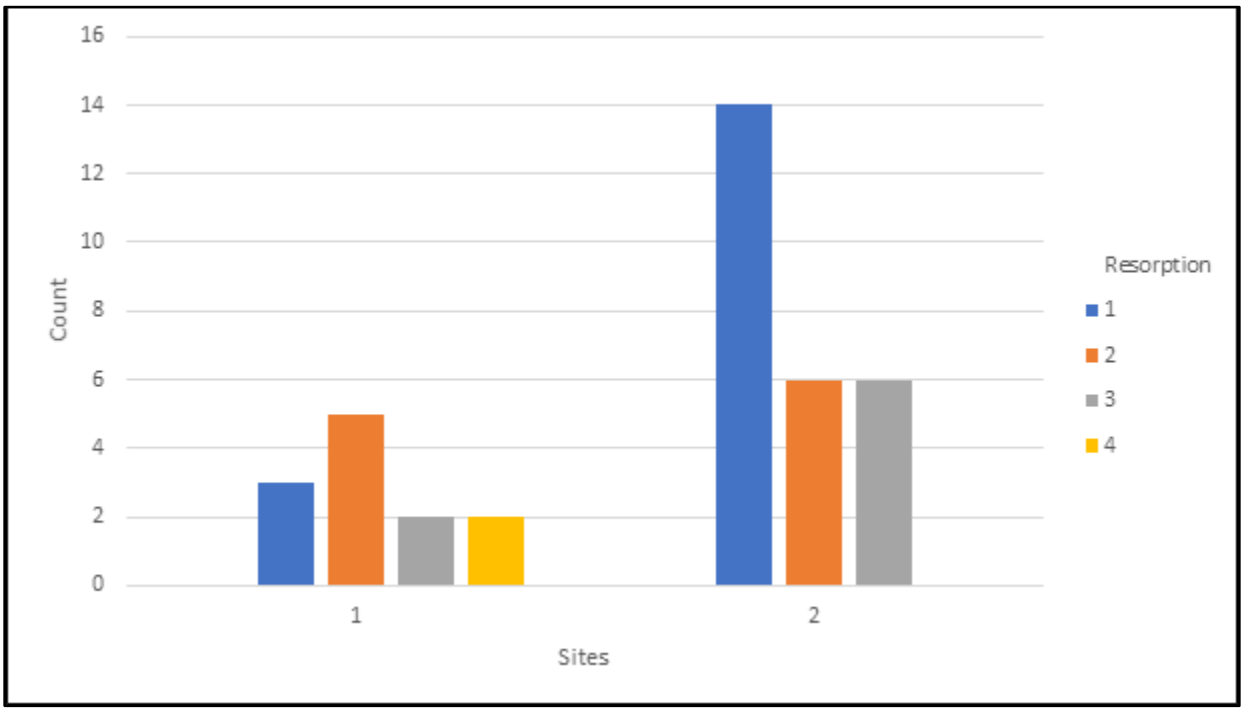
The bar graph above presents the comparison of the abscess frequencies of Salapunku (1) and Saqsahuaman (2). The results show that there are six individuals with (0) zero abscess, six individuals with (1) one abscess, four individuals with (2) two abscess, one individual with (3) three abscesses, and one individual with (5) five abscess from Salapunku. At Saqsahuaman, there are sixteen individuals with (0) zero abscess, eighteen individuals with (1) one abscess, four individuals with (2) two abscess, six individuals with (3) three abscess, three individuals with (4) four abscess, one individual with (5) five abscess, one individual with (6) six abscess, one individual with (7) seven abscess, one individual with (8) eight abscess, and one individual with (9) nine abscess. This shows a high amount of abscess observed at Saqsahuaman and possibly reflects differing diet and health between the two sites.

7.2.2 Antemortem Tooth Loss

Antemortem tooth loss is a widespread occurrence in both sites; however, at Salapunku, some individuals are completely edentulous. There are twelve individuals out of the eighteen observed with antemortem tooth loss from Salapunku, not including the edentulous individuals. There are twenty-eight individuals out of the fifty-two observed from Saqsahuaman with antemortem tooth loss. This shows high frequencies of resorption in both populations. Antemortem tooth loss is related to a variety of factors; poor dental care, habitual activity, oral pathology, and generalized poor health (Ortner et al. 2003).

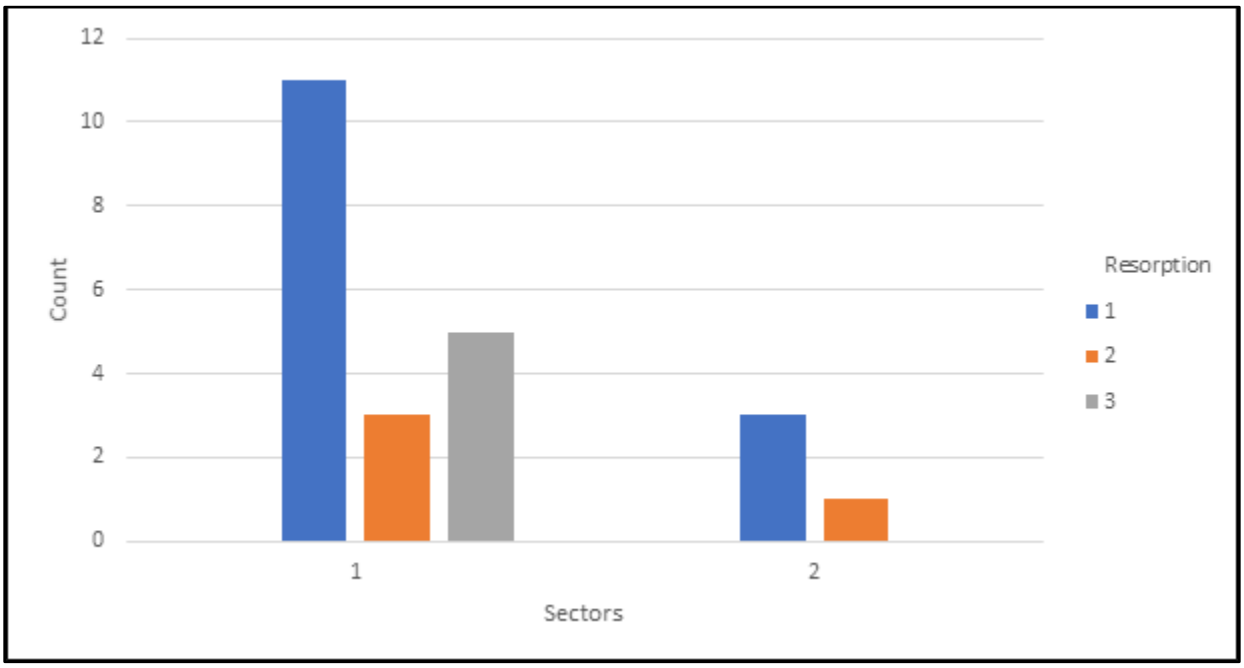
A total of 2% of individuals are edentulous in the Saqsahuaman sample compared to 7% among the sample from Salapunku. In total, 9% of individuals observed in this study were edentulous. At Saqsahuaman, 64% of individuals exhibited varying stages of resorption compared to the 27% from Salapunku. In total, 91% of individuals observed in this study had resorption. The results show extremely high tooth loss and can be a consequence of numerous factors, including oral decay and infections, heavy dental attrition, nutrition, and underlining general health conditions.

Table 7.4 Severity of AMTL: Salapunku and Saqsahuaman



The bar graph above shows the frequency of individuals who have AMTL (resorption) at both sites Salapunku (1) and Saqsahuaman (2). Resorption is recorded by a scoring system of (1) Minimal, (2) Moderate, (3) Significant, and (4) Edentulous. The results show that there are two individuals with (1) minimal resorption, five individuals with (2) moderate resorption, two individuals with (3) significant resorption, and two individuals with (4) edentulous observed from Salapunku. For Saqsahuaman (2) there are fourteen individuals with (1) minimal resorption, six individuals with (2) moderate resorption, and six individuals with (3) significant resorption. There are no individuals observed with endentulism at Saqsahuaman (2). The results highlight that Salapunku has a high frequency for resorption when you consider the sample size differences between the two sites.

Table 7.5 Severity of AMTL: Suchuna and Muyukmarka



The bar graph above shows the frequencies of resorption between two sectors at Saqsahuaman: Suchuna (1) and Muyukmarka (2). AMTL is recorded by a scoring system of (1) Minimal, (2) Moderate, (3) Significant, and (4) Edentulous. There is no evidence of edentulous individuals at Saqsahuaman. The results show that there are eleven individuals with (1) minimal AMTL, three individuals with (2) moderate AMTL, and five individuals with (3) significant AMTL from the Suchuna (1) sector at Saqsahuaman. There are zero individuals with (1) minimal AMTL, three individuals with (2) moderate AMTL, and one individual with (3) significant AMTL from the Muyukmarka (2) sector at Saqsahuaman.

7.2.3 Non-pathological Oral Observations

Interestingly, abnormal occurrences are observed and recorded like agenesis of the third molars. Conjoined adult incisors, two cases of supernumerary teeth, and enamel pearls are

recorded from individuals from Saqsahuaman. None of these abnormal occurrences were present in Salapunku, except a wide interproximal diastema of the upper central incisors that was noted. (*Figures 7.1 and 7.2)* demonstrate interesting pathologies observed from the sites in my study.

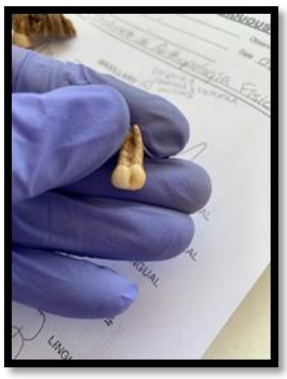


Figure 7.1 Conjoined Deciduous Left Central and Lateral Incisors

Figure 7.2 Supernumerary Dentition

7.3 Dental Wear Findings

Dental wear was documented thoroughly using the visual recording form from the SOD (Buikstra and Ubelaker 1994: Ch.5). Only two individuals from Salapunku exhibit heavy wear patterning. Mild to moderate wear was regularly seen in both sites. Of the two individuals with dense wear patterning from Salapunku, one showed evidence for mechanical attrition like one

observed in Saqsahuaman. The inventories show significant wear patterns from twenty-six individuals excavated at Saqsahuaman. Wear is observed on the upper and lower dentition, but it should be noted that most of the wear patterning is predominantly recognized on the mandibular molar and premolars. When exhibited on the mandibular dentition, it is often evenly distributed on both left and right occlusal surfaces; however, when observed on the maxillary dentition, the wear tends to favor aside. This patterning likely indicates habitual behavior or activity where people have utilized their teeth as tools.

Two individuals exhibited severe wear on the mandibular molar and premolar dentition that was associated with wear that had been observed in past and modern coastal fishers. After consulting with Lic. Elva Torres, a well-known bioarchaeologist in Peru and the Director of the Cusco Gabinete de Antropología Física, she agreed that the wear appears to be a result of fishers activity. The wear is present on the mandibular molars and premolars; the direction is angled from the lingual aspect of the tooth to the buccal side. The occlusal surface is entirely worn; dentin is exposed. The likely cause of this patterning is due to pulling the cords of the nets through the posterior mandibular dentition. Over time the enamel of the tooth is worn away exposing dentin. This would have been extremely painful until the wear was so significant that the pulp cavity where the nerves of the tooth are stored is destroyed. Bacteria could quickly eat away at the tooth and associated bone due to infection. This is exhibited in both cases; however, the individual from Salapunku exhibited extreme pathological infections on the right mandibular 1st-3rd molars. This is probably a result of the individual preferring the right side of the mouth for pulling the cord; the right dentition exhibits heavier patterning than the left dentition. (*Figures 7.3, 7.4, 7.5 and 7.6*) displays the fisherman wear referenced above.

Figure 7.3 Right Lingual View of Fisher's Wear and Abscess

Figure 7.4 Right Buccal View of Fisher's Wear

Figure 7.5 Right Posterior View of Fisher's Wear

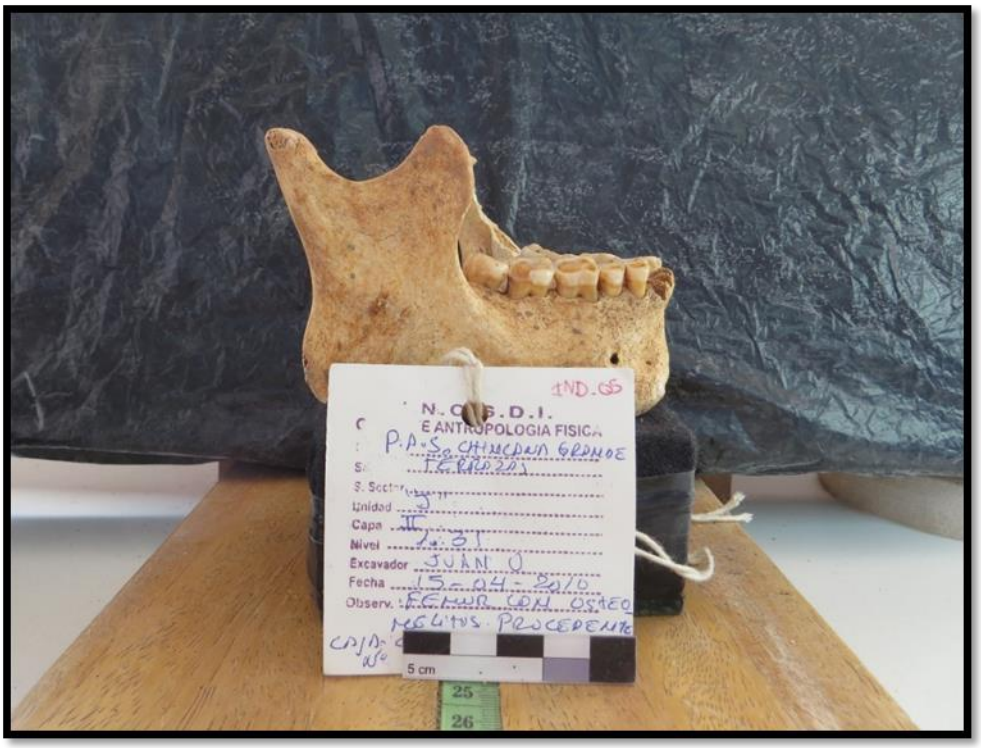


Figure 7.6 Right Anterior Buccal View of Fisher's Wear

Most of the individuals in the study are adults; however, there was one sub-adult inventoried from Salapunku and two from Saqsahuaman. One of the subadults show moderate wear and appear to be fairly young in age based on the development of the permanent teeth that were once in the crypt. The wear observed in this individual could speak to the type of tasks they performed daily utilizing their teeth or could be a result of heavy grit in the diet. Once the profiles are added to the data set, the demographics of each site will be compared with the oral pathological frequencies. There were significantly more individuals with heavy wear present at Saqsahuaman than Salapunku. This is indicative of the concerted use of the dentition as tools for habitual activities possibly associated with specific daily responsibilities.

7.4 Aspects of Identity: Cranial Trauma and Modification Findings

As noted in earlier chapters, contextual information about residential origin, trauma, *ayllu* membership, or other aspects of identity and/or lived experience may help to frame interpretations of oral pathology within and between the two sites in this study. Here, there were numerous non-oral pathological observations noted from both sites. Only the crania with associated dentition were analyzed. No postcranial elements were examined for this study. Cranial trauma was documented and consisted of antemortem and perimortem injuries. Taphonomic observations were also noted but only consist of postmortem breakage and copper staining on the dentition. Taphonomic copper staining was present in two individuals from Saqsahuaman, which is associated with high-class burials. The cranial pathologies observed consisted of button osteoma, periostitis, trepanation, and healed fractures. Trepanations are observed frequently in the Cusco region and were utilized strictly as medical treatments (Andrushko and Verano 2008). Healed

cranial trepanations indicating long-term survivorship show that this form of treatment that assists in trauma related seizures was an effective approach (Andrushko and Verano 2008). The cranial trauma observed consisted of broken nasal bones and sharp force trauma (cut markings) on frontal, parietals, and occipitals elements.

Cranial modification was recorded during the duration of the study. Tabular modification is the expansion of the parietals using boarding to create a flat back of the head shape; see Figure 7.0.7 below (Bass 1987). Annular modification is elongating the cranium through binding or wrapping; see (*Figure 7.7)* below (Bass 1987). At the Salapunku site, four individuals exhibited tabular modification, and one individual who exhibited annular modification. Comparatively, Saqsahuaman had two individuals who exhibited annular modification and one individual with tabular. It is interesting to see the frequency of modification at Salapunku, especially since Saqsahuaman has a larger sample size and is close to the imperial capital which would have been a residential area for various elites. However, there's no indication that elites were interred at Saqsahuaman, but it was near an urban center and the seat of power for the empire, so it would be reasonable to look for demographic and/or health differences in the samples from both sites to assess whether these contextual variables have any significant associations.

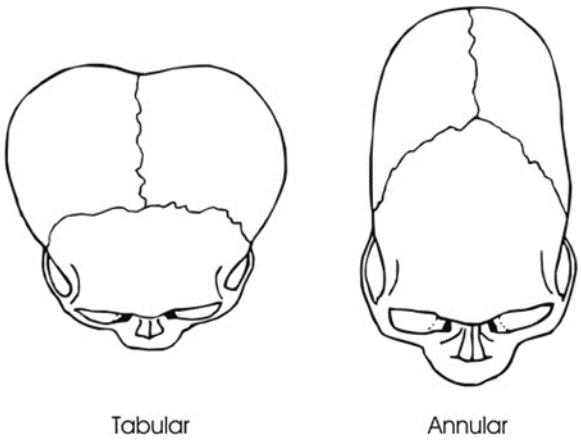
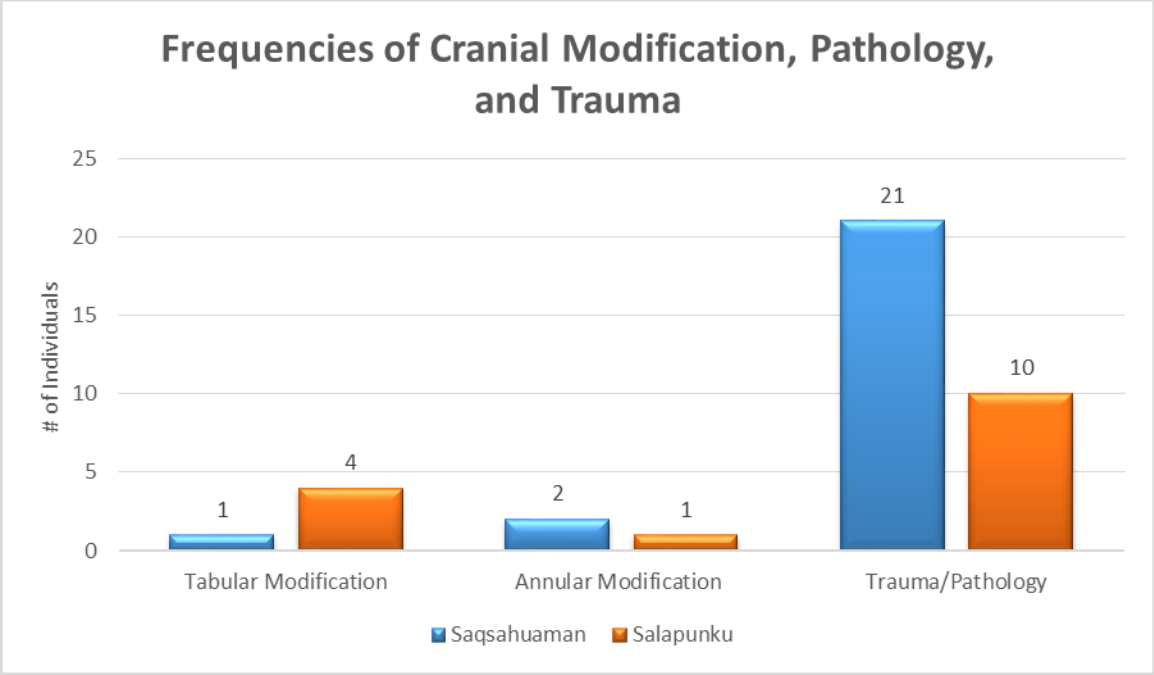


Figure 7.7 Types of Cranial Modification Recorded

The (*table 7.6)* below provides the number of individuals from each site that exhibited annular or tabular modification along with trauma or pathological observations. Salapunku had four individuals that exhibited Tabular and one that exhibited annular modification out of a total of 34 individuals. There were ten individuals from Salapunku that exhibited a variety of cranial pathology or trauma. A few pathologies observed were button osteoma, periostitis, and healed nasal fractures. Traumas observed consisted of antemortem nasal fractures and sharp force trauma. In comparison to Salapunku, Saqsahuaman had one individual with tabular and two had annular modification. There were eleven more cranial traumas and pathologies observed in Saqsahuaman than Salapunku. The pathologies observed were button osteoma, trepanation, and periostitis. Traumas observed were sharp force cut marks, unhealed trepanation, and antemortem nasal fractures. Cranial trauma data collected on the individuals from both sites from my thesis will be utilized in coming publications. I recorded other observations like cranial pathology and trauma from the individuals examined. Thus, my interest in future analysis is using $^{87}Sr/^{86}Sr$ and possibly $\delta^{18}O$ to reconstruct residential mobility that might be useful in investigating whether individuals with signs of habitual trauma were ‘locals’ or ‘foreigners,’ using working definitions of those categories that are regionally and culturally relevant.

Table 7.6 Frequencies of Cranial Modification, Pathology, and Trauma: Salapunku and Saqsahuaman



7.5 Statistical Analyses

Statistical tests were conducted to identify significance among the oral pathologies analyzed of the two sites. The collections that I observed do contain numerous fragmentary and/or commingled remains and are considered when conducting the statistical analysis. In this section I present findings through non-parametric tests, independent samples tests, and cross-tabulations with Chi-square tests of significance.

By conducting non-parametric tests, the intent is to showcase any variance or relationship between Salapunku and Saqsahuaman. The test compares the medians instead of the means because it does not assume that the data are normally distributed. This type of test was run to compare the aggregate wear scores I calculated. Anterior, posterior, and overall median scores

were compared with one another. The posterior wear score closely approaches significance, and given the small sample sizes, this could be interpretively significant. The overall wear score also approaches significance, likely because posterior wear is included in the aggregate score.

The Chi-Square tests calculate a numerical difference between what was collected from each site and sector. The results of this type of tests show that the caries frequencies from the sites are not hugely different from one another. There were no significant differences in the frequencies for the aggregate scores. However, the AMTL prevalence is approaching significance for resorption observed on anterior vs. posterior dentition. These results can be expanded when the demographic data are available. Independent median samples test show there is no significance in median between the sites for caries frequencies or crude prevalence. During the Chi-Square test some of the cells in the crosstabs had fewer than the required minimum cases. When this occurs one usually runs a Fisher's Exact test. However, for unknown reasons Georgia State University's license to SPSS does not include the feature for adding cross tests for exact cross tabulations like Fisher's Exact. No one is sure why the function is not present on this version of SPSS.

CHAPTER 8: CONCLUSIONS & FUTURE PLANS

8.1 Introduction

The findings illustrate interesting patterns in oral frequencies and wear observed that will be expanded on when the demographic data are received. From the analysis results indicate comparable dental pathologies from Salapunku and Saqsahuaman. Although, in few of the non-parametric tests for frequencies the results are close to being significant. However, in this study the dental pathologies are comparable and indicate that despite different locations and site contexts within the Sacred Valley the sites show similar patterns of oral decay and wear. The interpretations of the results from Chapter 7 are discussed in the following sections.

8.2 Comparing Oral Health Frequencies of the Two Sites

Although there are more individuals observed in Saqsahuaman there are interpretatively significant findings observed in oral pathologies than Salapunku, which could likely be due to the urban climate of the imperial city. High concentrations of people bring about a disease which is enhanced due to mobility. Thus, the oral pathologies observed in Saqsahuaman is perhaps a result of urban living environments (Andrushko et al. 2006). This indicates that the overall health of people from Salapunku was much better than the individuals from Saqsahuaman. Oral health not only is indicative of social organization, diet, or habitual activity but overall health. However, this will be expanded upon once compared to the demographic data and will likely reflect higher frequency differences from the two sites in regards to age and sex.

8.2.1 Social Organization, Diet, and Habitual Activity

The Inka statecraft is highly debated because the only form of documentation comes from Spanish colonial accounts. This study shows contradicting results from the accounts and after future analysis will hopefully provide clearer understanding of the social organization of the Inka. Diet can be interpreted through the presence of malnutrition stress and oral decay. The habitual activity is recognized on the dental attrition. Wear observed from an individual from Saqsahuaman shows a fisherman type patterning seen in coastal Inka populations, meaning the individuals likely spent most of their life on the coast before coming to the mountains. Therefore, mobility is highlighted and brings about new research questions for the future.

8.3 Comparing Contextual Features

8.3.1 Social Status of the Inka

Studies of biological evidence of the effects of imperialism can show the transition in the social status of the Inka through the results in frequencies of the oral pathologies observed. The health disparities can be seen throughout both sites and suggests that the individuals from Salapunku and Saqsahuaman are non-elite members of the Inka. Non-elite members would have had limited access to resources but engaged in heavy labor. Thus, this study highlights that the capital and outpost centers likely had similar structures and organization of ranks when it comes to people.

Other aspects of social status was explored through analyzing the presence of cranial modification and trauma. There were more individuals observed with modification at Salapunku than Saqsahuaman. At Salapunku there were more tabular modification than annular. This could

indicate possible ethnic groups residing in-between the capital and the sacred city of Machu Picchu. Further studies could showcase the significance of the frequency of cranial modification at Salapunku opposed to Saqsahuaman.

8.4 Recommendations for Future Analysis

Future statistical analysis will be conducted once the appropriate data is received from Peru. I intend to run G-Tests to see the significance between the two populations. A Spearman and Pearson tests will allow me to see the relationship between two variables and rank the values of these variables within each site. The demographic information from the site will also be utilized. For further publications, the above statistical tests will be included and discussed to provide further insight into the demographics of the frequencies of oral pathology between the populations. Questions such as, do men have higher frequencies in oral pathologies than women? What about dental wear? How does this demographic data contribute to the project?

Another component to continue the expansion of this study will be accomplished through collaborating with Dr. Bethany Turner conducting stable isotopic analysis, which will provide a thorough understanding of diet and mobility from the individuals between these populations. By investigating diet, we will be able to see stages of dietary transitions that may be linked to mobility patterns. Samples were taken while recording data at the Gabinete, and a request for transport was submitted. At the beginning of April, the samples had been scheduled for hand-delivered by a colleague from the Ministerio de Cultura however, due to COVID-19 transport was delayed until further notice. Once the samples are delivered we will begin the early stages of processing for the stable isotopic analysis once the campus is open to the public. The stable isotopic research will be helpful to investigate the possible "Chosen Women" who were brought from all over the empire

to serve the Sapa Inka and will ultimately help trace the influx of people coming in and out of the imperial city.

8.5 Concluding Remarks

This project expands on the growing knowledge of Inka statecraft from the bottom up. By focusing on the life histories of the non-elite members of Inka society, interpretations can be formed on the overall role non-elites played in imperial state affairs. The study provides an interesting take on oral pathology, for it contributes to understanding how dental health can indicate other health issues. Health disparities can then be interpreted through a statecraft lens.

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APPENDICES

Appendix A Data Collection Sheets

Appendix A.1 Oral Pathological Conditions Recorded

MO#	Site	Sector	Context	Unit	Individual #	Dental Pathologies
1	Saqsahuaman	Suchuna	Cemetery	Feature 14	Ind 14	Few teeth present but heavy wear observed;
2	Saqsahuaman	Suchuna	Tumbas 15		Ind 1	No maxillary dentition present; heavy wear seen on mandibular molars and premolars; copper staining on Right lower mandible
3	Saqsahuaman	Suchuna	Cemetery Tumbas 24	Unit N18-E6	Ind 1	Buccal pitting seen on Upper/Lower Right/Left 1st molars; heavy wear, caries present
4	Saqsahuaman	Suchuna	Tumbas 23		Ind 1	Resorption present in upper L/R 2nd and 3rd molars - lower LM1 and LM3; Wear; Caries
5	Saqsahuaman	Suchuna	CF 22	Unit 12-W2		Only few teeth present; heavy wear observed
6	Saqsahuaman	Suchuna	CF 19			Heavy wear on maxillary and mandibular dentition
7	Saqsahuaman	Suchuna	Tumbas 01		Ind 1	No mandible present; missing much of the maxillary dentition; only upper left canine, 2nd pre-molar, and 1st molar present; heavy wear; carie present on molar
8	Saqsahuaman	Suchuna	Cemetery	Tumba 12	Ind 1	Only few teeth present; Caries seen on upper right 1st molar and lower left 1st molar
9	Saqsahuaman	Suchuna	Cemetery	Tumba 26-1	Ind 1	Heavy wear on maxillary and mandibular dentition
10	Saqsahuaman	Suchuna	Cemetery	Unit N22-EG Tumba 25-1		Heavy wear on maxillary and mandibular dentition; Abcesss on upper LM3
11	Saqsahuaman	Suchuna	Cemetery	Unit N18-W2 Tumba 27		No dentition present; Complete resorption observed on the maxillae and mandible - Lower/Upper L/R Premolars and Molars

12	Saqsahuaman	Suchuna	Cemetery	Tumba 32	Ind 1		Heavy wear; abcess on upper and lower molars; caries
13	Saqsahuaman	Suchuna	Cemetery	CF 33			Slight wear; carie on lower right 1st molar; abcess on lower left 3rd molar
14	Saqsahuaman	Suchuna	Cemetery	Tumba 31			Slight wear; carie on lower right 1st molar and left 3rd molar; abcess on left 3rd molar
15	Saqsahuaman	Suchuna	Cemetery	Tumba 30			Wear; abcess on lower right 3rd molar; caries on lower right 1st and 2nd molars
16	Saqsahuaman	Suchuna	Cemetery	Tumba 40			Slight wear; caries observed on upper and lower dentition; abcess on the root of the upper right 2nd molar
17	Saqsahuaman	Suchuna	Cemetery	Unit N16 E2	Tumba 37		Mandibular alveolar bone is completely resorbed; Maxillary bone in different stages of resorption - some dentition present with heavy caries and abcess; upper left 1st premolar erupted sideways
18	Saqsahuaman	Suchuna	Cemetery	CF 38			Slight wear; caries observed on lower right 3rd molar and left 2nd molar; abcess observed on upper right 3rd molar
19	Saqsahuaman	Muyukmarka	Unit 2A N4E 15-16	Nivel 271			Hardly any wear; 3rd molars still in crypt; Abcess on alveolar bone where the root for the upper left 2nd premolar would be
20	Saqsahuaman	Muyukmarka	S16 W12	Tumba 02			Agensis of the 3rd molars; sideways eruption of lowerand upper central incisors which makes them overlap the left lateral incisor
21	Saqsahuaman	Muyukmarka	N6 E35 4B	Context 413	Ind 2		Wear; resorption present for lower left 2nd and 3rd molars; abcess on upper left 2nd molar;
22	Saqsahuaman	Muyukmarka	S. Sector Andean Sur	Unit U-18 Nivel III		1.1	All 3rd molars in crypt except the lower right which is resorbed; caries on molars
23	Saqsahuaman	Muyukmarka	Patio 1	Cuardo 04y05 CF			Single Tooth (Upper canine with wear)
23	Saqsahuaman	Muyukmarka	Patio 1	Cuardo 04y05 CF			Mixture of subadult dentition
24	Saqsahuaman	Muyukmarka	Patio 1	Cuardo 04y05 CF			Only maxillary dentition; adult dentition in different stages of development (no wear); subadult right molar present

25	Saqsahuaman	Chincana Grande	S. Sector Huacus 01	Unit 03 Capa II	Ind 1	Heavy wear; abcesses on several mandibular teeth; resorption observed in upper left and right molars and lower right 3rd molars
26	Saqsahuaman	Chincana Grande	Waka II Cuardo TE-O4A	Context II	Ind 6	Heavy resorption observed on almost all the maxillary dentition and lower right 2nd and 3rd molars - left 1st and 2nd molar; abcesses observed on lower right 1st molar and lower left 3rd molar
27	Saqsahuaman	Chincana Grande	Unit J Capa II		Ind 5	Heavy wear; abcess on upper right canine; caries on lower left 2nd and 3rd molars
28	Saqsahuaman	Qochapata	CF 1133		Ind 1	Slight wear; carie observed on the upper left 2nd premolar
29	Saqsahuaman	Cruz Moqo	N-4 E10		Ind 8	Resoprtion observed in the upper right 1st and 3rd molars and left 1st molar - lower left and right 3rd molars; abcesses observed in several lower dentition
30	Saqsahuaman	Suchuna	Cemetery	Tumba 7	Ind 1	Resorption observed in lower left and right 2nd premolar-3rd molars; abcesses observed in upper right canine and 2nd premolar- lower right lateral incisior;
31	Salapunku		Sector III CF 4	Unit TV - 04	Ind 7	No mandible present; major resorption observered for upper R pm2, m1, and m3 and upper L m1 and m3
32	Salapunku		Cueva 3 Sector III		Ind 5	Completely endontulous - resorption on maxillae and mandible
33	Salapunku		Sector III CF 4	Capa III	Ind 3	The following permanent dentition is still in the crypt Upper R M2, I2, and CI1; Upper L CI1, I2, and M2 - Lower R M2 and lower L M2 / lower L&R lateral incisors are in the process of erupting / Heavy wear of decidious dentition present
34	Salapunku		Sector VII S Sector A	Unit 9 Tumba 03	Ind 3	No mandible present; complete resorption for maxillary dentition
35	Salapunku		Sector III CF 1	Unit 07 Capa I	Ind 1	
36	Salapunku		Sector VII S Sector Andean 8-9	Unit 07 TB-02 Capa II	Ind 1	Complete resoprtion of the Maxillary teeth, Mandibular dentition show heavy signs of caries and abcess or PM loss - in different stages of resorption ; Trauma - healed broken nose
37	Salapunku		VII Hatun QAQA	Unit 01 Capa II CF02	Ind 2	3rd molars still in crypt; Supernumerary permanent dentition (upper central incisors); Tabular cranial modification; Abcesses; heavy wear
38	Salapunku		VII Hann QAQA	Unit 01 CF 3	Ind 1	Tabular modification; button osteoma; healed trauma (occipital); soft tissue failed dental eruption; abcesses, resorption of rm3.

39	Salapunku		Sector VII Hatun QAQA	Unit 01 Nivel III CF 06	Ind 6	Tabular modification; supernumerary teeth (Left extra 3rd molar in crypt); Caries; Wear
40	Salapunku		ISLA CHICO	CF 2	Ind 1	Resorption of right upper pm2; abcesses of molars; caries
41	Saqsahuaman	Muyukmarka	N20 W32	Capa VII	Ind 1	Slight wear; resorption observed in upper right and left 1st molar and lower 1st molar; caries observed in mandibular dentition
42	Saqsahuaman	Muyukmarka	Sector B-06	N16-E17 Context 606C		Buccal pitting observed on lower molars; lower canines sideways eruption; abcess observed on right 2nd premolar; lower right 3rd molar not fully erupted
43	Saqsahuaman	Muyukmarka	S. Sector B-06	N16-E15 Context 608A		Only few teeth present; resorption on the lower right 1st molar; carie and abcess present on the lower right 3rd molar
44	Saqsahuaman	Muyukmarka	S.S B-6	Capa 608 B		Few maxillary teeth present; abcesses present on the lower right 2nd and 3rd molars and lower left 3rd molar
45	Saqsahuaman	Muyukmarka	Patio 1	04y05	Ind 1	No maxillary teeth present; heavy wear present on the mandibular dentition; resorption present on the lower right 3rd molar; abcess on alveolar bone on the left aspect of the mandible
46	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 3		Heavy wear on the upper and lower incisors, canines, and premolars; resoprtion on the lower right 1st molar; abcess on the left aspect of the mandible
47	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 2		Caries present on both lower and upper dentition; abcesses present on the upper left 2nd and 3rd molars and lower right 1st premolar
48	Saqsahuaman	Suchuna	Saqsahuaman	Context No 5		Heavy wear; abcesses on several maxillary teeth; caries on both maxillary and mandibular dentition
49	Saqsahuaman	Suchuna	Saqsahuaman	Context No 4		Heavy wear on both maxillary and mandibular dentition; caries present on the lower right 2nd molar; resorption is present on the upper left 2nd and 3rd molars and lower left 3rd molars
50	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 11		Heavy wear both maxillary and mandibular dentition; resorption present on the upper right 1st premolar; caries present on lower right 2nd and 3rd molars; buccal pitting on the lower right molars; abcess present on the upper right 1st molar
51	Saqsahuaman	Suchuna	Saqsahuaman	N12-W2 4E3 Tumba 18		Few teeth present; abcesses present on upper and lowe right 1st molars
52	Saqsahuaman	Suchuna	Saqsahuaman	N4-E2 Tumba 13		Several abcesses on the upper and lower dentition; heavy wear

53	Saqsahuaman	Suchuna	Saqsahuaman	N14 W2 Tumba 21	Ind 2	Few teeth present; heavy wear; caries seen on lower right 2nd molar
54	Saqsahuaman	Suchuna	Saqsahuaman	1.1 99-2005 Tumba 17		Resorption present for the upper left canine; abcess on the lower left 2nd molar and upper left 3rd molar; caries on the lower right 1st molar
55	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 21	Ind 1.2	Only three teeth present; caries on the lower right 2nd molar
56	Saqsahuaman	Suchuna	Saqsahuaman	CF 28		Resorption present on the upper right 3rd molar and left 1st and 2nd molars - lower left 1st premolar and molars; Abcesses present on the upper right 1st molar and left 2nd premolar - lower right 1st and 2nd molars; carie on the upper left 3rd molar
57	Saqsahuaman	Suchuna	Saqsahuaman	N20-E6 Tumba 29		Wear present on upper and lower dentition; carie present on the upper right 2nd molar; resorption present on the lower right 3rd molar; abcess present on the lower right 2nd molar
58	Saqsahuaman	Suchuna	Saqsahuaman	N20 W2 Tumba 34	Ind 2	Heavy wear on upper and lower dentition; abcesses on upper and lower dentition; resorption present on the lower right 2nd molar and left 3rd molar
59	Saqsahuaman	Suchuna	Saqsahuaman	CF 35		Abcesses present on the upper left 1st molar and lower right 3rd molar and left lateral incisior; resorption on the lower left 2nd molar
60	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 39		Heavy wear on both upper and lower dentition; abcesses on upper and lower dentition; resorption present on the lower right molars and left 1st and 2nd molars
61	Saqsahuaman	Salapunku	Cusup 3		Ind 6	Only mandibular dentition present - complete resorption for the lower R PM2, M1, M2, and M3; complete resorption for the lower L M1, M2, and M3; wear on dentition present
62	Saqsahuaman	Suchuna	Saqsahuaman	Unit T-21 Capa I		No mandibular dentition present; abcesses present on the upper right 2nd premolar and left 2nd premolar and 1st molar
63	Saqsahuaman	Suchuna	Saqsahuaman	N8-W2 Tumba 6		No maxillary dentition present; heavy wear seen on mandibular dentition; resorption present on the lower right and left 2nd and 3rd molars; abcess on the lower right 1st premolar
64	Salapunku		Cueva 01		Ind 1	Heavy wear on dentition present - abcess on interproximal roots of upper L m1 and m2; caries on occlusal surface on the lower R m3
65	Salapunku		Sector III	CF 2	Ind 2	abcesses on several mandibular dentition; resorption of right upper 3rd molar
66	Salapunku		IV Choquellusca Andean 8-9	Unit 07 TB: 01 Capa II	Ind 2	No maxillaery dentition present; resorption present on lower RM3, RM1, RPM1, RLI, RCI, LLI, LPM1, LM3; Abcesses present on lower RM2, RC, LPM2, LM1, LM2

67	Salapunku	Sector III Cueva 4	T - 04 Capa II - U2		Only mandible present - complete resorption lower R M2 and M3; Lower R M1 exhibits an abcess on the buccal aspect of the root - lower R PM2, M1, and M2 are in active resorption
68	Salapunku	VII Challaqata S. Sector A	Unit 09-T-03 Capa I	Ind 1	No maxillary dentition present; Resorption present on lower right and left molars 1-3 and central incisors; abcess present on the buccal aspect of the root for LPM1
69	Salapunku	VII Challaqata S. Sector A	Unit 08 Capa Sup	Ind 1	Caries seen on lower molars; one abcess on RM3 that covers tooth and surrounding alveolar bone
70	Salapunku	VII Challaqata Tumba 03	U E.N 09 (Mummy)	Mummy	Wide diastema between upper central incisors; resorption observed on L/R upper lateral incisors and LM2; lower LCI resorped; Abcess visible on lower LM1

Appendix A.2 Cranial Trauma and Pathology Recorded

MO#	Site	Sector	Context	Unit	Individual #	Cranial/Post-cranial Pathologies
1	Saqsahuaman	Suchuna	Cemetery	Feature 14	Ind 14	Cut mark present on Right Parietal
2	Saqsahuaman	Suchuna	Tumbas 15		Ind 1	copper staining
3	Saqsahuaman	Suchuna	Cemetery Tumbas 24	Unit N18-E6	Ind 1	
4	Saqsahuaman	Suchuna	Tumbas 23		Ind 1	
5	Saqsahuaman	Suchuna	CF 22	Unit 12-W2		Button osteoma on right parietal (posterior)
6	Saqsahuaman	Suchuna	CF 19			
7	Saqsahuaman	Suchuna	Tumbas 01		Ind 1	
8	Saqsahuaman	Suchuna	Cemetery	Tumba 12	Ind 1	Trephenation observed on Right parietal - not healed
9	Saqsahuaman	Suchuna	Cemetery	Tumba 26-1	Ind 1	Annular modification
10	Saqsahuaman	Suchuna	Cemetery	Unit N22-EG Tumba 25-1		
11	Saqsahuaman	Suchuna	Cemetery	Unit N18-W2 Tumba 27		
12	Saqsahuaman	Suchuna	Cemetery	Tumba 32	Ind 1	Abcess on mandible

13	Saqsahuaman	Suchuna	Cemetery	CF 33			Button osteoma observed on frontal
14	Saqsahuaman	Suchuna	Cemetery	Tumba 31			
15	Saqsahuaman	Suchuna	Cemetery	Tumba 30			Abcess on mandible
16	Saqsahuaman	Suchuna	Cemetery	Tumba 40			
17	Saqsahuaman	Suchuna	Cemetery	Unit N16 E2	Tumba 37		
18	Saqsahuaman	Suchuna	Cemetery	CF 38			
19	Saqsahuaman	Muyukmarka	Unit 2A N4E 15-16	Nivel 271			Possible infection or large root holes for upper left 2nd premolar; Tabular modification
20	Saqsahuaman	Muyukmarka	S16 W12	Tumba 02			
21	Saqsahuaman	Muyukmarka	N6 E35 4B	Context 413	Ind 2		Periosteal reaction on frontal
22	Saqsahuaman	Muyukmarka	S. Sector Andean Sur	Unit U-18 Nivel III		1.1	
23	Saqsahuaman	Muyukmarka	Patio 1	Cuardo 04y05 CF			
23	Saqsahuaman	Muyukmarka	Patio 1	Cuardo 04y05 CF			
24	Saqsahuaman	Muyukmarka	Patio 1	Cuardo 04y05 CF			
25	Saqsahuaman	Chincana Grande	S. Sector Huacus 01	Unit 03 Capa II	Ind 1		Trephenation and cut mark on frontal

26	Saqsahuaman	Chincana Grande	Waka II Cuardo TE-O4A	Context II	Ind 6	
27	Saqsahuaman	Chincana Grande	Unit J Capa II		Ind 5	
28	Saqsahuaman	Qochapata	CF 1133		Ind 1	
29	Saqsahuaman	Cruz Moqo	N-4 E10		Ind 8	
30	Saqsahuaman	Suchuna	Cemetery	Tumba 7	Ind 1	
31	Salapunku		Sector III CF 4	Unit TV - 04	Ind 7	
32	Salapunku		Cueva 3 Sector III		Ind 5	
33	Salapunku		Sector III CF 4	Capa III	Ind 3	Tabular Cranial Modification
34	Salapunku		Sector VII S Sector A	Unit 9 Tumba 03	Ind 3	
35	Salapunku		Sector III CF 1	Unit 07 Capa I	Ind 1	
36	Salapunku		Sector VII S Sector Andean 8-9	Unit 07 TB-02 Capa II	Ind 1	
37	Salapunku		VII Hatun QAQA	Unit 01 Capa II CF02	Ind 2	
38	Salapunku		VII Hann QAQA	Unit 01 CF 3	Ind 1	
39	Salapunku		Sector VII Hatun QAQA	Unit 01 Nivel III CF 06	Ind 6	

40	Salapunku		ISLA CHICO	CF 2	Ind 1	Annular modification; occipital bunning
41	Saqsahuaman	Muyukmarka	N20 W32	Capa VII	Ind 1	Periosteal reaction on frontal; healed depression on left lateral aspect of the parietal; possible abcess on the left mastoid process
42	Saqsahuaman	Muyukmarka	Sector B-06	N16-E17 Context 606C		
43	Saqsahuaman	Muyukmarka	S. Sector B-06	N16-E15 Context 608A		
44	Saqsahuaman	Muyukmarka	S.S B-6	Capa 608 B		
45	Saqsahuaman	Muyukmarka	Patio 1	04y05	Ind 1	
46	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 3		
47	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 2		
48	Saqsahuaman	Suchuna	Saqsahuaman	Context No 5		
49	Saqsahuaman	Suchuna	Saqsahuaman	Context No 4		
50	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 11		
51	Saqsahuaman	Suchuna	Saqsahuaman	N12-W2 4E3 Tumba 18		
52	Saqsahuaman	Suchuna	Saqsahuaman	N4-E2 Tumba 13		
53	Saqsahuaman	Suchuna	Saqsahuaman	N14 W2 Tumba 21	Ind 2	

54	Saqsahuaman	Suchuna	Saqsahuaman	1.1 99-2005 Tumba 17		
55	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 21	Ind 1.2	
56	Saqsahuaman	Suchuna	Saqsahuaman	CF 28		
57	Saqsahuaman	Suchuna	Saqsahuaman	N20-E6 Tumba 29		
58	Saqsahuaman	Suchuna	Saqsahuaman	N20 W2 Tumba 34	Ind 2	
59	Saqsahuaman	Suchuna	Saqsahuaman	CF 35		
60	Saqsahuaman	Suchuna	Saqsahuaman	Tumba 39		
61	Saqsahuaman	Salapunku	Cusup 3		Ind 6	
62	Saqsahuaman	Suchuna	Saqsahuaman	Unit T-21 Capa I		
63	Saqsahuaman	Suchuna	Saqsahuaman	N8-W2 Tumba 6		
64	Salapunku		Cueva 01		Ind 1	Enamel pearl on lower R m3 lingual side
65	Salapunku		Sector III	CF 2	Ind 2	
66	Salapunku		IV Choquellusca Andean 8-9	Unit 07 TB: 01 Capa II	Ind 2	
67	Salapunku		Sector III Cueva 4	T - 04 Capa I - U2		

68	Salapunku	VII Challaqata S. Sector A	Unit 09-T-03 Capa I	Ind 1	
69	Salapunku	VII Challaqata S. Sector A	Unit 08 Capa Sup	Ind 1	Bumpy new bone formation on posterior aspects of the L/R parietals along the saggital suture - possible healed fracture (periostitis)
70	Salapunku	VII Challaqata Tumba 03	U E.N 09 (Mummy)	Mummy	

Appendix A.3 Number of Teeth Recorded with Oral Pathological Conditions

MO #	Site	Sector	Ind #	# Teeth Ob-served	# of Caries Present	Caries Pre-valence	Caries Freq	Caries Loca-tion	# Abs-cesses	Abscess Loca-tion	# teeth Re-sorbed
1	Saq	Suchuna	Ind 14	16	0	0	0		0		0
2	Saq	Suchuna	Ind 1	11	4	36	2	6	0		0
3	Saq	Suchuna	Ind 1	18	3	17	2	6	1		1
4	Saq	Suchuna	Ind 1	12	10	83	2	6	0		0
5	Saq	Suchuna		7	0	0	0		0		0
6	Saq	Suchuna		16	15	94	2	3	1	1	0
7	Saq	Suchuna	Ind 1	3	1	33	1	3	0		0
8	Saq	Suchuna	Ind 1	6	7	117	2	6	0		0
9	Saq	Suchuna	Ind 1	21	7	33	2	6	0		0
10	Saq	Suchuna		24	2	8	1	3	1	1	0
11	Saq	Suchuna		0	0		0		0		13
12	Saq	Suchuna	Ind 1	24	3	13	2	6	6	1	0
13	Saq	Suchuna		23	2	9	1	6	1	1	0
14	Saq	Suchuna		17	2	12	1	3	2	1	0

15	Saq	Suchuna		16	3	19	2	3	1	1	0
16	Saq	Suchuna		22	3	14	2	6	2	1	0
17	Saq	Suchuna	Tumba 37	6	3	50	2	6	2	1	0
18	Saq	Suchuna		25	2	8	1	3	1	1	0
19	Saq	Muyukmarka		20	0	0	0		0	2	0
20	Saq	Muyukmarka		24	0	0	0		0		0
21	Saq	Muyukmarka	Ind 2	12	0	0	0		1	1	4
22	Saq	Muyukmarka	1.1	31	5	16	2	6	0		1
23	Saq	Muyukmarka		8	0	0	0		0		0
24	Saq	Muyukmarka		8	0	0	0		0		0
25	Saq	Chincana Grande	Ind 1	15	3	20	2	3	5	1	8
26	Saq	Chincana Grande	Ind 6	11	0	0	0		2	1	21
27	Saq	Chincana Grande	Ind 5	18	3	17	2	6	1	1	0
28	Saq	Qochapata	Ind 1	29	1	3	1	3	0		0
29	Saq	Cruz Moqo	Ind 8	21	2	10	1	3	4	1	5
30	Saq	Suchuna	Ind 1	7	0	0	0		3	1	8

31	Salp		Ind 7	0	0			0		5
32	Salp		Ind 5	0	0			0		16
33	Salp		Ind 3	17	1	6		0		0
34	Salp		Ind 3	0	0			0		16
35	Salp		Ind 1	25	7	28	2	6	1	1	0
36	Salp		Ind 1	5	1	20	1	4	2	2	13
37	Salp		Ind 2	31	3	10	2	3	1	1	0
38	Salp		Ind 1	26	2	8	1	3	1	1	1
39	Salp		Ind 6	25	2	8	1	6	0		0
40	Salp		Ind 1	31	4	13	2	3	2	1	1
41	Saq	Muyukmarka	Ind 1	24	3	13	2	6	1	1	3
42	Saq	Muyukmarka		28	1	4	1	3	1	1	0
43	Saq	Muyukmarka		6	1	17	1	3	1	1	1
44	Saq	Muyukmarka		18	0	0	0		3	1	0
45	Saq	Muyukmarka	Ind 1	8	0	0	0		1	1	1
46	Saq	Suchuna		17	0	0	0		1	2	1

47	Saq	Suchuna		15	1	7	1	6	3	1	0
48	Saq	Suchuna		21	4	19	2	3	7	1	4
49	Saq	Suchuna		18	2	11	1	3	0		3
50	Saq	Suchuna		16	3	19	2	3	1	1	1
51	Saq	Suchuna		11	0	0	0		3	1	0
52	Saq	Suchuna		18	0	0	0		8	1	1
53	Saq	Suchuna	Ind 2	10	1	10	1	3	0		0
54	Saq	Suchuna		18	5	28	2	6	1	1	0
55	Saq	Suchuna	Ind 1.2	3	1	33	1	3	1		0
56	Saq	Suchuna		10	2	20	1	3	4	1	7
57	Saq	Suchuna		25	1	4	1	3	1	1	1
58	Saq	Suchuna	Ind 2	21	4	19	2	6	9	1	1
59	Saq	Suchuna		10	0	0	0		3	1	1
60	Saq	Suchuna		21	3	14	2	3	4	1	7
61	Saq	Salapunku	Ind 6	4	0	0	0		0		9
62	Saq	Suchuna		10	0	0	0		3	1	0

63	Saq	Suchuna		7	0	0	0		1	1	4
64	Salp		Ind 1	21	1	5	1	3	2	1	0
65	Salp		Ind 2	24	2	8	1	3	3	2	1
66	Salp		Ind 2	9	0	0	0		5	2	7
67	Salp			1	0	0	0		1	1	6
68	Salp		Ind 1	5	1	20	1	5	1	1	8
69	Salp		Ind 1	30	3	10	2	3	2	2	0
70	Salp		Mummy	13	0	0	0		1	1	4

Appendix A.4 Aggregate Scores

MO #	Site	Sector	Ind #	# Teeth Observed	#Teeth w/ Attrition	Attrition Severity	Asymmetrical Wear	Atypical Wear	Overall Wear Score	Anterior Wear Score	Posterior Wear Score
1	Saq	Suchuna	Ind 14	16	13	2	0	0	4	3.72	4.6
2	Saq	Suchuna	Ind 1	11	11	2	1	0	5.54	5.83	5.2
3	Saq	Suchuna	Ind 1	18	10	2	0	0	3.37	3.55	3.2
4	Saq	Suchuna	Ind 1	12	12	3	1	0	5.42	5.44	5.43
5	Saq	Suchuna		7	6	3	0	0	4.82	4.8	4.86
6	Saq	Suchuna		16	16	2	1	0	5.76	4.85	6.47
7	Saq	Suchuna	Ind 1	3	3	2	0	0	4.41	4.5	4.25
8	Saq	Suchuna	Ind 1	6	6	2	0	0	3.79	4	3.68
9	Saq	Suchuna	Ind 1	21	18	3	1	0	5.67	616	5.03
10	Saq	Suchuna		24	22	3	1	0	6.2	5.8	6.62
11	Saq	Suchuna		0			0	0	0	0	0
12	Saq	Suchuna	Ind 1	24	23	3	1	0	5.7	5.38	6.79
13	Saq	Suchuna		23	14	2	0	0	3.89	4	3.72
14	Saq	Suchuna		17	10	2	0	0	3.55	3.8	3.33

15	Saq	Suchuna		16	15	3	0	0	4.6	4.5	5
16	Saq	Suchuna		22	10	2	0	0	3.6	3.5	3.78
17	Saq	Suchuna	Tumba 37	6	4	2	0	0	3.87	3.6	5.25
18	Saq	Suchuna		25	23	2	0	1	5.2	4.06	7.2
19	Saq	Muyukmarka		20	0	1	0	0	1.18	1.37	1.14
20	Saq	Muyukmarka		24	1		0	0	2.04	1.58	3.14
21	Saq	Muyukmarka	Ind 2	12	7	3	1	0	5.72	7	5.17
22	Saq	Muyukmarka	1.1	31	0	1	0	0	2.2	2.1	1
23	Saq	Muyukmarka		8	0		0	0	2.05	2	2.12
24	Saq	Muyukmarka		8	1		0	0	3.5	0	3.5
25	Saq	Chincana Grande	Ind 1	15	12	2	0	0	5	5.25	4.25
26	Saq	Chincana Grande	Ind 6	11	11	3	0	0	5.29	4.75	6.75
27	Saq	Chincana Grande	Ind 5	18	16	3	0	0	5.45	5.33	5.58
28	Saq	Qochapata	Ind 1	29	11	2	1	1	2.89	3.05	2.63
29	Saq	Cruz Moqo	Ind 8	21	11	3	0	0	3.55	3.72	2.85
30	Saq	Suchuna	Ind 1	7	7	3	0	0	6.07	6.33	4.5

31	Salp		Ind 7	0		0		0	0	0	0	0
32	Salp		Ind 5	0		0		0	0	0	0	0
33	Salp		Ind 3	17	17?		3	0	0	3.78	4.75	3.43
34	Salp		Ind 3	0		0		0	0	0	0	0
35	Salp		Ind 1	25		11	2	0	0	2.76	2.85	2.67
36	Salp		Ind 1	5		5	3	1	0	6.35	7.33	4.87
37	Salp		Ind 2	31		8	1	0	0	2.63	1.5	1.66
38	Salp		Ind 1	26		14	2	1	0	3.46	2.64	5.11
39	Salp		Ind 6	25		13	2	0	0	3.64	3.33	4.58
40	Salp		Ind 1	31		20	2	0	0	3.8	4	3.4
41	Saq	Muyukmarka	Ind 1	24		8	2	0	0	3.15	3.37	2.71
42	Saq	Muyukmarka		28		0	1	0	0	2.18	2.55	1.69
43	Saq	Muyukmarka		6		6	3	0	0	6.62	6.4	7.75
44	Saq	Muyukmarka		18		14	2	0	0	4.6	5.5	3.5
45	Saq	Muyukmarka	Ind 1	8		8	3	0	0	8.25	7	9.5
46	Saq	Suchuna		17		17	3	0	0	6.13	5.86	8.12

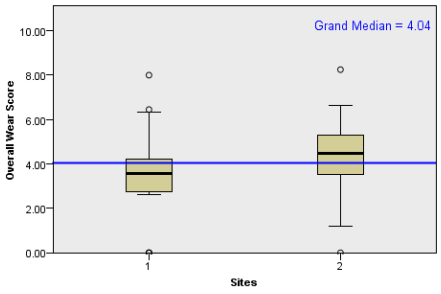
47	Saq	Suchuna		15	4	2	0	0	3.5	4.66	3.06
48	Saq	Suchuna		21	14	3	0	0	4.2	4.3	4.12
49	Saq	Suchuna		18	13	2	0	0	4.52	5	3.93
50	Saq	Suchuna		16	12	2	0	0	4.09	4.5	3.68
51	Saq	Suchuna		11	9	2	1	0	4.88	4.83	4.95
52	Saq	Suchuna		18	9	2	0	0	3.59	3.88	3.3
53	Saq	Suchuna	Ind 2	10	10	2	0	0	4.42	4.2	4.65
54	Saq	Suchuna		18	13	3	1	0	4.84	4.25	5.32
55	Saq	Suchuna	Ind 1.2	3	2	2	0	0	3.75	0	3.75
56	Saq	Suchuna		10	5	2	0	0	4.5	5.8	3.2
57	Saq	Suchuna		25	2	2	0	0	2.43	2.29	2.71
58	Saq	Suchuna	Ind 2	21	17	3	0	0	4.81	5.61	3.32
59	Saq	Suchuna		10	10	3	0	0	5.27	5.4	5.15
60	Saq	Suchuna		21	14	2	0	0	4.59	4.88	2.83
61	Saq	Salapunku	Ind 6	4	4	3	0	0	8	8	0
62	Saq	Suchuna		10	0	2	0	0	2.38	2.2	2.62

63	Saq	Suchuna		7		3	0	0	5.14	4.33	10
64	Salp		Ind 1	21	21	3	0	0	6.45	6.35	6.64
65	Salp		Ind 2	24	13	2	0	0	3.22	3.15	3.29
66	Salp		Ind 2	9	4	3	0	0	3.86	4.33	2.92
67	Salp			1	1	2	0	0	3.5	0	3.5
68	Salp		Ind 1	5	2	3	0	0	3.2	3.2	0
69	Salp		Ind 1	30	17	2	0	0	4.23	3.66	5.08
70	Salp		Mummy	13	6	3	0	0	5.33	5.33	0

Appendix B

Appendix B.1 Statistical Outputs

Independent-Samples Median Test



Total N		70
Median		4.045
Test Statistic		4.786
Degrees of Freedom		1
Asymptotic Sig. (2-sided test)		.029
Yates's Continuity Correction	Chi-Square	3.665
	Degrees of Freedom	1
	Asymptotic Sig. (2-sided test)	.056

1. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The medians of # of Abscess are the same across categories of Sectors.	Independent-Samples Median Test	.124	Retain the null hypothesis.
2	The medians of Caries Prevalence are the same across categories of Sectors.	Independent-Samples Median Test	.258	Retain the null hypothesis.
3	The medians of # of Resorption are the same across categories of Sectors.	Independent-Samples Median Test	.551	Retain the null hypothesis.
4	The medians of Post. Wear Score are the same across categories of Sectors.	Independent-Samples Median Test	.103	Retain the null hypothesis.
5	The medians of Overall Wear Score are the same across categories of Sectors.	Independent-Samples Median Test	.204	Retain the null hypothesis.
6	The medians of Anterior Wear Score are the same across categories of Sectors.	Independent-Samples Median Test	.204	Retain the null hypothesis.

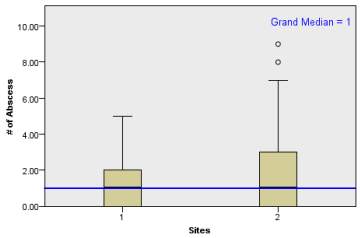
Asymptotic significances are displayed. The significance level is .05.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The medians of # of Abscess are the same across categories of Sites.	Independent-Samples Median Test	.850	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Independent-Samples Median Test



Total N		70
Median		1.000
Test Statistic		.010
Degrees of Freedom		1
Asymptotic Sig. (2-sided test)		.921
Yates's Continuity Correction	Chi-Square	.036
	Degrees of Freedom	1
	Asymptotic Sig. (2-sided test)	.850

1. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The medians of # of Abscess are the same across categories of Sectors.	Independent-Samples Median Test	.137	Retain the null hypothesis.
2	The medians of Caries Prevalence are the same across categories of Sectors.	Independent-Samples Median Test	.167	Retain the null hypothesis.
3	The medians of # of Resorption are the same across categories of Sectors.	Independent-Samples Median Test	.970	Retain the null hypothesis.
4	The medians of Post. Wear Score are the same across categories of Sectors.	Independent-Samples Median Test	.194	Retain the null hypothesis.
5	The medians of Overall Wear Score are the same across categories of Sectors.	Independent-Samples Median Test	.543	Retain the null hypothesis.
6	The medians of Anterior Wear Score are the same across categories of Sectors.	Independent-Samples Median Test	.543	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Sectors * Carie Frequency	47	100.0%	0	0.0%	47	100.0%
Sectors * Resorption	23	48.9%	24	51.1%	47	100.0%

Sectors * Carie Frequency

Crosstab

Count

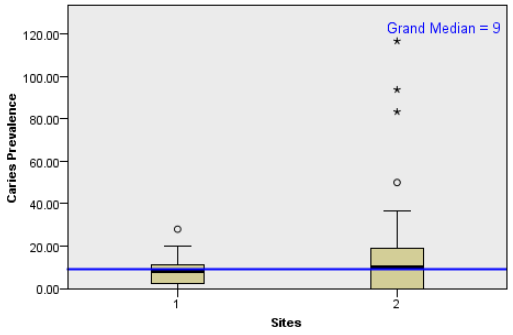
		Carie Frequency			
		0	1	2	Total
Sectors	1	10	11	15	36
	2	7	2	2	11
Total		17	13	17	47

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.746[a]	2	.093
Likelihood Ratio	4.634	2	.099
Linear-by-Linear Association	4.014	1	.045
N of Valid Cases	47		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 3.04.

Independent-Samples Median Test



Total N		66
Median		9.110
Test Statistic		.776
Degrees of Freedom		1
Asymptotic Sig. (2-sided test)		.378
Yates's Continuity Correction	Chi-Square	.345
	Degrees of Freedom	1
	Asymptotic Sig. (2-sided test)	.557

1. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Sites * Resorption

Crosstab

Count

		Resorption				
		1	2	3	4	Total
Sites	1	3	5	2	2	12
	2	14	6	6	0	26
Total		17	11	8	2	38

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.001[a]	3	.072
Likelihood Ratio	7.398	3	.060
Linear-by-Linear Association	2.921	1	.087
N of Valid Cases	38		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .63.

Group Statistics

	Sites	N	Mean	Std. Deviation	Std. Error Mean
Caries Prevalence	1	15	9.02	8.343	2.154
	2	51	16.23	23.921	3.350

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
Caries Prevalence	Equal variances assumed	.258	-7.212	6.315
	Equal variances not assumed	**.075**	-7.212	3.983

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
Caries Prevalence	Equal variances assumed	-19.828	5.405
	Equal variances not assumed	-15.173	.749

Descriptive Statistics

	Mean	Std. Deviation	N
Caries Prevalence	14.59	21.551	66
# of Abscess	1.61	1.958	70

Correlations

		Caries Prevalence	# of Abscess
Caries Prevalence	Pearson Correlation	1	-.126
	Sig. (2-tailed)		.312
	N	66	66
# of Abscess	Pearson Correlation	-.126	1
	Sig. (2-tailed)	.312	
	N	66	70

Correlations

			Caries Prevalence	# of Abscess
Spearman's rho	Caries Prevalence	Correlation Coefficient	1.000	-.008
		Sig. (2-tailed)	.	.946
		N	66	66
	# of Abscess	Correlation Coefficient	-.008	1.000
		Sig. (2-tailed)	.946	.
		N	66	70

Sectors * Resorption

Crosstab

Count

		Resorption			
		1	2	3	Total
Sectors	1	11	3	5	19
	2	3	1	0	4
Total		14	4	5	23

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.373[a]	2	.503
Likelihood Ratio	2.207	2	.332
Linear-by-Linear Association	.885	1	.347
N of Valid Cases	23		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .70.