DIET, SUBSISTENCE AND HEALTH:

A BIOARCHAEOLOGICAL ANALYSIS OF CHONGOS, PERÚ

A Dissertation

presented to

the Faculty of the Graduate School

at the University of Missouri-Columbia

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

---

by

MICHAEL J. DIETZ

Dr. Robert A. Benfer, Jr., Dissertation Supervisor

Dr. Deborah M. Pearsall, Co-Dissertation Supervisor

MAY 2009

The undersigned, appointed by the dean of the Graduate School, have examine the dissertation entitled

DIET, SUBSISTENCE AND HEALTH:
A BIOARCHAEOLOGICAL ANALYSIS OF CHONGOS, PERÚ

Presented by Michael J. Dietz

a candidate for the degree of Doctor of Philosophy of Anthropology

Adn hereby certify that, in their opinion, it is worthy of acceptance

Professor Robert Benfer

Professor Deborah Pearsall

Professor Lisa Sattenspiel

Professor Gregory Blomquist

Professor Richard Hessler

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the help and support of numerous individuals and organizations. The time, effort, energy, expertise, graciousness of sharing collections and data, and support offered to me contributed immeasurably to the success of this project.

I would like to begin by thanking my dissertation committee for their efforts throughout the dissertation process. They are Drs Robert A. Benfer, Jr., Deborah Pearsall, Richard Hessler, Lisa Sattenspiel and Gregory Blomquist. Thank you to Bob, Debby, Dick and Lisa for sticking with me through the whole process, and thank you to Greg to agreeing to join the committee late in the process. I appreciate all of their efforts. I especially want to thank Bob Benfer and Debby Pearsall, my dissertation supervisor and co-supervisor. Both put forth Herculean efforts to turn my dissertation into something presentable. I cannot thank them enough. Both have also been instrumental in my development as an anthropologist. Debby, thank you for your patience, your willingness to step up and take on an expanded role in my dissertation, your tireless work on the dissertation, your careful eye and editing skills, and efforts to help me find an academic position. Bob, thank you for introducing me to bioarchaeology, helping me get settled in Perú, working to find an interesting skeletal collection for my dissertation project, your patience and tireless work on the dissertation and other research projects, your enthusiasm for my professional development, and efforts to help me find an academic position. I also thank you for your friendship.

I would also like to acknowledge Carol Ward and Mark Flinn for serving on my PhD qualifying exam committee; Kathryn Coe, Whitney Hicks, and Eduardo Simoes for serving on my PhD comprehensive exam committee. I also would like to thank Dr. Peter Gardner for his thoughtful advice and support throughout my time at the University of Missouri. My conversations with Dr. Gardner are some of my fondest memories of Swallow Hall. Craig Palmer has been very supportive and helpful in his role as graduate advisor. I thank him for all his help.

Joe Adducci at the College of DuPage made the map of Perú in Figure 1.1. I thank him for taking time out of his schedule to help me. I also would like to thank the library staff at both the University of Missouri and the College of DuPage for their efficiency in processing my loan requests. Thank you all.

I would also like to thank a number of people and institutions for their unique contributions to this project. In Perú Mercedes Delgado was instrumental in my work in Chongos. She recommended that I work with the Chongos skeletal collection, and helped with the initial contacts in Ica. I also thank Mercedes for her efforts to help me feel welcome in Lima, and for introducing me to several members of the archaeological and scientific community there. Mercedes also helped me navigate the bureaucratic process with the National Institute of Culture, speeding the process for me to export samples for analysis in the United States. I also thank her for her friendship.

While I performed research in Perú several people were instrumental in the success of this project. First, I would like to thank Arqa. Susana Arce Torres, director of the Museo Regional de Ica. Susana allowed me access to the

Chongos skeletal collection. Susana provided me with a comfortable work environment for my research, and made me feel at home in the museum. She helped to recruit local university students to volunteer on the project, and allowed her staff members to help me when necessary. She also became a friend. I also would like to acknowledge the late Jose Cahuas who was the regional director of the National Institute of Culture and allowed for me to collect samples for analysis in the US. Guillermo “Piro” Moron was a great colleague in Ica, helping me in numerous ways with my data collection. Thank you my friend. Jossie Porta and Cristhian Siguas spent numerous hours volunteering their time to help with data collection. I thank them for their efforts, as well as all the university students in Ica who spent even the smallest amount of time helping me. Sra Maria and her family made me feel like I had a family away from home. I thank them for their hospitality.

Many friends and colleagues helped me with their time, expertise and support. Karol Chandler-Ezell took time from her dissertation research to work with me on phytolith analysis. I thank her for her continued support and friendship. I thank Neil Duncan, Dave McBride, Kate Pechenkina, and Joe Vradenburg for stimulating conversations related to my dissertation topic. Rick Sutter and Kathy Forgey offered a supportive ear when I was frustrated and good advice when needed. Kevin Vaughn shared his research with me and engaged in good discussions about the south coast of Perú. Ann Peters sent me a copy of her dissertation, allowed me to reproduce the site map of Chongos as Figure 2.1 in the dissertation, and was quick to respond with questions that I had regarding her knowledge of the Chongos site. John Staeck offered unconditional support to me in my professional development, including the occasional push when it was needed. I thank him for all he does as a colleague and a friend. Mary Licklider and Susan Hazelwood were understanding and accommodating supervisors and colleagues. I thank them for their support. Dwight Wallace was my committee member without the official title. Conversations with Dwight while in Ica were so enjoyable and enlightening, about Chongos and all things related to anthropology. He also has been very generous sharing his time and knowledge with me. I cannot thank him enough.

Finally, I would like to thank my family for their support. They stuck with me through this entire process, even though it took longer than any of us had anticipated. Thank you to my wife Sarah for her enduring support and pushes when necessary. Thank you to my children Addison, Jamison and Emmerson for their patience while daddy finished his 'book'. Finally, thank you to my parents for their support while I forged my career path. I love you all.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

DIET, SUBSISTENCE AND HEALTH: A BIOARCHAEOLOGICAL ANALYSIS OF CHONGOS PERÚ

Michael Dietz

Dr. Robert A. Benfer, Jr., Dissertation Supervisor
Dr. Deborah Pearsall, Co-Dissertation Supervisor

ABSTRACT

It is possible to assess important archaeological questions about prehistoric individuals and groups, learning a great deal about their lives through bioarchaeological analysis of human skeletal remains. This dissertation analyzes a skeletal collection from a major archaeological site in south-central coastal Perú, Chongos, to investigate the health and diet of the people buried there. The population was hypothesized to have engaged in intensive agriculture. Health data, such as skeletal and dental pathology, trauma, and degenerative joint disease were analyzed. Dental calculus and hair samples were examined for phytolith, trace element and isotope analyses to reconstruct diet. These data permitted evaluation of the predicted health impacts of intensive agriculture.

Results of the study demonstrated that the people buried at Chongos had poor community health that reflected a population newly reliant on agriculture, a pattern seen in Perú and around the world with the origins of intensive agriculture. Some individuals, nonetheless, had a diet similar to that of marine foragers. Thus, an unexpected finding was that the cemetery, like others at the time period, likely contained the remains of two ethnic groups, possibly farmers and fishers whose economy was a dual one based on exchange.

CHAPTER 1: INTRODUCTION

Human skeletal remains offer direct research opportunities to address archaeological questions about individuals and groups (e.g. Buikstra 1977). Through bioarchaeological analysis, it is possible to learn a great deal about the lives of prehistoric peoples. Bioarchaeology allows for the interpretation of events that occur during life, such as disease, physiological stress, injury, violence, physical activity, diet, tooth use, and paleodemography, among others (Larsen 1997).

This dissertation describes the skeletal collection from Chongos, a major archaeological site in south-central coastal Perú (Figure 1.1). The Chongos site is located in the lower Pisco river valley, approximately 14 kilometers (km) from the Pacific Ocean and one km south of the Pisco River on a river terrace. The Chongos site was a major population, and likely administrative center of the Topará tradition, dating to the late Early Horizon (EH) and the first part of the Early Intermediate Period (EIP) (Peters 1987/88, 1997; Wallace 1986). Chongos may also have been part of the Paracas tradition (Peters 1987/88, 1997; Proulx 2008). Excavations at Chongos uncovered other occupations, including a late EIP and Late Intermediate Period occupation (Figure 2.1) (Arce Torres personal communication 6/04/08; Peters 1987/88, 1997). The site contained both habitation and mortuary remains. The site will be discussed in greater detail in Chapter 2.

Figure1.1: Map of Perú Showing Archaeological Sites Discussed in the Text

Map created by Joe Aducci

1.A: Statement of the problem, Research Question, and Goals

One of the major questions that bioarchaeological methods can help address is the community health of a skeletal population (e.g. Cohen and Crane-Kramer 2007a; Steckel and Rose 2002). Community health is affected by a synergistic combination of environmental conditions, settlement strategies, dietary patterns, cultural influences, individual genetic variation, local geological conditions and occupational activities. The skeletal collection excavated from the Chongos site provides a unique opportunity to describe community health during the EH/EIP along the south central coast of Peru. I am specifically interested in the subsistence activities of the people who lived at Chongos, and the impact these activities had on community health.

Recent work along the central coast of Perú (e.g. Pechenkina and Delgado 2006; Rhode 2006) demonstrates that skeletal differences among individuals may be the result of differences in social groups and/or differing subsistence strategies. If two groups engaged in different subsistence strategies, the different activities associated with each strategy should become noticeable enough through time to be distinguished skeletally. This would allow differentiation of individuals by occupational strategy (i.e. farmer or fisher, high or low status), and likely by health outcomes (Larsen 2002).

Rhode (2006) showed that the repetitive activities specific to each subsistence activity resulted in discernable muscle marking patterns. Repetitive, specific forms of manual labor developed specific muscles, which over time altered the muscle markings on the skeleton. In general, fishers had more highly developed upper bodies while farmers had more highly developed lower bodies. Using Rhode's coding pattern, it is possible to determine if the skeletal remains from a person living along the coast of Perú belonged to a fisher, a farmer, or a person who engaged in a mixed subsistence strategy (horticulture, marine and terrestrial foraging). Larsen (2002; see also Peterson 2002) acknowledges the potential utility of investigating muscle attachment site morphology to identify differences in activity pattern, but cautions that differences in muscle insertion sites may only be noticeable in individuals who engaged in lifetime activities with a very heavy physical demand.

Rhode also believes that his method can differentiate between status and/or occupational specialists, such as craftspeople. In a socially stratified society, higher status individuals, such as administrators and priests, should exhibit less muscular development than commoners who must engage in intensive subsistence activities. Specialists should exhibit muscular development consistent with their specialized activity, such as textile production.

Finally, Rhode (2006) suggests that skeletal differences in degenerative joint disease, dental pathology, cross-sectional geometry and chemical reconstruction of diet will strongly complement muscle marker patterns to improve the accuracy of prehistoric activity pattern.

Pechenkina and Delgado (2006) found a strong association between health differences and social differences. The question, of course, is what is the cause of the social differences? It could be that social differences result from differences in status, differences in geographic origin of two or more groups of people buried in the same location, or two or more groups of people engaged in different economic or subsistence strategies (farming vs. fishing, for example). Pechenkina and Delgado (2006) found that health indicators differed significantly based on the presence or absence of artificial cranial deformation. These health differences were mainly ones that developed early in life, such as childhood anemia, which leaves scars that are visible in adults who survive with it. Based on this result, they hypothesize that differences in artificial cranial deformation among prehistoric peoples equates to the presence of different ethnic groups (people whose natal groups are different), and that these different ethnic groups have measurable health differences. These different ethnic groups almost certainly engaged in different occupational activities. Thus, differences in health indicators and cranial deformation in a skeletal population along the coast of Perú should provide support for the presence of more than one ethnic group living in the area and using the same cemetery. Individuals of different ethnic groups living in a settlement may reflect specialists that fill an economic (and therefore dietary and social) niche for that settlement (Rhode 2006). Pechenkina and Delgado (2006) also found health differences among individuals based on burial accoutrements. This implies a difference in status among the skeletal population. These health differences were mainly associated with activity level that occurred later in life, such as degenerative joint disease.

In this dissertation I present a bioarchaeological analysis of the Chongos skeletal collection. My hypothesis is that the individuals buried at Chongos reflect the current interpretation of inhabitants of Topará habitation sites (Peters 1997; Proulx 2008), that is, that these people carried out diversified irrigation agriculture, supplemented by fishing and perhaps hunting. Though this a broad hypothesis, it is not a self-evident conclusion to be reached about peoples who were buried in a cemetery that is located in a fertile river valley, but also lies only a few km (14) from the coast (e.g. Rostworowski 1977, 1981, 1999). Carbohydrates are hypothesized to have provided the bulk of calories with many fewer calories coming from protein from the sea. I will compare the Chongos data with published data from other skeletal collections along coastal Perú to test any potential effect of subsistence strategy, site location and/or cultural context on my hypothesis.

The main goal for this research project is to test this hypothesis. A secondary goal is to provide a bioarchaeological description of the Chongos skeletal collection that, with accumulating additional samples, will be useful in testing broader hypotheses. To the extent that this is possible, given the paucity of comparative material available until now, I will attempt to place the Chongos collection in the broader context of the south central Andean coast and the Early Horizon/Early Intermediate Period (EH/EIP) in Perú (see Chapter 2).

This project contributes to an understanding of the bioarchaeology of populations in coastal Peru. This is the first bioarchaeological analysis of skeletal remains from the lower Pisco River valley. This project will also be one of the few bioarchaeological projects in the south central coastal region. Most of these other studies center on the Nazca River drainage to the south, with periods of interest in the later part of the EIP and into the Middle Horizon (e.g. Forgey 2006; Kellner 2002; Torres-Rouff 2002, 2003).

1.B: Research Design

To reiterate, in this dissertation I present a bioarchaeological analysis of the Chongos skeletal collection, hypothesizing that the individuals buried there were farmers who supplemented their diet with fishing and perhaps hunting. As discussed below, this hypothesis will be tested using standard bioarchaeology methods, with the results compared to previously published collections from coastal Perú. This dissertation is structured within an archaeological framework. Therefore, I first place the Chongos skeletal collection within its temporal, spatial, environmental and historical context.

To address the hypothesis and goals presented above, data collection and analysis methods are presented on dental pathology (caries, abcesses, enamel hypoplasias), stature, non-specific indicators of stress (NSIS), degenerative joint disease (DJD), and trauma. The method of analysis by entheses, muscle markings presented by Rhode (2006) was not available when these data were studied. However, DJD may serve as a partial proxy along with specific lesions or pathologies, such as external auditory exostoses, schmorl's nodes, and spondylitis, which could provide evidence for specialized activities (or even chronic pain).

There are four research objectives that will support my research goals and test my research hypothesis. These are to present data that will permit one to:

1. analyze diet
2. describe non-specific indicators of stress
3. compare results by sex, discussing potential implications of the results on gender/sex differences in diet and/or activity patterns
4. compare the Chongos results with published collections from similar time periods and/or similar ecological zones.

Taken together, these objectives will provide a picture of the Chongos skeletal population, allowing me to test the hypothesis that the population(s) using this cemetery were primarily farmers. Each research objective yields its own set of testable questions directly related to my hypothesis:

A. data on diet should fall within published ranges of known groups who consumed a predominantly agriculture-based diet. These data include dental pathology, such as caries rate, abscess rate, and presence of enamel hypoplasia, phytolith analysis from dental calculus, and trace element and isotopic analysis of hair samples.
B. nonspecific indicators of stress should also be consistent with previously published groups who consumed a predominantly agriculture-based diet. These indicators include anemia, systemic infection, degenerative joint disease (DJD), and achieved adult stature.

C. differences by sex should be mixed. Males and females should have equal access to all types of food, resulting in no difference in skeletal, mineral or isotopic indicators of diet by sex. Differences in activity pattern should indicate differences in the sexual division of labor, with males engaged in more intensive agriculture-related activities. Thus, rates of dental pathology should be the same when compared by sex. Nonspecific indicators of stress should also be similar, with the possible exception of DJD. Differences in DJD may indicate differences in farming related activities and the consistent need to carry heavy loads (i.e., Schmorl's nodes, vertebral arthritis). If males were engaged in more intensive agriculture-related activities, I suspect that they experienced higher rates of trauma than females, reflecting farming related accidents.

The data generated from the Chongos skeletal collection are presented by topic, such as age and sex specific caries rate, cribra orbitalia and stature. This approach allows me to analyze any population structure differences that may exist within the skeletal population, such as differential pathogen load, differences in activity pattern, or differential access to food. This approach also allows me to compare the Chongos data to other skeletal collections from coastal Perú. I will compare the Chongos data to published data from Asia, Cardal, El Pampón, Huaca Pucllana, La Marcha, Los Médanos, Paloma, and Villa El Salvador. While all of these sites are located along the coast of Perú, they differ by time period and subsistence pattern. Asia, Cardal, Huaca Pucllana, Paloma and Villa el Salvador are located along the central coast of Perú, while El Pampón, La Marcha, and Los Medanos are located in the Nasca river drainage along the south coast. These sites will be described in Chapter five.

This comparative approach allows me to test the research objectives outlined above in relation to my research hypothesis. After all topics are presented I discuss the overall community health of the Chongos skeletal collection, specifically as it relates to my research hypothesis that the people living in the Chongos region during the EH/EIP were farmers with a significant marine component to their diet.

1.C: Introduction to the Chapters

There are five remaining chapters in this dissertation. Each chapter addresses one or more specific topics designed to describe the Chongos skeletal collection, placing it in regional and temporal context. The chapters are summarized as follows:

In Chapter Two, I present background information related to the Chongos site, placing the site in environmental, social and chronological context in Andean prehistory. I also describe the site itself, including the skeletal sample. I will use this information in Chapters five and six, discussing results in the context of the environmental and social constraints that affected the people living at Chongos.

Chapter Three presents the methodological approach I took in data collection while in the field. Additionally, I describe the analyses conducted back at the University of Missouri.

The mechanisms for data analysis and presentation, and the results are presented in Chapter Four. In Chapter Five I discuss the results presented in Chapter Four, based on the research goals and objectives presented above. My results are compared to published results from other skeletal collections in coastal Perú. In Chapter five I also discuss skeletal results from Chongos that may support the osteological paradox (Weiss et al. 1992). Finally, in Chapter Six I provide concluding remarks, linking my hypothesis, goals and objectives to the actual data. I discuss how my results may fit into the larger context of existing research in the region. Specifically I discuss two broad topics. First, I explore the possibility that gender, occupation, status and/or ethnicity could account for skeletal differences observed at Chongos. Second, I discuss the function of the Chongos site and its accompanying cemetery based on the skeletal remains, including the possibility that Chongos and Villa el Salvador were part of the same regional state. I end the dissertation with a discussion of future research needs and expectations for the region in general.

CHAPTER 2: BACKGROUND

This chapter details the temporal, ecological, archaeological and theoretical framework necessary for understanding the Chongos site and its environs. I begin the chapter (2.A) with a discussion of general Andean chronology, focusing on the Early Horizon and Early Intermediate Period. These time periods encompass the time period the Chongos skeletal collection was living, placing the site and its occupants in temporal context.

In section 2.B, I describe the environment and geography of the Chongos region. Perú is a country of ecological and meteorological extremes, with a number of ecological zones often encountered over a relatively small distance. The environmental variation in Perú supports a number of different economic and subsistence strategies, but can also negatively impact individuals or groups of people. The impact of the environment may affect individuals quickly, as in the case of injuries or natural disasters, or the impact may not be felt for some time, as in the case of variable weather patterns that negatively impact crop yields.

Section 2.C briefly presents the archaeology of the south central coast of Perú, specifically the Paracas and Topará cultural traditions. Archaeological evidence from Chongos indicates that people from Paracas and Topará, or at least their culture, influenced the site. It is possible that for a short time the Paracas and Topará cultural traditions were present at Chongos at the same time, which will be further discussed in Chapter 6. Cultural influence at an archaeological site can manifest itself through artifacts, or bioarchaeologically through indicators such as diet, stress indicators and activity patterns, where cultures differ in their subsistence strategies and status or group marking methods, such as head deformation.

In section 2.D I highlight major features of theoretical and methodological approaches designed to explain patterns of exchange along the coast of Perú, and potential issues in the interpretation of bioarchaeological data. In section 2.E I describe the Chongos site, including its archaeological history and current interpretations of the principle functions carried out at the site. Section 2.F includes the excavation strategy employed by the archaeologists who conducted the salvage excavation of the site, and the role excavation strategy plays in placing the Chongos skeletal collection in archaeological context, specifically, the non-probabilistic nature of a rescue excavation.

In section 2.G I introduce the Chongos skeletal collection, including a discussion of the strengths and limitations of the sample. This discussion is based on the contextual information generated by the excavations conducted at Chongos and presented in section 2.F. Being aware of the strengths and limitations of the data set condition interpretation in Chapters four and five. I end the chapter (2.H) with a brief summary of the presented material and how it relates to the research hypothesis, goals and objectives that I laid out in Chapter one.

I rely heavily on the work of Ann Peters (1987/88, 1997, n.d.) in this chapter. Peters participated in the salvage excavation at Chongos, and presents the most comprehensive research analysis and interpretation available for the Chongos site, and for the lower Pisco river valley. Her research at Chongos and the lower Pisco river valley focused on site architecture, ceramics and textiles.

The work of Dwight Wallace (1962, 1971, 1985, 1986) also figures prominently in this chapter. Wallace discovered and named Chongos, defined the Chongos ceramic phase, worked with Edward Lanning in defining the Topará ceramic tradition, and was instrumental in the initial interpretation of the regional and temporal role of the Chongos site.[1]

2.A: General Andean Chronology

The general Andean chronology provides an organized way to approach data and to compare results. The chronology also allows me to place the Chongos skeletal collection in temporal, and to a lesser degree, cultural, context.

The general Andean chronology that I use in this dissertation is the system commonly used by Andean archaeologists from the United States. This system was first proposed by Rowe (1960) and later derived through field and museum research from a master sequence of pottery styles from the Ica valley (Menzel et al 1964; Rowe 1960, 1962, 1963) (Table 2.1). Though initially proposed as a relative dating method, the chronology was later verified by radiocarbon dating (Rowe and Menzel 1967). The Menzel, Rowe and Dawson (MRD, 1964) chronology consists of seven distinct time periods – three horizons and four intermediate periods. The horizons are interpreted to represent times of rapid spread of continuity (cultural, religious and/or political) throughout a region. Continuity may be reflected by similarity in artifact production, with the similarity assumed to represent political and/or ideological/religious and/or cultural control (Willey 1991). The four intermediate periods are interpreted to represent times of local control and influence. This local political, cultural and ideological/religious influence may have been due to the collapse of the larger regional integration reflected during the horizon periods. Despite the consistent use of the MRD (1964) chronology, some scholars working along the south coast of Perú have reservations regarding the chronology of the south coast region (e.g. DeLeonardis 1997; Massey 1986; Paul 1991b; Wallace 1986), suggesting more work is necessary on this topic.

Table 2.1: General Andean Chronology with Cultural Affiliation

Rowe 1960 Horizons	Dates	Cultural Affiliation
Late Horizon	A.D. 1476 – 1534	Inca
Late Intermediate Period	A.D. 1000 – 1476	Chimu, Chincha, Chancay
Middle Horizon	A.D. 600 – 1000	Huari, Tiahuanaco, Huaca Pucllana
Early Intermediate Period	200 B.C. – A.D. 600	Nasca, Moche, Topará, Paracas Necropolis, Villa el Salvador, Huaca Pucllana
Early Horizon	900 – 200 B.C.	Paracas, Chavin
Initial Period	1800 – 900 B.C.	Chavin, Cupisnique, Erizo, Cardal
Preceramic	2500 – 1800 B.C.	Asia, El Paraíso
Preceramic	4200 – 2500 B.C.	San Nicolas/Otuma, Paloma
Perceramic	6000 – 4200 B.C.	Paloma
Preceramic	8000 – 6000 B.C.	Paijan
Preceramic	< 8000 B.C.	Quebrada Jaguay

2.A.1: Early Horizon

The Early Horizon (EH) period is defined by the MRD (1964) chronology as beginning when Chavin influence arrived at the Ica valley, dating from about 900 to about 200 BC (also Rowe 1967). Chavin de Huantar is a monumental ceremonial center located in the highlands of northern Peru. The manner of Chavin influence is still debated, whether it is religious and/or political, but there is no debating the fact that Chavin influence spread rapidly throughout the Andean region (Bruhns 1994; Burger 1992; Moseley 1992a). Chavin influence spread to the south central coast of Perú, where it was most strongly felt in the Ica river valley and at the coastal site of Karwa (Silverman 1996). Chavin influence was also found in the Pisco river valley and at the Paracas Peninsula. Chavin influence was evident in the iconographic figures found on ceramics and textiles.

Though there is evidence of irrigation agriculture along the central and north coast of Perú at this time, as well as in the highlands, there is no definitive evidence of irrigation along the south coast (Sandweiss and Richardson 2008; Silverman 1996; but see Proulx 2008). The south coast did not have the large settled sites with monumental architecture that were found along the central and north coast during the Early Horizon. Instead, along the south coast the archaeological record consists of smaller habitation sites, with little to no evidence for temple mounds (Peters 1997; Silverman 1996; but see Wallace 1986). Sites were located close to the major resource types that were exploited by the group, including sources of permanent water. Swampy areas and wooded areas near riverbanks were also important resource zones (see section 2.B below).

Burger (1992) states that Chavin was a set of religious beliefs that manifest themselves in material culture that spread throughout a large part of the Andean world. At many coastal sites, perhaps most dramatically at Karwa, Chavin appears to have been influential in the region, but to have not completely overtaken local ideology (Bruhns 1994; Silverman 1995, 1996; Wallace 1962, 1971). Instead, Chavin influence appears to have been incorporated into the local culture, showing variation from 'pure' Chavin in iconographic representations in ceramics and textiles (Bruhns 1994; Silverman 1996; Wallace 1962). Outside of Karwa and the Ica valley, Chavin influence may have been minor (Silverman 1996). Some of the iconographic motifs from this time period show the first evidence of widespread warfare (for example trophy heads in Paracas and Nasca), though such images increase dramatically in the Early Intermediate Period (Lumbreras 1979; Silverman 1993). Chavin lost its regional influence around 200 BC, perhaps due to a series of severe climatic events (Moseley 1992a; Silverman 1996).

2.A.2: Early Intermediate Period

The Early Intermediate Period (EIP) lasted from about 200 BC until about AD 600. It is characterized as a period of population growth with local cultural florescence in many different regions. Many of these regions experienced a concentration of large coastal polities and emerging urban centers (Bruhns 1994; Lumbreras 1979; Makowski 2002; Moseley 1992a; Silverman 1993, 1996; Wallace 1985, 1986). Along the north coast of Perú the first true state in the region developed, the Moche, which encompassed multiple river valleys. Along the south coast of Perú the best known EIP culture is Nasca, known for its elaborate pottery, iconographic styles, geoglyphs and trophy skulls (table 2.1 – also see table 2.2) (Moseley 1992a; Proulx 1968; Silverman 1993, 2002). It is possible that Nasca derived from the Paracas and Topará cultures (Bruhns 1994; Menzel et al 1964; Proulx 2008; Wallace personal communication 10/24/08)

The presence of urban centers along the coast increased scarcity of some resources, prompting innovations in agriculture such as irrigation (Silverman 1996). This was also a time of increased craft specialization, evidenced by elaborate ceramics, textiles, and metalwork. These crafts likely served multiple purposes – trade, ceremonial/religious, funerary, 'gifts' for elites. The urbanism and increased vocational specialization of the era likely resulted in, or was a result of, a hierarchical society (Burger 1992; Moseley 1992a). The EIP ended about AD 600 with the expansion of an Andean state, Tiahuanaco, which extended its influence to parts of the south central coast of Perú.

2.B: Environmental and Geographic Background

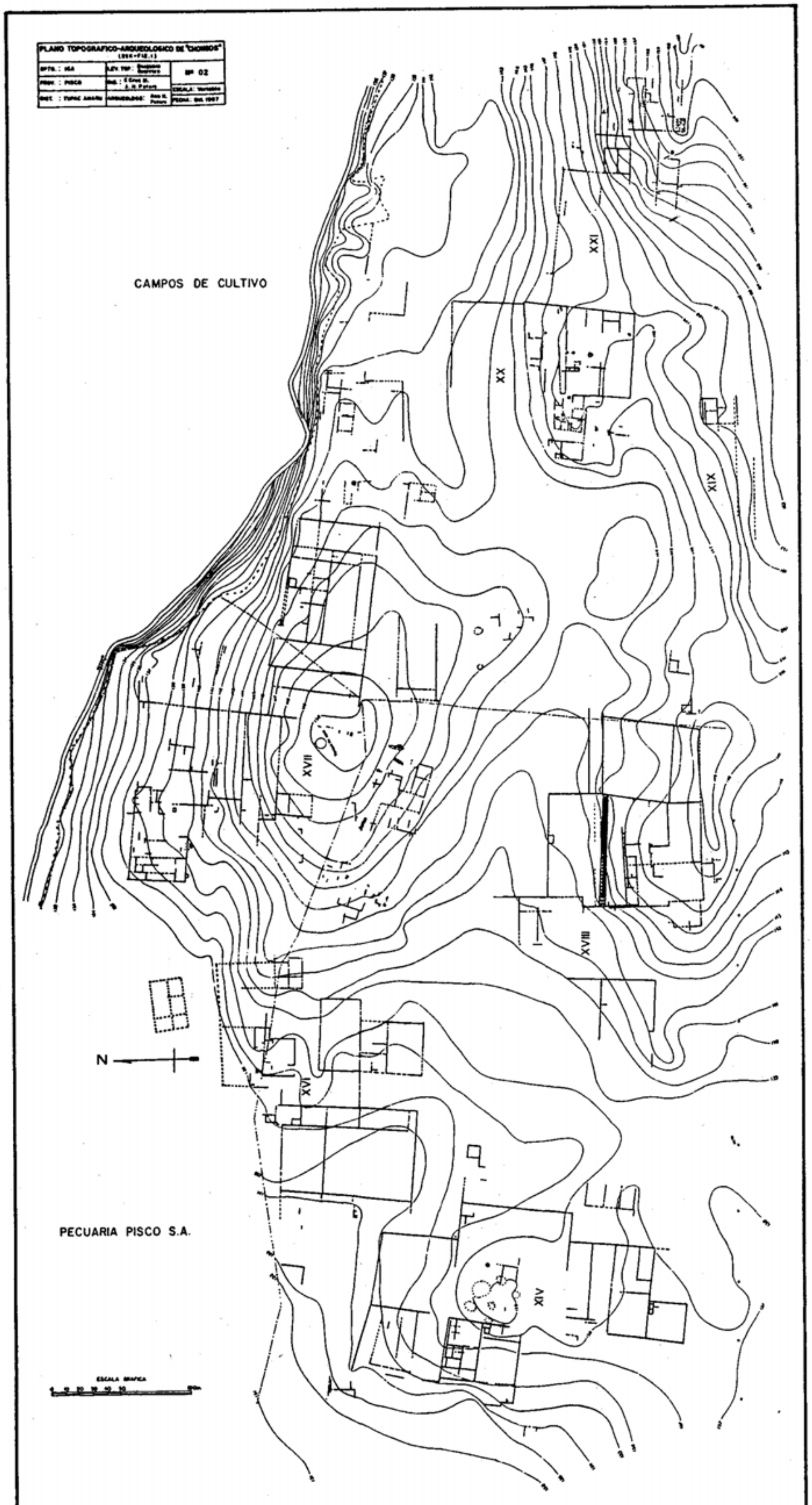
This section is designed to place the Chongos site in its environmental, ecological and geographic context. Perú is a land of extremes which directly impacts all people currently living there or who lived there in the past. The geographic location of the site and the environmental features in the surrounding region provided constraints and opportunities for the inhabitants of Chongos.

The Chongos site is located in the lower Pisco Valley approximately 14 kilometers (km) from the Pacific coast, and less than one km from the Pisco River, at an elevation of approximately 140 meters above sea level (masl) (Peters 1997) (Figure 1.1, 2.1). The site itself sits on a ridge top looking over the Pisco River, just above the cultivated valley floor in an area that supports irrigation agriculture (Silverman 1996; Wallace 1986). The site is situated on the narrow coastal plain of Perú, at the upper edge of the lower valley of the Pisco River (Peters 1997; Silverman 1997; Wallace 1971). This part of the coastal plain is a very dry desert, with a consistent and occasionally strong ocean wind.

The central Andean region, of which the Pisco river valley is a part, is characterized by diverse ecologies and complex topography created by dramatic changes in altitude and precipitation. The whole region consists of four general ecological zones: central desert, 0-1500 masl, where Chongos is located; central Andean highlands, 1500-6000 masl; high altiplano or desert plain, 2000-4000 masl; and eastern lowland tropical rainforest, 0-2000 masl. Of course, within each general ecological zone, there are literally thousands of microclimates, creating important ecological niches for people to exploit. Latitude affects climate with the north being quite wet and the south arid. Changes in altitude at any latitude can lead to changes in ecologies in a relatively short distance. Because of this, it is possible for humans to exploit a number of different climates within a day's walk. As a result, numerous scholars have attempted to model human interaction with their environment, including subsistence patterns, sedentism and the emergence of complex societies (e.g. Lathrap 1973; Moseley 1975, 1992a, b; Rostworowski 1977, 1981) (see theory section below).

The central desert is in the rain shadow of the Andes, creating one of the driest deserts in the world (Moseley 1992a, b; Piperno and Pearsall 1998; Sandweiss and Richardson 2008). The strong prevailing winds come from the south and west and often run parallel to the coast. These winds are shielded by the Andes to the west and waters of the Humboldt (Peruvian) current. The cooled air contains water evaporated from the ocean surface, but this air is unable to rise high enough into the atmosphere to condense into rain. However, during the winter months in Perú (July, August, September) this heavy air condenses along the warmer coast as dense fog (garua). The fog condenses on land and plants, often providing the only moisture in areas of the central desert not directly fed by a river. The western river valleys derive almost all of their water from rain and snowmelt in the Andes above 3,000 masl. It is estimated that the arid conditions of the central desert and coastal plain have existed for the past three million years (Hsu 1988).

Figure 2.1: Map of Chongos



From Peters (1997), used with permission of author

The basic topography of the central desert is relatively level terrain cross-cut by short rivers, several in very steep valleys, originating in the central Andean highlands. Most rivers are seasonally dry, normally flooding late in the highland rainy season, between January and April. In some rivers during some periods of the year the water never reaches the Pacific shoreline as surface water, flowing instead beneath the surface to pool as brackish water over salt water at the coast.

The Pisco River is one of just four coastal rivers in Perú that flows continuously from the Andean Cordillera through the floodplains into the Pacific Ocean. Though the Pisco valley is narrow, the reliable flow of water nourishes high quality, consistently productive arable lands. Later in Prehispanic times, the river was exploited for irrigation systems that expanded arable lands throughout the middle and lower valleys (Peters 1997; Silverman 1997).

The landscape in and around Chongos likely was conducive to the cultivation of a number of different plant species. However, many other plant species could simply have been collected or managed. For example, in the Chongos area people may have harvested marsh reeds, canes, cactus, and hardwoods. In the lower river valleys exploited by the Topará and Paracas cultures (i.e. Ica, Pisco, Chincha and Cañete river valleys), which are found in the immediate and surrounding regions, people also could have hunted, fished and gathered shellfish and crustaceans (Peters 1997). Domesticated guinea pigs and camelids (llamas and/or alpacas) may have also been kept. DeLeonardis (1997) and Peters (1997) both believe trade networks in the region were likely, providing people in the lower Pisco valley access to the fine wools produced on the puna (high plains) of the Andean cordillera, exotic feathers from birds such as macaws from the Amazonian rainforest, as well as gold, obsidian, coal and special clays from diverse, localized sources.

The western base of the Andean cordillera is dry like the coastal desert, with bare gravel hills rising from the coastal plains. However, in some areas of the coastal plain leading into the Andean foothills permanent vegetation is sustained by the humidity of the air (garua), alone or in combination with subsurface water. These areas, called lomas, or fog oases, consist of several ecological zones based on elevation rising up the Andean foothills. These ecological zones produce trees, cactus, bushes, grasses and other plants, as well as a wide variety of animal resources (Lanning 1967; Moseley 1992b; Peters 1997; Rostworowski 1977, 1981; Sandweiss and Richardson 2008). In antiquity these areas ranged from small 'fog oases' to expansive forests (Sandweiss and Richardson 2008)

When the Pisco River descends from the middle valley to the lower valley and coast, it takes a fairly sharp curve to the west on to the coastal plain. There is evidence, however, that the river once flowed straight southwest to meet the ocean by the Paracas Peninsula, long before human habitation in the region (Peters 1997). Though the river changed its course, substantial groundwater flow remained in this direction. This subsurface water feeds a series of small lakes along the southern border of the Pisco valley. These areas were cultivated during the Colonial period, and likely were cultivated during pre-Colonial times.

Today these areas are irrigated by pumped well water, though there are tree crops that are grown using subsurface water directly (Soldi 1982; Engel 1987). In prehistoric times on the central coast, subsurface water was often reached by lowering fields to the level of the water (e.g., Benfer et al. 1987).

The Paracas Peninsula has sandy bays and rocky outcrops which create a wide variety of ocean shore environments, each with a specific type of microenvironment. The Pisco valley provides resources stratified by altitude. Since the Pisco river flows year round, it provides a dependable water source for agriculture. The abundant water of the Pisco river also allowed for reed swamps (totorales) and shallow ponds within two kilometers of the Chongos site (Peters 1997). This variety of ecosystems in a relatively small area provided the people living at and near Chongos with immediate access to reliable sources of shallow water fish, shellfish, crustaceans, ocean birds and ocean mammals, terrestrial mammals, and close by access to resources of the fertile Pisco valley. As stated in Chapter 1, the major question addressed by this dissertation is, were the EIP peoples who lived and died there primarily farmers who supplemented their diet through fishing, or were they primarily fishers, with gardens for carbohydrates.

The ocean resources off the Pacific coast of South America are extremely rich. The upwelling of the cold waters of the Humboldt Current, affected by the Coriolis force, are nutrient rich, supporting a rich marine ecosystem from Paleoindian times to this day (Moseley 1992a, b; Paulsen 1976; Sandweiss 1992; Sandweiss et al. 1996). In the area of the mouth of the Pisco River and the Paracas peninsula, large schools of sardines and anchovies not only support human populations, they also support large populations of ocean birds and larger pelagic fish. The ocean birds live on the rocky cliffs of the Paracas peninsula and on the small islands just off the peninsula. A number of mollusk and crustacean species are supported in microenvironmental niches along the coast and up into the river mouth. The Paracas peninsula and Pisco River mouth represented an overlap in ecological zones for many species (northernmost or southernmost territory of a species), increasing the ecological diversity of the region (Chirichingno 1980). Finally, seals and sea lions are present on and near the coast of the Paracas peninsula. This may have provided a seasonal source of meat and fat to prehispanic hunters during breeding season.

To the north of the Paracas Peninsula are a number of small, rocky islands, the Islas Ballestas, Islas Tres Marias and Isla Blanca. Much of the coast of the Paracas Peninsula is also rocky, creating cliffs and small, inaccessible bays. However, the body of the peninsula is relatively flat land broken only by the outcrop of Cerro Colorado. To the northeast of the neck of the Peninsula is the modern resort town of Paracas, which lies on the shallow Bay of Paracas with its beautiful beaches. Near the town of Paracas are the series of archaeological sites that gave their name to the Paracas tradition. To the southwest of the Peninsula is the Bay of Lagunilla. In the outcrops bordering the bay are veins of coal and iron oxide nodules (Craig and Psuty 1968; Tello and Mejia 1979).

The information presented above describes significant micro-climatic variation along the south-central Peruvian coast. The lower valleys in and near the Pisco River valley had areas of swamp, lakes, reed ponds, irrigated farmland, lomas, etc., all within a relatively small area. A change in the local environment is often cited as an impetus for social or cultural change, especially in Perú (e.g. Benfer 1999; Moseley 1983, 1992; Peters 1997). The change often occurs due to tectonic movement and/or changes in rainfall.

Today, the lower Pisco valley is largely flat and relatively featureless. The land is mostly taken up in large fields cultivated in salt-resistant crops like cotton, alfalfa and sweet potato. On the margins of the irrigated valley lie the hills of the Pisco and Huamani geologic formations. On the southern edge of the valley are very large sand dunes. Along the Panamerican Highway there is dense urban sprawl.

The changes seen in the lower Pisco valley at the end of the 20th century and beginning of the 21st century when compared to what the environment may have been like during the EH/EIP Chongos occupation include: 1) the loss of forested land in the lower foothills; 2) monocrop agriculture; 3) reduction of the totorales (reedbeds); 4) an increase in irrigation and irrigated farmland, and 5) the degradation of the coastal lakes (Rostworowski 1981; Peters 1997). Rostworowski (1981) argues that during the 1500 years that passed between the Paracas/Topará era and Spanish contact, human forces permanently changed the landscape. Indeed, Rostworowski states that the Pisquenos faced the same issues in the Pisco valley at the time of Spanish contact. These forces are: 1) the creation and/or expansion of irrigation systems throughout the coast; 2) a series of demographic expansions and collapses associated with the expansions and collapses of stratified societies; 3) deforestation associated with expansion of population, with the wood used for fuel and construction, and the land used for fields; 4) the increased use of land for special uses, such as trees cultivated for economic use, reed ponds, clay mines, salt pans, etc. While arguments can be made regarding the relative impact (productive or destructive) of these human actions on the landscape and environment, there is little doubt that these activities increased the human impact on the local ecology (Wilson 1988).

Peters (1987/88, 1997) hypothesizes that there existed a thick scrub forest along the floodplain of the lower Pisco River. She believes that the inhabitants of the region chose to live near the forested area, as it aided in the control of agricultural land. The Pisco River is relatively short and steep, and is prone to flooding with large variations in river flow associated with El Niño Southern Oscillation (ENSO) events. Severe floods can destroy farmland, with potentially catastrophic results for villages dependent on agriculture. The scrub forest would help keep the waters of the river under control if and when they went beyond the river channel. This would help control the severity of flooding. It is also possible that swampy areas located along the river were manipulated by humans, and served a similar function as the scrub forest, helping to absorb excess floodwater.

In addition to the potential for flood control, there may be subsistence advantages for choosing to live near a scrub forest and/or swampland. These microenvironments could increase the diet breadth of agriculturalists living nearby. The forest would have provided refuge for wild animals, which could be exploited as a consistent source of protein, in addition to vegetal materials that could be foraged as a form of diet breadth and/or variance reduction. Peters (1997) writes that in recent times the lakes and river-bottom areas in the Pisco valley were known as rich hunting areas. Freshwater fish and crustaceans also likely lived in the swampland. The scrub could also be used as a source of fuel, and as a source of material for tools and building materials, with other vegetal materials in the scrub, lakes and swamps being exploited for raw materials for domestic use, such as baskets. The described richness of the ecosystems near Chongos during the EH/EIP could have provided resources for subsistence, building supplies and other materials, offering a mechanism for variance reduction in diet during times of environmental unpredictability.

At the time the Chongos site was occupied in the lower Pisco River valley, much of the valley may have been filled with forest that was supported by groundwater and periodic flooding of the region. By the beginning of the EIP small irrigation canals were built adjacent to the river (Peters 1997). This would have opened up additional land on both sides of the river for farming in areas that normally were not flooded, increasing the potential agricultural yield of the lower Pisco river valley. These new fields would have required fertilizer and crop rotation, as they would not benefit from the deposition of nitrogen in the flood plains. The narrowness of the Pisco valley limits the amount of arable land when compared to nearby valleys, such as Chincha, Cañete and Ica.

At the time of Spanish contact the inhabitants of the lower Pisco valley engaged in a variety of specialized activities, with centralized labor allocation to ensure that all necessary goods were produced. Individuals engaged in specialized agriculture, fishing, household craft production, and production of goods for tribute and trade (Rostworowski 1977, 1981, 1999). If this overall economic specialization, or a close approximation, existed during the EH/EIP, this would place the inhabitants of Chongos as specialized laborers who engaged in agriculture. The fruits of their labor would have met their subsistence needs but also have been used to trade with others. If the ethnohistoric analogy presented by Rostworowski (1977, 1981, 1999) is accurate back to the EH/EIP, the organization of labor may have occurred at the local level (Peters 1997). This would support the archaeological interpretations along the south central coast of Perú that no one dominant group exerted control (Peters 1997; Silverman 1996). I will discuss this topic more in Chapter five.

2.B.1: Summary

The Chongos site is located in a small yet fertile coastal valley, with narrow strips of arable land. The potential for irrigation existed due to the relatively flat coastal valley, permanent flow of the Pisco River, and presence of a high water table evidenced by occasional oases and swampy areas. The inhabitants of the lower Pisco valley, including those living at Chongos, were able to grow a variety of crops to meet their subsistence (and perhaps economic) needs.

The lower Pisco valley and surrounding area also has many ecological features that provide opportunities to supplement an agricultural subsistence strategy. These include marine foraging in the nearby Paracas Bay or Pacific coast, as well as exploiting the Pisco River and associated swamplands. Scrub forest provided building and fuel resources, as well as the potential for terrestrial foraging. If the people living at and near Chongos chose to supplement their agriculture-based diet by foraging, there appears to have been numerous micro-habitats to exploit. Ethnohistoric reconstructions of division of labor also imply that economic specialists existed during the EH/EIP in this region. If this is true, people at Chongos may have been farmers who supplemented their ‘income’ by trading with others nearby and throughout the Andean region.

2.C: Archaeological Background

The skeletal remains recovered from Chongos are affiliated with the Topará, and perhaps, Paracas, cultural tradition based on grave goods and architectural features in and nearby the Chongos cemetery. I begin this section providing a brief description of the better-known Paracas cultural tradition, moving to the Topará cultural tradition, and finally concluding this section by discussing the interaction between the two cultural traditions and the influence of Topará on Paracas in the Pisco River valley and the Paracas Peninsula. ‘Paracas’ can refer to a location, weather phenomenon, culture, pottery and textile style, and modern town. To alleviate any potential confusion, I will add descriptors to specify the 'Paracas' to which I am referring. Topará can refer to a small river valley, ceramic tradition or culture. For the same reasons outlined regarding Paracas, I will add descriptors to specify the 'Topará' to which I am referring.

Understanding the archaeological background is necessary in order to place the Chongos skeletal collection in proper cultural context. Internal and external cultural influences on the individuals living at and near Chongos impacted subsistence strategies, migration patterns, and health behavior, all of which can be manifested in skeletal remains.

2.C.1: A Brief Introduction to Paracas

Paracas is strong, persistent wind that can create strong sand storms in the Peruvian desert. The Paracas peninsula, noted for its strong afternoon winds and common sand storms, is named for this indigenous word (DeLeonardis 1991, Rostworowski 1977). This is the name applied to the ceramics and textiles originally discovered on the Paracas peninsula. These remains date to the first millennium B.C. based on recovered ceramics. Paracas tradition remains date to the Early Horizon (table 2.1) based on the General Andean chronology. Paracas tradition remains have been located in seven coastal river drainages, from south to north, Acari, Nasca, Ica, Pisco, Chincha, Topará, and Cañete (see Figure 1.1) (Moseley 1992a; Paul 1991a, b). The Paracas Peninsula lies in the middle of these river valleys, located between the Ica and Pisco Rivers. The Pisco River empties into the Pacific Ocean just north of the Paracas Bay. Paracas era ceramics reflect approximately 900 years of occupation on the south coast of Perú (table 2.1).

Paracas ceramics are characterized by globular, stirrup-spouted jars, with a distinctive form being a double spouted vessel with a bridge handle (Lumbreras 1979) that was a preferred drinking vessel (Moseley 1992a). The pottery includes painted polychrome and negative-painted varieties, with regional and temporal variants (Massey 1991; Silverman 1991). Later ceramics also exhibited Chavinoid iconography, reflecting the influence of Chavin in the region (Burger 1992; Lumbreras 1979; Moseley 1992a; Silverman 1995, 1996). Textiles associated with the Paracas tradition contain the same kinds of designs as the ceramics. Recovered textiles from this tradition have painted designs, such as anthropomorphic deities that are also painted on ceramics from the same time period. Many textiles also contain geometric shapes and designs that are found on ceramics. It appears that some fine ceramics and textiles from the Paracas tradition served an ornamental or ceremonial function. However, Paul (1991b) argues that the textiles and pottery from Paracas sites each exhibit their own artistic style, meaning that there is no single Paracas style.

Archaeologists linked Paracas to Chavin in the highlands. This was due to incised feline designs and other forms of iconography found on ceramics and textiles (DeLeonardis 1997; Burger 1992). In addition to very complex geometric shapes and iconography, the Paracas textiles are known for their quality.

Current understanding of the Paracas tradition is based on excavations conducted throughout the Paracas Peninsula and Ica river valley by Uhle (1913, cited in Paul 1991b; Kroeber and Strong 1924), Tello (1929, 1959; Tello and Mejia 1979), and to a lesser degree Engel (1966). Tello is credited with conducting the first systematic explorations of the Paracas Peninsula in 1925, and officially named the tradition 'Paracas' (summarized in Paul 1991b; Tello 1929). The Paracas tradition was defined largely through mortuary analysis of the spectacular funerary complex on the Paracas Peninsula (Peters 1997). This is where the ceramics and textiles associated with the Paracas tradition were first described and placed in an archaeological context. An analysis of the human skeletal remains that made up the funerary complex, however, was not conducted, except for descriptions of artificial cranial modification and trephanation. Because there was not, and still has been little, archaeological work on Paracas domestic settings, researchers can only reconstruct what everyday life was like for the people associated with Paracas based on mortuary patterns (DeLeonardis 1991, 1997; Peters 1997). As DeLeonardis (1997) states, the typical "residential unit" associated with the Paracas tradition has yet to be defined.

Tello posited two groups at Paracas based on the cemeteries on the peninsula – Cavernas and Necropolis (Tello 1959; Tello and Mejia 1979). He believed these groups represented early and late social formations of the Paracas civilization, with Cavernas as lower social status and Necropolis as higher status. This distinction was based on grave goods associated with the burials and also the burial itself. In general, the larger the funerary bundle, the higher the status of the individual (DeLeonardis 1997). The presence of complex burial patterns, iconography on ceramics and high quality textiles, artificial cranial deformation and trephanation as a surgical technique points to a cultural tradition with complex social organization.

In the late 1950’s analyses by Lanning (1960, 1967) and Wallace (1971, 1985, 1986) on ceramics recovered from the Pisco, Chincha and Cañete river valleys and the Topará Quebrada led to the designation of a new ceramic tradition, which Lanning called Topará (see more detailed description below).

Topará exhibited characteristics closely related to ceramics recovered from Necropolis, specifically thin-walled, monochrome vessels. The current view is that Tello’s interpretation of Cavernas and Necropolis is incorrect (e.g. Massey 1986; Peters 1997; Proulx 2008). Rather, the Paracas cultural tradition is characterized by Paracas and Topará pottery, with Paracas pottery occurring early and Topará later. Temporal overlap between the two does exist at the end of the Early Horizon. Paracas cannot be easily characterized by two distinct status groups, but the cultural relationship of the two traditions is still unresolved (see 2.C.3 below).

There is still debate on an agreed-upon chronology for the Paracas tradition (Deleonardis 1997; Paul 1991b). Most research on Paracas tradition sites utilized relative dating techniques rather than radiocarbon sequencing, with a series of radiocarbon dates for Paracas materials only being presented in the 1990s (DeLeonardis 1997; Wallace personal communication 3/10/08). There is still debate about the official start of the Paracas tradition, because of a lack of radiocarbon dates and a solid definition of what distinguishes Paracas from other influential traditions, such as Chavin. At the end of Paracas, there is debate over when, how and if, the Paracas tradition transitioned to a new style, such as Topará, Necropolis or Nasca (Deleonardis 1997). For example, Peters (1987/88, 1997) found evidence for Paracas and Topará occupations in the Pisco River valley. Though some Topará occupations were located stratigraphically on top of Paracas, in other occupations Paracas and Topará appeared to be contemporary (Peters 1997). At a minimum we know that the Paracas tradition persisted for hundreds of years and spread over much of the south-central coast of Perú (Paul 1991b). Of course, a related question to the transition of traditions is if the change in cultural tradition is indicative of a transition in social formation.

2.C.2: A Brief Introduction to Topará

Topará is a ceramic tradition named for the Topará Quebrada, based on artifacts recovered from excavations beginning in 1956 by Lanning (1960, described in Peters 1997; Wallace 1985, 1986) at the site of Jahuay (Figure 1.1). These artifacts were similar to those recovered by Wallace at sites in the Pisco, Chincha and Cañete valleys, and different from those recovered and described from Paracas (Peters 1997; Wallace 1971, 1986). Lanning found that the material excavated from Jahuay had three distinguishable temporal phases, which he termed Jahuay 1-3 (table 2.2). These excavations were part of a systematic study of habitation refuse and associated architecture outside of the Paracas Peninsula, extending into the Pisco, Chincha and Cañete river valleys. This study was conducted by Lanning and Wallace as part of their dissertation fieldwork in the late 1950s. The work of Lanning and Wallace led to the definition of the Topará ceramic tradition, considered to be contemporaneous to the sites of the Paracas Peninsula (Peters 1997; Wallace 1986). Topará ranges in the north from the Rimac river valley south to the Ica river valley and even into parts of the Nazca river drainage (Peters 1997; Stothert 1980; Wallace 1986). The Topará tradition ran contiguous to the Paracas tradition located immediately to the south, with the Topará and Paracas traditions mixing in parts of the Ica and Pisco valleys, as well as on the Paracas Peninsula (Peters 1997; Wallace 1986).

In general, Topará ceramics consist of utilitarian ware characterized by coarse temper, thin walls and a neckless mouth. Fine wares have very fine temper, thin walls with few vessels having any surface decorations. Of those few, designs included fish and geometric designs (Wallace 1986). Some fine ware funerary bottles were made in the form of a squash (DeLeonardis 1997; Peters 1997). Topará fine ware is considered to be the highest quality pre-hispanic Perúvian ceramic ever produced (DeLeonardis 1997; Wallace 1986).

At the Chongos site, Topará materials are found on top of Paracas tradition materials. Peters (1997) interprets this as indicating a continuity from the earlier period of Paracas and Topará. However, the location of Topará tradition material stratigraphically on top of Paracas tradition material may indicate replacement rather than continuity. The question is important since replacement would imply new people being buried in the cemetery. On the Paracas Peninsula, Topará period cultural remains are found at Wari Kayan and Cabeza Larga. The cultural remains are associated with Paracas Necropolis burials.

Temporally, the Topará tradition consists of Los Patos, Jahuay, Chongos, Quebrada, and Campana phases, from earliest to latest (Wallace 1986). Each phase is named for its type-site, with Los Patos located in the Cañete valley, Jahuay in the Jahuay quebrada just north of the Chincha river, Chongos in the Pisco valley, Quebrada in the Cañete valley, and Campana in the Chincha valley. Jahuay has four ‘sub-phases’ (Jahuay 1, 2A, 2B, 3), Chongos two sub-phases (A and B) and Quebrada two (also A and B) (table 2.2). Local differences existed in Topará tradition ceramics (Peters 1997; Stothert 1980; Wallace 1986).

Peters (1997) believes that the concept of “Topará” refers to a meaningful set of resemblances among artifacts. Thus, while it may be easy to say that a ceramic ‘resembles’ a Topará sherd, it is equally difficult to say that two sherds from different Topará-related sites look exactly alike. Of course, diagnostic ceramic traits are only apparent in decorated ceramics, such as funerary or ceremonial ceramics. It is probable that utilitarian ceramics, which likely made up the majority of ceramics in a domestic site, were simple plainware, and unable to be distinguished from other site separated geographically or temporally. The only way to distinguish them would be through chemical analysis to source the clay and/or the temper.

Table 2.2: Early Horizon and Early Intermediate Period Ceramic Phases and Styles on the South Coast of Perú

Cañete river valley	Chincha river valley	Pisco River valley	Paracas sites	Upper Ica river valley	Lower Ica river valley	Nazca Valleys	Period Chronol -ogy	Absolute dates (estimated)
Carmen	Carmen	Carmen and Nasca 4		Nasca 4	Nasca 4	Nasca 4	EIP 4	A.C. 300 – 400
Carmen	Carmen	Carmen and Nasca 3	Carmen	Nasca 3	Nasca 3	Nasca 3	EIP 3	A.C. 200 – 300
Quebrada B Quebrada A	Cam-pana	Cam-pana	Cam-pana	Cam-pana and Nasca 2	Nasca 2	Nasca 2	EIP 2	A.C. 100 – 200
Jahuay 3	Jahuay 3	Jahuay 3	Ocucaje 10 and Jahuay 3	Ocucaje 10 and Jahuay 3	Ocucaje 10	Ocucaje 10 and Tajo	EH 10	100 – 1 B.C.
Jahuay 2B Jahuay 2A	Jahuay 2B Jahuay 2A	Jahuay 2B Jahuay 2A	Ocucaje 9 and Jahuay 2	Ocucaje 9	Ocucaje 9	Ocucaje 9 and Tajo	EH 9	200 – 100 B.C.
Jahuay 1	Jahuay 1 and Pinta/ Paracas style	Jahuay 1 and Pinta/ Paracas style	Paracas style	Ocucaje 8	Ocucaje 8	Ocucaje 8 and Tajo	EH 8	300 – 200 B.C.

modified from Silverman (1997)

Based on cross-dating with the Menzel, Rowe and Dawson ceramic chronology (1964), the Topará tradition dates to the Early Horizon and into the beginning phases of the Early Intermediate Period (see table 2.1). This corresponds to the Ocucaje 8 through Nasca 1 and perhaps 2 phases of the MRD (1964; Silverman 1997) ceramic chronology (table 2.2). The Topará tradition overlaps with Paracas immediately to the south, which will be discussed in secion 2.C.3 (tables 2.2 and 2.3). Peters (1997) believes that the Topará tradition exerted its influence in the Pisco River valley by EH4 (Paracas 10 in the

MRD [1964] system) and moved very quickly to become the dominant influence in the valley. By EIP1, Topará sites replaced Paracas sites in the Pisco valley.

Topará tradition ceramics do not appear to have been influenced by the earlier Paracas Cavernas period or any other ceramic tradition to the south (e.g. Ocucaje phases outlined by Menzel, Rowe and Dawson [1964]). Rather, Topará ceramics appear to have been influenced by Initial Period ceramics from the central coast (Peters 1997, Wallace 1986), with close association between Topará and the Miramar ceramic style along the Central Coast (Wallace 1986). Stothert (1980) states that many of the basic features of the Villa Salvador ceramic style are found in Topará tradition pottery. Villa Salvador is located in the Lurin river valley just north of the important oracle site Pachacamac, approximately 40 km south of Lima (Figure 1.1). Stothert (1980) reported Topará influence in at least one other ceramic site from the Lurin valley, supporting the influence of Topará in the region. Villa (El) Salvador is one of the sites to which I compare Chongos in Chapter five. Based on ceramic tradition, Chongos and Villa El Salvador were temporally similar, though they are separated by approximately 200 km. They may have had cultural similarities, with the inhabitants of the sites perhaps even interacting with one another.

Menzel, Rowe, and Dawson (1964) recognize that Topará influence is found in Ocucaje 9 and 10 phases, persisting into Nasca 1 (Wallace 1986). Wallace (1986) believes that the distinctiveness and widespread influence of the Topará tradition is one of the most notable cultural expansions in Perúvian prehistory, and almost certainly was accompanied by major cultural influence, such as political expansion into the Upper Ica valley and Nasca river drainage. I will discuss the potential influence of Topará in Chapter 6.

Though the Topará tradition is most known from its ceramics, peoples associated with this tradition also created distinctive adobes and textiles. Wallace (personal communication 3/10/08) noted that Topará textiles exhibit geometric shapes but no distinct figures. However, Peters (1997) states that Topará textiles exhibit similar iconography to later Paracas textiles, differing only in yarn, color, range of techniques used and proportions.

Wallace (1986) believes there are two types of Topará sites, ceremonial platform mounds and extensive residential sites. He believes Chongos is a residential site, largely based on the lack of temple mounds at the site (also discussed below in the section describing the Chongos site). I will argue that Chongos may have had a residential component, but mainly served as an administrative center. However, Peters (1997) describes evidence of mound-building that may be evidence for ceremonial space within the residential site of Chongos. In Chapter 6 I discuss potential functions of the Chongos site, and how the skeletal remains from Chongos can inform on its function.

Data from the Topará tradition remains relatively underpublished compared to other ceramic traditions, with only the early work of Lanning (1960, 1967) and Wallace (1971, 1985, 1986) in print (Peters 1997) (see end note). This opinion is shared by Silverman (1997; also in more general terms in 1996), who notes that before her Alto del Molino project in the lower Pisco River valley, dating to the Topará tradition, there were only three investigations conducted in that valley (also Arce Torres personal communication 6/04/08). In fact two of these three investigations mentioned by Silverman were surface collections or surveys, lacking any type of systematic archaeological excavations.

2.C.3: Topará interaction with Paracas, or 'Topará in Paracas'

At the same time the Topará tradition was defined by Lanning (1960, 1967) and later Wallace (1985, 1986), it was immediately recognized as related to the ceramics from the Paracas Necropolis and to some ceramics in contemporary burials from Ocucaje in the Ica Valley (Lanning 1960; Menzel, Rowe and Dawson 1964) (table 2.2). Topará is widely considered to directly influence the Ocucaje 10 ceramic phase, which was directly descendent to the Nasca 1 ceramic phase (Menzel, Rowe and Dawson 1964; Peters 1997; Wallace 1986). In fact, the cultural material originally defined by Tello as "Paracas Necropolis" is now redefined as Chongos phase (Topará tradition) (Silverman 1997; Tello and Mejia 1979).

Peters (2000, also 1997) argues that the peoples associated with the Topará and Paracas traditions had contact with one another during this time period. In fact, she believes that some sites, such as Campana in the Chincha valley, have ceramics associated with both the Paracas and Topará traditions (Figure 1.1). Peters (1987/88, 1997) also states that Paracas ceramics were found on the outskirts of Chongos, suggesting very close interactions between the two societies. What remains unknown is the manner of interaction, whether the relationship between the two cultures was one of competition, cooperation, or subordination and/or political power (DeLeonardis 1997).

In many places, Topará tradition sites were located close to Paracas tradition sites, in general in areas that marked major ecological or social boundaries – the neck of the Paracas peninsula, areas between irrigated fields and forests/swamplands, or flanks of coastal valleys that were major travel routes between valleys or between the coast and the highlands (Peters 1997). Chongos phase materials were buried at the Chongos site in refuse from the Paracas tradition, just as at the Paracas site on the peninsula (Silverman 1991). Whether peoples associated with the Topará and Paracas traditions interacted or not, it is clear that they occupied similar locations at similar time periods.

It is important to remember that virtually all that is known about the culture and culture history of peoples associated with the Paracas and Topará traditions come from ceramic and textile remains, even more specifically, ceremonial remains. Historically, most direct research on Paracas occurred either on the Paracas peninsula or in the Ica river valley (e.g. DeLeonardis 1997; Massey 1986; Menzel, Rowe, and Dawson 1964; Tello 1959; Tello and Mejia 1979; Wallace 1962). It is necessary to expand research on Paracas to look at its influence regionally, and how it interacted with other regional polities and vice-versa (e.g. Wallace 1985). There is some research on domestic sites associated with these traditions (DeLeonardis 1997; Massey 1986; Peters 1997), but until more work is done to define a culture based on all aspects of material remains, including residential material culture, it will be difficult to discern the exact nature of Paracas and Topará interaction.

Continued work in Pisco, including work at Chongos, may be key to understanding the interaction between Topará and Paracas. There is evidence of early Paracas occupations in the Pisco River valley (Engel 1957), demonstrating early influence of this tradition. The presence of Paracas and Topará occupations very close to one another is evidence of consistent Paracas occupation in the valley for the whole of the Paracas tradition (Silverman 1997). However, no research to date has been conducted to determine the Paracas (or Topará) settlement pattern in the Pisco River valley, which would greatly aid in our understanding of social, political and economic organization not only in the valley but for both cultural traditions as a whole.

2.C.4: Summary

The Paracas and Topará ceramic traditions influenced a large area of coastal Perú for over 1000 years. Most research with these traditions comes from mortuary contexts – very little is known about the day-to-day life of the people who made these ceramic vessels.

At Chongos, the Topará and Paracas traditions appear to both be represented. Peters (1997, 2000) believes the different traditions represented different cultures living with or next to one another at the same time. However, it is possible that the peoples associated with the Topará tradition replaced the people associated with the Paracas tradition and controlled the Chongos site. In this case Paracas era artifacts should be eliminated from the archaeological record immediately after the appearance of Topará artifacts. If there were two cultures living together, I think that they could have represented occupational specialization such as is hypothesized by Rhode (2006) or described by Rostworowski (1977, 1981, 1999) for Perú at the time of Spanish contact. Additional research must be done to understand the pattern of interaction between these two traditions, regionally as well as at Chongos and the surrounding area.

2.D: Theory

Over the past 30-35 years, Andean archaeologists have used ethnohistoric models to attempt to explain prehistoric culture change and variability (e.g. Sutter 2000). As Sutter explains, these models assume that ethnic similarities are due to both cultural and genetic affiliation. Of course, these models also assume that the same factors that led to economic, cultural and biological associations and variability today are the same factors that impacted people in antiquity. Ecology must also play a role in any such model, especially in a region with environmental extremes such as coastal Perú (see 2.B above).

I briefly describe the ecological complementarity model (Murra 1972, 1985) and the horizontal complementarity model (Rostworowski 1977, 1981, 1999), both designed to explain economic relationships between different peoples and different regions. These models may provide explanatory power for my results. An additional question is how far back in antiquity each model provides explanatory power.

I hypothesize that the Chongos skeletal collection comes from farmers, and will exhibit dietary, health and activity patterns consistent with agriculturalists. Their access to marine resources would be either through direct foraging or exchange; these two strategies lead to different predictions of occupational markers that would be registered on the skeletons and teeth.

Murra (1972, 1985) developed the ecological complementarity ('verticality') model using ethnohistoric and ethnographic data on resource utilization and exchange between vertical ecological zones among the Inca. This model originally offered an economic explanation of how people adapted to an environment characterized by dramatic altitudinal differences, leading to great changes in ecology and geography over a small distance. Basically, each ecological zone is limited in what could be grown or raised there, based on climate and altitude. A group would send out 'colonists' to different ecological zones to exploit the resources available there. Or, a community would control multiple ecological zones by seasonal use of these areas. The control of resources from different ecological zones and the ability of groups to exchange with people who controlled resources from other ecological zones was central to the Incan economy. On a regional level, farmers and herders in the highlands could engage in exchange relationships with farmers and marine foragers in the lower altitudes, along the coast or in the Amazon

Basin. The possibility of exchange could allow a cultural or ethnic group to gain access to resources through trade/exchange relationships without having to move to new regions and learn new strategies to exploit new resources. Such a model would explain how numerous and varied products could be exchanged over a large area, and would lead to a multi-ethnic coastal region as many groups from the highlands would occupy the same coastal valleys for resource exploitation. Murra argues that verticality could provide economic stability to Andean populations as a form of variance reduction strategy, reducing potential variation in day-to-day food availability, allowing a single group to be economically self-sufficient. It is known that this strategy is still used today, where Andean groups exchange food products for salt and fertilizer brought by herders (Guillet et al. 1995).

Exchange in the Pisco region between ethnic groups of fishermen and farmers was well established in late Prehispanic times. Rostworowski's (1977, 1981) model of horizontal complementarity was developed to explain coastal valley marine/agricultural exchange, that residents of coastal valleys developed their own economic systems, and these populations grew into separate, independent polities. She emphasizes the importance of marine resources to the coastal economy, using ethnohistoric data to argue that the marine fishers and foragers had their own language, culture and belief system. These groups engaged in trade relationships with farmers along the coast or in the river valleys. It is important to note that the horizontal complementarity model is not an alternative to the model presented above. Rather, this model complements the above model, additionally highlighting the important role of fishers and marine foragers in trade networks, and the potential for coastally based independent ethnic groups. Rostworowski's model is especially relevant given the long history of marine exploitation along the coast of Perú (e.g. Arriaza 1995; Benfer 1990; Sandweiss 1992). Murra's may be more useful in the high Andean region.

The results of my study may contribute to our understanding of trade activity along the south central coast of Perú during the EH/EIP. Andean scholars (e.g. Burger 1992) argue that exchange relationships existed at the time Chongos was occupied, and likely even before. However, these relationships are often presented as occurring between social elites. What is less well known is how these exchange networks functioned, if at all, among non-elites at the local level, what goods were exchanged, and if the social elite controlled all exchange networks. While addressing these questions is beyond the scope of this study, Chongos, as will be discussed below, does not appear to have been a site controlled by social elite, and would therefore represent a more 'local level' view. Evidence of trade at Chongos would offer evidence that these exchange networks indeed involved all levels of Andean society.

The osteological Paradox (Wood et al. 1992) discusses the validity of using skeletal samples to represent the health of the living population that it represents. Specifically, Wood and colleagues identified three key issues that make bioarchaeological analyses of health and/or adaptation complicated at a population level. These include: 1) demographic nonstationarity; 2) selective mortality; and 3) hidden heterogeneity in risk.

Issues regarding demographic nonstationarity in skeletal populations have been widely recognized for a number of years (e.g. Sattenspiel and Harpending 1983). Unless an archaeological population is stationary (constant population due to equal proportion of deaths and births) the skeletal age distribution of a cemetery population reflects fertility patterns of the population much more than mortality patterns.

The second issue, selective mortality, identifies that the skeletal remains represent individuals who died for a reason. These individuals by definition are different from all other individuals of the same age, with skeletal characteristics of individuals who died at that particular age. However, it is impossible to know the skeletal characteristics of the individuals who lived longer. As Wood and colleagues (1992) state, an individual who dies at age 60 displays the skeletal characteristics of people who died at age 60, and not the characteristics that would allow an individual to live beyond age 20. Therefore, a skeletal sample of a particular age group, especially younger age groups, will disproportionately contain skeletal features that increase the risk of death at a particular age. Rather than providing a window on the health of the entire population, skeletal remains only represent the health of the population who died at a particular age.

Hidden heterogeneity relies on the assumption that the living population from which the skeletal collection is drawn from had an unknown mixture of individuals who varied in their susceptibility to disease and death (Wood et al. 1992). The individual variation may reflect differences in gender, status, genetic composition, or climatic adaptation. Also, healthier looking skeletons may not reflect healthier individuals (see issue two above). Wood and colleagues state that because of this hidden heterogeneity it is difficult to impossible to discuss aggregate-level mortality rates in terms of individual risk of death.

The publication of The Osteological Paradox stimulated much discussion in the area of bioarchaeology (e.g. Cohen 1994; Goodman 1994; Wright and Yoder 2003). Perhaps the two strongest critiques of The Osteological Paradox come from Cohen (1994) and Goodman (1994). Cohen admits that while the theoretical issues raised by Wood and colleagues (1992) have merit, he does not agree with how they reinterpreted health trends associated with the transition from foraging to agriculture. Specifically, Cohen cites the strong association between paleopathology data and results from the ethnographic record and epidemiologic theory. Cohen also emphasizes morbidity data from modern foraging groups, showing that these extant groups mimic what is predicted for prehistoric foragers. In short, pathological data strongly mimic data for modern groups and modern epidemiological theory. If this is the case, Cohen (1994) asks, why would the results be different for archaeological skeletal populations? His answer, of course, is that there is no difference, contradicting the interpretation of Wood and colleagues (1992).

Goodman (1994) argues that the osteological paradox as described by Wood and colleagues (1992) is only a paradox because the authors emphasize the analysis of only single skeletal indicators of health and not the multiple indicators of health that most bioarchaeologists use. Goodman also emphasizes that Wood and colleagues ignore the importance of cultural context in the analysis of skeletal remains. Goodman counters the issue of selective mortality by clearly identifying that skeletal lesions do in fact represent morbidity that occurred at some time before the individual actually died (Ortner 1991), but do not represent mortality. Examples could include enamel hypoplasias that occur during childhood development of permanent dentition. Another criticism Goodman had against the issues raised by Wood and colleagues (1992) is that bioarchaeologists had already identified the potential problem of selective mortality by the 1970s. Despite the critiques of the osteological paradox offered by Cohen (1994) and Goodman (1994), Wright and Yoder (2003) believe that bioarchaeology is a stronger discipline because of the issues raised by Wood and colleagues (1992).

Of the issues identified in The Osteological Paradox (Wood et al. 1992), the second and third issues, selective mortality and hidden heterogeneity, are most germane to this study. Specifically, does a skeleton without noticeable lesions represent a healthy person who did not contract any diseases or illnesses that would leave a mark on the skeleton? Or, does a skeleton without noticeable lesions represent a weak individual who died shortly after contracting a disease or illness, dying before any lesions could form on the bone. Finally, does the presence (or absence) of lesions on an individual’s skeletal remains indicate individual-level population variation in relation to susceptibility to disease or other forms of environmental stress rather than population-wide exposure to disease or some other form of environmental stress. In Chapter five I will discuss one particular result from the Chongos collection where individuals with lesions were more likely to die than individuals without that lesion.

2.E: The Chongos Site

The Chongos site, 28K.F12.1, was originally discovered by Dwight Wallace during archaeological survey work for his dissertation from 1957-1959. Wallace named the site after an old canal which runs from an intake point up the valley margin, and for an old hacienda northwest of the site that was watered by the canal (Peters 1997). Though discovered and preliminarily surveyed, Wallace did not perform any excavation at Chongos (Peters 1997; Silverman 1996, 1997; Wallace 1971, 1986). Rather, Wallace made surface collections of ceramics and textiles, described the architectural methods used to build walls, and drew sketch maps of the site. The site later received superficial investigation by Alexander Pezzia, where he excavated areas of the site where looters had disturbed the site. His initial excavations were described in 1969. Pezzia described a mummy bundle he excavated, stating that these bundles are like miniature museums due to the number and variety of items interred in the burial (Peters 1997). Chongos is described by Engel (1966) and Tello and Mejia (1979) as the most important site of monumental or habitational architecture contemporary with Paracas Necropolis outside of the Paracas peninsula itself. In spite of its importance, Chongos was not formally excavated until 1986 and 1987 (Peters 1987/1988, 1997). In 1986 and 1987 the National Institute of Culture in Perú commissioned a salvage excavation at Chongos because the site and its surrounding land had been approved to become part of a large-scale commercial pig farm, Pecuario Pisco, a subsidiary of La Fabril, S.A. (Peters 1987/88, 1997). Pecuario Pisco also contributed money to facilitate the excavation. The site was mapped by Theodolite by Benjamin Guerrero (Peters 1997). The published site map (Peters 1987/88, 1997) shows the sectors of the site, including the sectors that were excavated during the salvage excavation. However, it is unclear where exactly the burials were located in these sectors (Figure 2.1).

The Chongos site is considered a major population center of the Pisco valley, and perhaps of the south-central Peruvian coast. Its habitation remains cover at least 40 ha (Peters 1987/88; Silverman 1997; Wallace 1986). The site contains components that correspond to both the Paracas and Topará traditions during the EH/EIP, with Peters arguing that the site may have been occupied at different times by people from different cultures over a relatively short period of time. However, the central area of the site was affiliated with the Topará tradition based on associated ceramics. Burials were dated to this time based on associated ceramics. Even after the Chongos site was abandoned as a residential site it was used as a cemetery throughout the EIP (Peters 1997).

The salvage excavation was supervised by a team of archaeologists from the U.S. and Perú, including Ann Peters, Susana Arce Torres, Oscar Bendezú and Bejamin Guerrero. This supervisory team was directed by Carlos Deza and administered by the regional supervisor of National Institute of Culture in Ica, Miguel Pazos (Peters 1987-88). The excavations took place in 1986 and 1987, with the bulk of the excavations occurring between September and December 1987 (Peters 1987-88). The excavated materials are curated at the Regional Museum in Ica, Perú. The entire site was not excavated due to the sheer size of the site and because the pig farm was to begin operation. The skeletons recovered from this salvage excavation provide the material I used for my dissertation project.

The Chongos site was occupied intermittently from the Preceramic through the Late Horizon. Based on midden accumulation, peak occupations for Chongos came during the end of the Early Horizon and the beginning of the Early Intermediate Period, the time period under consideration for this project, and later during the Late Intermediate Period/Late Horizon (Peters 1987/88, 1997). During the EH/EIP Chongos was occupied at least from Ocucaje 9/ Jahuay 3 until the Chongos phase in the Topará sequence (corresponding to Nasca 1) (Peters 1987/88). The relative dates from Chongos correspond well to published radiocarbon dates from cemeteries at the Paracas Peninsula type site, 300 B.C. – A.D. 200 (Silverman 1991). Given the strategic location of the site and the rich resources near this location, it is possible that the site was situated there to be a strategic location to control water and other important natural resources (Peters 1987/88).

Based on Wallace's hypothesis of two main types of Topará sites, ceremonial or residential, Chongos is generally considered a residential site (Peters 1997; Silverman 1997; Wallace 1986, personal communication October 24, 2008) with evidence of residential expansion throughout its history (Peters

1997). The size and density of residential space puts the site into the range of the "urban" centers noted by Rowe (1963; also Silverman 1997) that occurred in the EH/EIP along the south-central Perúvian coast (see also Wallace 1986). Wallace (1986) states that the Chongos site was a small urban center, lacking a well-developed nucleus. He further states that the lack of temple mounds at Chongos argues against the site being a ceremonial center, positing that during the EH/EIP along the south coast of Perú, there was a separation between ceremonial centers and towns (Wallace 1986). Stothert (1980) believes the presence of residential and public spaces supports either an administrative or ceremonial function in addition to being a residential site.

Architecturally, the Chongos site is laid out in sectors, with distinct compartmentalized compounds and plazas (Peters 1987/88, 1997; Silverman 1997; Stothert 1980; Wallace 1986; Figure 2.1). According to Silverman (1997), this architectural layout is similar to that found at the contemporary site of Cabeza Larga-Arena Blanca on the Paracas Peninsula, originally assigned to the Paracas necropolis tradition. The sectors of Chongos are generally oriented towards the cardinal directions, which is to say to the equinoxes, and the architectural division of Chongos into sectors corresponds to a conscious division of space in the site, likely for administrative, social or cultural purposes. Each of the sectors has well defined open spaces that look like plazas and may have functioned in a similar manner (Peters 1997; Wallace 1986), serving as a venue for public gatherings of a political, ceremonial and/or religious nature. Peters (1997) also notes that each sector at Chongos contains at least one ridgetop, with the higher elevations perhaps serving as strategic observation points for the site and the valley as a whole.

The salvage excavation at Chongos demonstrated midden accumulation consistent with a habitation site (Peters 1997). However, midden accumulation was light. This supports Wallace's (1986) claim for a low-level urban occupation at Chongos. Midden was present throughout the site, implying the general use of all areas of the site for habitual activities, including a lithic workshop area in one of the sectors (Peters 1997).

As described above, Chongos is located at a strategic geographic point, making it a productive location for the multiple occupations identified at the site. The site is located on the Pisco River valley margin in a location close to totoral reeds that could be irrigated. Though the environment was rich for marine and terrestrial foraging, the narrow valley was of limited potential for agriculture. Finally, Chongos was located along ancient travel routes leading from the highlands to the coast, and near a midvalley travel route connecting the Pisco River valley to the Ica river valley (Peters 1997; Wallace personal communication 3/10/08). Recent studies of exchange of obsidian (Berger et al. 2000) show that trade extended to the interior valley.

When the Chongos site was occupied during the EH/EIP, the Pisco valley mostly contained sites associated with the Topará tradition. However, some Paracas tradition settlements have been discovered (Peters 1997). As described above, the Chongos site is associated with the Topará tradition, with a major Topará ceramic phase named for the Chongos type site. However, Peters

(1987/88, 1997) argues that there is a Paracas tradition settlement at the edge of the Chongos site, which she estimates to be contemporary with Chongos occupation. Peters (1987/88) further proposes that the Chongos site was of great importance as a point of contact between peoples from the Paracas and Topará traditions. It also could have served as a power base for the economic, political, cultural, and religious forces of the south central Perúvian coast, especially during a time of transition between the waning influence of Paracas, the expansion of Topará southward, and the development of Nasca.

2.E.1: Summary

The Chongos site is the largest archaeological site in the lower Pisco valley, and represents the largest Topará tradition residential site ever discovered. Although Chongos was found by Wallace 50 years ago, it was not excavated until 20 years ago. Peters (1987/88, 1997, 2000) believes that at Chongos people from the Paracas and Topará traditions lived together, or at least closely interacted.

2.F: Excavations at Chongos

This section discusses the excavations at Chongos that yielded the skeletal collection I analyzed for this project. Therefore, I focus on the salvage excavation conducted in 1986 and 1987. Peters' 1985 preliminary excavation, Pezzia's excavations and Wallace's survey and surface collection will not be discussed.

The emphasis of the salvage excavation was to uncover specific sectors of the site that would reveal architectural and habitation patterns, as well as to gather chronological information and evidence of activity patterns (Peters 1987-88). The archaeologists provided detailed description on wall construction patterns and adobe shape (also described in Peters 1997). Another important result of the excavation was the creation of a complete map of the site, displaying the visible architectural remains at the site. The owners of the commercial pig farm also financed a phase of the excavation where diagonal trenches were dug in the site and a series of tombs were excavated (Peters n.d.). The excavations were in areas of the site in danger of being destroyed by the farm. Excavations were conducted in Sectors XIV, XVI, XVII, XVIII and XIX of the Chongos site. Burials were recovered from these sectors (Figure 2.1).

Though it was not possible to excavate in the entire site, mapping the site made it possible to differentiate the perimeter of the site and map the indoor (i.e., residential) and outdoor (i.e. public) spaces within the site. It also appears that the salvage excavation allowed the team to clearly define the extent of the Topará and Paracas components of the site, including the living floors, i.e. to determine if Topará was superimposed on top of Paracas or if they were contemporary. Peters states that Paracas and Topará materials are found to coexist during the Jahuay 3 phase of the Topará tradition (Table 2.2).

In some sectors of the site diagonal trenches were dug and excavations were conducted in interior structures and tombs. An attempt was made to define the use of public and residential space, including the cemeteries. However, the amount of actual excavation was limited, and there was almost no wall cleaning (Peters 1997). Peters (1987/88) also states that there was evidence of looting at the site.

The burials recovered at Chongos may or may not reflect a social community, meaning individuals from one place at one time. It is also possible, based on mortuary analysis, that the individuals came from a similar time period but different settlements of different communities (Peters 1997).

2.G: Strengths and Limitations of the Chongos Skeletal Sample

This section introduces the Chongos skeletal sample. I also detail the strengths of the sample. However, the sample has limitations associated with the collection and excavation methodology that I describe below.

The skeletal sample from Chongos that is presented in this analysis comes exclusively from the archaeological salvage excavation conducted in 1986 and 1987 (Peters 1987/88, 1997). All skeletal remains were analyzed, representing approximately 61 individuals. However, only undisturbed single burials are presented here, representing 50 individuals. This is because commingled remains could not be confidently separated by individual. Methods used to analyze the skeletal collection are presented in Chapter 3.

Preservation of the human remains excavated at Chongos ranges from fully mummified individuals to completely skeletonized remains. Some skeletal elements had sun and wind damage, as they were exposed to the elements for some time before excavation, presumably due to looting. All in all, preservation was excellent.

Any associated mortuary items that were included with the skeletal remains were recorded and inventoried. A basic description of each item was done, and photographs of the items were taken. However, these items were not systematically analyzed and thus will not be presented nor discussed here. Many of the textiles associated with the Chongos skeletal collection presented here were analyzed at a later date by experts in the textiles of the time and region. Though the analysis is complete, the results have yet to be published (Katterman personal communication 1/09/08; Wallace personal communication 2/10/08).

The greatest strength of the Chongos skeletal collection is the excellent preservation quality. The excellent preservation allowed for detailed macroscopic analysis of the entire skeleton, described in Chapter 3. The excellent preservation also allowed for the collection of skeletal samples, such as hair, fingernails and dental calculus, for chemical analysis.

2.G.1: Limitations

The limitations of the Chongos skeletal sample fall into one of two broad categories:

- limitations on the quality of the skeletal sample itself; and
- limitations based on excavation methodology implemented during the salvage excavation, including material that was collected

2.G.1.a: Sample quality

Many of the individuals analyzed did not have complete skeletons. Commonly missing skeletal elements include the skull, mandible, and bones of the hands and feet. It is unclear why these elements were not recovered during excavation, whether the elements were not present at all during excavation or if they simply were not recovered during excavation.

Many infants in the collection permitted little analysis. This is because the infants were excavated as complete burial bundles. The infants were wrapped in textiles before burial and after burial remained relatively undisturbed. In these instances, an estimation of age at death was completed when possible using the least invasive methods possible to not further disturb the bundle burial – dental eruption from any teeth that were easily viewable or limb bone length if a long bone was easily accessible without having to manipulate the textile. I was unable to access the infant materially fully without disturbing the funerary textile.

In some cases preservation can be too good. The analysis of many skeletal elements was not possible due to the presence of soft tissue through natural mummification. If soft tissue did not allow for macroscopic osteological investigation, a note was made in the data forms, and those parts that could be analyzed were. The same situation occurred for those individuals with hair. For those individuals with a full head of hair, the hair was not removed to allow for macroscopic osteological analysis of the skull. Removal of the tissue would be invasive and beyond the scope of the investigation.

The sample is relatively small, numbering 50 individuals presented in this study. The smaller numbers make population-based analyses, such as analyses of pathologies by sex and age group of limited statistical power. When I did separate the skeletal collection into groups, such as males and females who had a certain pathology, the numbers were very small. The small samples make it harder to recognize a pattern unless the effect is extremely robust.

2.G.1.b: Excavation methods and data collection

There is a general lack of contextual information regarding the Chongos skeletal collection. From the site maps and published accounts of the Chongos excavation, it is impossible to know the exact location of the individuals excavated at Chongos. We do know the sectors that were excavated, Sectors XIV, XVI, XVII, XVIII and XIX (Figure 2.1), but within those sectors do not know the locations of the burials. There are no excavation notes from Chongos curated at the Regional Museum in Ica with the excavated materials. The lack of contextual data makes it impossible to know if any patterns existed in burial strategy at Chongos. If a burial pattern could be discerned at Chongos, such as infants buried in one location, adult females in another, or all individuals buried in a non-systematic fashion, it would be possible to infer if the sample I analyzed for this study represented the larger burial collection. That is not the case.

The methodology used in skeletal excavation at Chongos was not published. Without this, it is impossible to know if the incomplete burials discussed above are the result of recovery techniques or taphonomic processes, although owing to the level of preservation, taphonomic factors seem unlikely.

The lack of contextual information makes it impossible to know if the Chongos skeletal collection is a representative sample of the living population at Chongos. This is, in part, because not all burials were excavated. Though we do know which sectors were excavated, portions of the site were not touched at all during excavation. Because of this, the potential of those parts of the site to produce skeletal remains has not been realized. It is also impossible from the site maps and published accounts to know the exact burial location of the individuals excavated at Chongos.

Because I am not confident the Chongos skeletal collection is a representative sample of the living population at Chongos, and owing to the small sample size, demographic characteristics of the Chongos skeletal sample will not be discussed in detail. Rather, skeletal data will be compared by sex and broad age groups, since bias towards these factors during excavation seems unlikely.

This limits the range of questions I can ask related to my stated hypothesis and research objectives. As discussed above, I am also limited in the types of analyses I can perform. Small samples make it difficult to recognize patterns unless the effect is extremely robust. If a pattern exists, I do not have sufficient sample size to investigate the limit to this pattern, for example by age, sex, or cranial deformation. Nonetheless, I am able to report some interesting individuals in a case-study format.

2.G.2: Summary

The Chongos skeletal collection has outstanding skeletal preservation, which allowed me to perform macroscopic analysis of all available skeletal elements. The quality of preservation also provided me with the opportunity to collect hair, nail, and dental calculus samples for analysis in the United States. The sample sizes were adequate for chemical and microscopic analyses.

Despite the excellent preservation, many individuals were not complete. Incomplete remains could result from collection or excavation methodology that didn’t emphasize collection of complete skeletal remains. The result of incomplete remains is that for each type of analysis conducted (see Chapter four), number of individuals analyzed, was different. It is possible for such analyses to inform on collection-wide phenomena but make comparison between any two individuals difficult.

2.H: Chapter Summary

In this chapter I provided background information to better understand the factors that influenced the individuals buried at Chongos. It is possible to describe the Chongos skeletal remains within a temporal context, with the individuals living around the EH/EIP transition. Peoples living at and near Chongos experienced a variety of micro-habitats within a small geographic area. They also lived in a well-watered river valley with the potential for irrigation agriculture dating back to the EH/EIP. The cultural affiliation of the people buried at Chongos is still not known. These individuals were likely associated with the Topará ceramic tradition, with the possibility of some people associating with the Paracas ceramic tradition. Peters (1997) believes people affiliated with the Topará and Paracas traditions lived together or nearby, so they could have shared the same cemetery.

The potential association of two or more different groups of people in such a small area, and indeed sharing a cemetery, presents intriguing economic and demographic questions. Trade networks likely existed at this time, but the exact nature of these relationships is unknown. Could the cemetery at Chongos contain individuals who engaged in very different economic and/or subsistence strategies? This is a question that even a small sample permits investigation.

The Chongos site was described, as was the excavation strategy. I concluded the chapter with a discussion of the skeletal sample from Chongos, detailed the strengths and limitations of the collection. With a better understanding of the context of the Chongos skeletal collection, I move on to the bioarchaeological methods employed in my analysis.

[1] – My understanding of the Chongos site and the history of archaeological exploration in the south central coast of Perú is greatly enhanced through numerous discussions with Dwight T. Wallace since 2000. Dr. Wallace brings a perspective that comes from a lifetime of working in the region, beginning in 1957.

Dr. Wallace was instrumental in defining the Topará ceramic tradition, and in understanding its role along the south central and central coast of Perú. However, not all of his data have been published, and some important reports, though unpublished, were widely distributed in Perú but not elsewhere. After his initial work with Lanning in defining the Topará ceramic tradition, professional duties and other research interests took him away from Topará related research for several years. He returned to the topic of Topará in print in 1985.

CHAPTER 3: METHODS

3.A: Introduction

This chapter discusses the methods I used to analyze the skeletal remains from Chongos. I also present methods for two additional types of analyses that were conducted on samples I collected in Peru and will present in Chapter four – phytoliths from dental calculus and mineral and stable isotope analysis of human hair.

All skeletal remains were investigated using traditional standards in skeletal analysis (Buikstra and Ubelaker 1994). Additional methods are described that supplement and/or provide additional accuracy in analyzing the skeletal remains.

Age and sex estimation were calculated using all available macroscopic methods. To estimate biological sex, when the elements were available, I analyzed the os coxae, crania, mandible, femoral head and general robusticity of the skeleton. Age estimation was performed using sternal rib end morphology, pubic symphyseal face, auricular surface of the os coxae, and dental attrition (Bass 1996; Buikstra and Ubelaker 1994; Iscan and Loth 1986a, b; Loth and Iscan 1989; Lovejoy et al. 1985a, 1985b; Meindl and Lovejoy 1985; Mensforth and Lovejoy 1985). Though endocranial and ectocranial suture closure data were collected, they were not used in the final age-at-death estimation. Age estimation will be discussed in more detail below. Both metric and nonmetric data were collected from the skeletal material to estimate diet, health, stress and injury (Bass 1996; Buikstra and Ubelaker 1994; Ortner and Putschar 1985; White 1991). The methods of data collection are described in more detail below.

3.B: Inventory

Over the course of three laboratory seasons in 1999, 2000 and 2001, approximately 61 individuals were examined macroscopically at the regional museum in Ica, Perú. Before beginning my analysis, each individual was laid out in anatomical position. All of the human remains were cleaned when necessary, using brushes and dental instruments to remove dust, dirt, salt or other deposits. The state of preservation of each skeleton was recorded, documenting if any soft tissue remains or hair was present, as well as the type and state of preservation of any funerary items.

Each individual skeleton was curated in one or more boxes, stored on shelves in the depository in the regional museum in Ica, Perú. In some cases skeletal elements were placed in padded manilla envelopes. Some remains were commingled. Many individuals had one or more funerary items included, such as food remains, gourds and/or ceramics. Textile remains were also common, as tradition at this time and place was for the dead to be buried in at least one wrapping (Peters 1997; Proulx 2008). The burials had no supporting documentation other than a burial number. The burial number was presumably associated with the sector of the site from which it was excavated, but the exact location of the burial at the site is unknown. When I refer to an individual I will refer to that person by their burial number, such as BP1820 burial 1.

Once the individual was cleaned and in anatomical position, a skeletal inventory of each individual was taken. Each skeletal element was scored as: 1 = complete, 2 = 75% ≤ 25% complete, 3 = < 25% complete, or blank = absent. The larger bones of the feet, calcaneus and talus, were recorded as individual bones. The remaining tarsals were inventoried together. Thus, if all remaining tarsals were present, I scored a ‘1’. However, if one or more of the tarsals were missing, a ‘2’ or ‘3’ was recorded. This inventory method was employed for the metatarsals and phalanges of the feet, and the carpals, metacarpals and phalanges of the hands. All bilateral skeletal elements were sided and inventoried by side. The skeletal inventory form had a comments section where I was able to record items such as state of preservation, individual skeletal elements that were missing (such as tarsals or carpals), robusticity of the skeleton, and genetic anomalies. Appendix 1 contains copies of the skeletal analysis forms I used.

The dentition was inventoried and each tooth was coded as follows: 1) present, but not in occlusion, 2) present, 3) missing with no associated alveolar bone, 4) premortem loss, 5) postmortem loss, 6) missing, congenital absence, or 7) present but damaged. For subadults who had a mix of permanent and deciduous dentition, an inventory of all observable dentition was recorded. For these individuals, deciduous dentition that was not present was not coded as missing. I simply coded the deciduous dentition that were present, and used the inventory coding procedures for the permanent dentition.

Each skeleton was examined individually, with all data collection completed before passing to another skeleton. After the skeletal inventory was taken, an estimation of sex and age at death was made. In this chapter, I describe the method to estimate sex (section 3.C). Next, each bone was analyzed macroscopically for pathology, trauma, and evidence of disease or stress. If the individual had artificial cranial deformation, the type of deformation was described, coded, drawn and photographed. All pathologies and skeletal anomalies were photographed using standard 35 mm photography. Congenital anomalies were also recorded and described. Once the analysis was completed, the skeleton was curated to facilitate long-term storage, with each skeletal element cleaned, dried, and packed in such a way as to protect against breakage, mold or any other environmentally-related damage. Each element or group of elements (right hand, for example) was placed in an individual plastic bag to protect the bones from the elements and reduce handling in subsequent analyses. A label was placed in each bag identifying the element or group of elements. The complete remains of the individual were stored in one box that was labeled with a unique identifier based on the burial number. There were two exceptions to this system. The first was if natural mummification made it impossible for the skeletal remains to be placed in only one box. In this case, each box was labeled with the unique identifier noting how many boxes were needed to store the entire skeleton (box 1 of 2, for example). Second, if a burial yielded commingled remains all elements were curated in the same box even if more than one individual was represented. If the commingled remains were unable to be differentiated by individual skeleton, they were curated by element, not individual. No results from commingled remains are presented in this study. Using these criteria for inclusion in the final sample, data are presented on 50 individuals.

3.C: Estimation of Sex

3.C.1: Adults

The skeletal element most commonly used to estimate sex on an adult skeleton is the pelvis. The morphology of the pelvis is different for men and women. While the male pelvis is adapted for locomotion, the female pelvis is adapted for locomotion and parturition. These differences make the pelvis the most accurate skeletal element used for sex estimation (Meindl et al. 1985; Phenice 1969; White 1991).

A complete pelvic girdle, composed of right and left os coxae and sacrum, contains several morphological differences between men and women that can be analyzed to estimate the sex of a skeleton. Though it is possible to use just one trait to estimate sex, accuracy in sex estimation increases as more morphological characteristics are analyzed (McBride et al. 2001).

It is also important to analyze dimorphic differences between males and females, especially as it relates to the skeletal collection being studied. The skull is a very useful element to estimate sex. Differences in the adult skull are based on sexual dimorphism and robusticity, with males having larger and more robust features (Bass 1996; Buikstra and Ubelaker 1994; White 1991). General robusticity of the post-cranial skeletal was also analyzed to estimate sex, with males generally being larger and more robust than females.

At Chongos males and females could usually be distinguished from one another based on skeletal robusticity. However, as a skeletal population the Chongos individuals are small in comparison with those described by Bass (1996). For measures such as the size of the femoral and humeral head, classic males from Chongos, based on morphology of the pelvic girdle and skull, were the same size as females described by Bass.

Sex estimates based on results from the pelvis, skull and skeletal robusticity were scored as: indeterminate sex, female, probable female, probable male, and male.

While all morphological features that were available were investigated, particular attention was paid to those features highlighted in standards (Buikstra and Ubelaker 1994). On the os coxa these features included the ventral arc, subpubic concavity and ischiopubic ramus ridge on the pubic bone, shape of the greater sciatic notch, and the preauricular sulcus. On the skull, these features included the nuchal crest, mastoid process, supra-orbital margin, supra-orbital ridge, and mental eminence on the mandible. In addition to those features, I also analyzed the sacrum, head of the femur and humerus, and overall bone robusticity.

3.C.2: Subadults

Sex is not usually estimated for subadults until the individual reached puberty (although see Benfer and Pechenkina [1998] and Sutter [2003] for methods being developed for this purpose). Puberty is when differences in bone size and robusticity reappear between males and females after an earlier expression in very young children. For adolescents, I attempted to estimate sex using the same methods that I used to estimate sex for adults. However, if sex was indeterminate based on these methods, a label of 'indeterminate sex' was used. In general, I looked for the presence of 'classic' features of a female or male. If an adolescent displayed one or more of these classic features, a sex estimate was given. For example, if an individual showed very strong morphological changes in the os coxae during adolescence, they could confidently be coded as a female. For adolescent males, coding of sex was based more on sexual dimorphism and skeletal robusticity. The youngest individual with a sex estimation was DE100-120, a probable female estimated to have died between the ages of 12 and 13.

3.D: Age at death estimation

3.D.1: Adults

Age estimation was performed using sternal rib end morphology, pubic symphyseal face, auricular surface of the os coxae, and dental attrition (Bass 1996; Buikstra and Ubelaker 1994; Iscan and Loth 1986a, b; Loth and Iscan 1989; Lovejoy et al. 1985a, b; Lovejoy et al. 1997; Meindl and Lovejoy 1985; Mensforth and Lovejoy 1985). For young adults, epiphyseal suture closure was analyzed for those elements that normally close during late adolescence or early adulthood, such as in the medial clavicle, the iliac crest of the os coxae, the sacrum, and the spheno-occipital synchondrosis (Buikstra and Ubelaker 1994, Ubelaker 1989; White 1991).

Most investigators emphasize the need to use multiple age estimation techniques rather than just one to improve accuracy (e.g. Buikstra and Ubelaker 1994; Mensforth and Lovejoy 1985; White 1991). Thus, all available age estimation techniques were used on each individual. Although I did score endocranial and ectocranial suture closure, these results were not used in my estimates of age at death. This is because most residents of Chongos were subjected to artificial cranial deformation, which likely affected the rate and location of cranial suture closure. After sex, age is the other most important variable in population structure.

All methods for estimating age at death from human skeletal remains rely on consistent morphological changes of the skeleton. These methods display greater accuracy among younger adults, with age ranges increasing later in life, and the accuracy of those age ranges decreasing. In fact, none of the macroscopic or microscopic methods of aging are useful beyond the 60s. For older individuals in the Chongos sample, they were only given a lower age boundary, such as 55+. Because of these methodological limitations, the age estimates of the oldest individuals may be flawed (Jacks 2000; Meindl and Russell 1998; Boquet-Appel and Masset 1982). However, since relatively few older adults survive, the percentage of this age is quite small. Benfer showed that even adding 15 years to the estimates of the 55+ group did not change demographic parameters significantly (Benfer 1990), so the criticism is not of great importance in bioarchaeology.

3.D.2: Subadults

The estimation of age at death for subadults used different methodology than I used for determining age at death for adults, with the exception of epiphyseal union. When visible, stages of epiphyseal union were recorded for all relevant bones (Buikstra and Ubelaker 1994; Lampl and Johnston 1996; White 1991; Ubelaker 1989). Depending on the bone and the stage of epiphyseal union (unobservable, open, partial union, complete union), it was possible to differentiate between younger adults and older individuals. For example, the epiphysis of the clavicle or the iliac crest of the os coxa fuses during adolescence or early adulthood. Most epiphyseal sutures are in complete union by about age 20.

The most common method used to estimate age at death for subadults is to assess dental development (Buikstra and Ubelaker 1994; White 1991; Lampl and Johnston 1996; Ubelaker 1989). This method tracks dental development from the time of crown mineralization in utero until the third molar has erupted. However, using macroscopic analysis I was not able to check for dental development until the first deciduous incisors erupted, at about six months of age. When the subadult was quite young at the time of death, younger than about age two, deciduous dental eruption and/or limb bone length were used to estimate age at death (Bass 1996; Buikstra and Ubelaker 1994; Ubelaker 1989). Limb bone lengths were taken using Mitituyo digital calipers, spreading calipers, or with an osteometric board if the bone was longer than 30cm.

3.E: Trauma

Trauma occurs when the body is exposed to an external shock, resulting in sudden physical injury. There are several types of trauma, ranging from accidental fractures to dislocations to violence to trephanation (Merbs 1989; Ortner 2003; Ortner and Putschar 1985; Steinbock 1976). The presence of trauma on skeletal remains can inform investigators on occupational hazards, societal conflict, or even for medical matters, as in the case of trephanation (Weis 1953).

All skeletal elements were analyzed macroscopically for evidence of trauma. If evidence of trauma was found, the location was identified and recorded, such as bone, side of the body, and aspect (proximal or distal, medial or lateral). I also recorded if the type of trauma could be identified, and if it was a fracture, the type of fracture, such as a depression, greenstick or radiating fracture. If any signs of healing were identified, such as bone remodeling, the trauma was coded as having occurred antemortem (Buikstra and Ubelaker 1994; Merbs 1989; Ortner and Putschar 1985). Finally, any additional complications associated with the antemortem break were recorded, such as arthritis, lesions, or loss of range of motion. Trauma that occurred at or near the time of death (perimortem) were identified by ‘clean’ breaks with no evidence of bone healing or remodeling. With perimortem fracture, it is also possible to have bone fragments break away from the bone from the impact on the bone, such as with a depression fracture (Buikstra and Ubelaker 1994; Ortner and Putschar 1985). Postmortem trauma is differentiated from perimortem trauma through examination of the surface of the broken fragments and the coloration of the bones involved. Postmortem trauma results in lighter coloration along the affected areas. In addition, postmortem breaks are often characterized by snap breaks or breaks at right or sharp angles (Buikstra and Ubelaker 1994; Ortner and Putschar 1985).

3.F: Dental Health

Dental health provides many avenues for estimating the health and lifestyle of an individual and population. Dental abcesses and carious lesions can inform on diet, and enamel hypoplasias inform on episodes of stress, especially molecular or dietary stress (Hillson 1996, 2000; Larsen 1997; Ortner 2003; Turner 1979). Furthermore, poor dental health can lead to dental infection, and severe cases can cause systemic problems, contributing to a general deterioration in overall health (Powell 1985), leading to death. Dental calculus provides another mechanism to estimate diet, but also has the capability to inform on occupation. The following section describes the methods used to estimate the dental health of the Chongos skeletal population.

3.F.1: Caries

Dental caries represent a disease process resulting from *Streptoccus mutans* (Loesche 1986) invading the oral cavity and demineralizing the hard tissues of the tooth (Larsen 1997). The result of demineralization is a lesion on the tooth – the product of the caries disease process. Caries can range from slight lesions creating opacities on dental enamel to large cavities destroying large portions of the tooth crown or root (Larsen 1997).

Dental caries usually form due to the dietary presence of carbohydrates, especially sugars (Larsen 1997). Therefore, the presence of caries in the archaeological record provides strong evidence for the presence of carbohydrates in the diet. If an individual has a number of caries, it can be hypothesized that that person had a diet high in carbohydrates. If a skeletal population has a very high caries rate, it can be hypothesized that carbohydrates made up a major component of that population's diet.

There are many factors in the environment that can affect caries frequency among humans. Positive factors include mineral content of soil and water, such as fluoride that can provide protective effects against the development of caries and cultural practices, such as cleaning. Negative factors could be the presence of abrasive substances in foods, such as sand (Larsen 1997; Powell 1985). However, abrasive materials, while causing rapid wear, also can remove the occlusal surface faster than caries can form there (Maat and Van der Velde 1987).

Other factors that can affect caries formation and prevalence besides diet and mineral content of water include oral hygiene, dental wear, tooth morphology, enamel strength, food preparation habits, oral habits not related to food consumption such as using teeth for tools, and individual salivary chemistry (Larsen 1997; Powell 1985). Developmental defects in enamel, such as with enamel hypoplasias (described below) provide opportunities for caries development, as the weakened enamel is more vulnerable to caries-creating microorganisms (Hillson 1996).

Caries development requires progressive demineralization. It takes time for the hard tissue on a tooth to become demineralized through continual exposure to invading microorganisms (Larsen 1997). Thus, caries rates should increase with age – on average, older people should have more caries than younger people, if caries proceeds faster than wear. In addition, in clinical studies females usually have higher frequencies of caries than males (Larsen 1997; Reich et al. 1999). These findings raise questions regarding causation that would lead to differential caries risk between men and women. Possibilities include differences in diet, oral hygiene, occupational activities that utilization the dentition, status, or perhaps even biological differences between men and women such as larger tooth size in males. This topic will be discussed in Chapter 5.

Carious lesions were recorded based on standard procedures (Buikstra and Ubelaker 1994) as follows:

0 = No Lesion Present

1 = Occlusal Surface

2 = Interproximal Surface

3 = Smooth Surfaces

4 = Cervical Caries

5 = Root Caries

6 = Large Caries

7 = Noncarious Pulp Exposure (not counted in caries rate)

If more than one caries was located on a single tooth, the number of caries and their locations were noted. Each tooth with caries was counted for the overall caries rate of the individual and population.

Caries rates were determined by adding all of the analyzed teeth and dividing by the total number of teeth with caries. Caries rates were determined in this way for individuals, groups (e.g. males and females), and the entire skeletal population. Antemortem tooth loss was not considered in the analysis although they were probably lost related to caries or other disease factors, nor were teeth lost postmortem (Schollmeyer and Turner 2004).

3.F.2: Abscesses

The *Streptococcus mutans* bacteria from a caries (or some other type of bacteria) can penetrate the pulp cavity and cause an infection. In extreme cases, the pressure from the pus in the infected pulp cavity can cause breakage in the alveolar bone, providing a place for the pus to drain. The location of this alveolar bone breakage is called an abscess, and is usually located near the tooth root apices (Ortner and Putschar 1985; White 1991). Abscesses are life-threatening in the maxilla since the infection can penetrate the neural cavity.

Abscesses were identified by the presence of a drainage passage in the alveolar bone of the mandible or maxilla. Each tooth socket was analyzed for presence of abscesses, regardless of tooth loss. In fact, an abscess would facilitate antemortem tooth loss (Ortner and Putschar 1985). The presence and location of abscesses were scored based on standards (Buikstra and Ubelaker 1994). Abscess rates were determined by individual, group and the entire skeletal population.

3.F.3: Enamel Hypoplasia

Enamel hypoplasias are enamel defects that occur during tooth development, specifically tooth crown mineralization. This defect leads to a reduction in enamel thickness at the location of the hypoplasia, taking the form of grooves or pits (Buikstra and Ubelaker 1994; Goodman and Rose 1990; Larsen 1997). Hypoplasias can be caused by three phenomena: systemic metabolic stress, hereditary anomalies, and localized trauma (Buikstra and Ubelaker 1994; Goodman and Rose 1991; Goodman et al. 1984). The majority of the hypoplasias identified in the archaeological record reflect systemic metabolic stress (Larsen 1997). Hereditary anomalies fixed in a relatively inbred population should be found in all dentitions, while localized trauma should only affect one or two teeth, those directly impacted by the trauma. Hypoplasias caused by systematic metabolic stress will manifest on all teeth that were undergoing enamel formation at the time of the metabolic stress (Buikstra and Ubelaker 1994; Sarnat and Schour 1941).

The presence of enamel hypoplasias can represent specific events in the health of an individual. Since the development of enamel in permanent dentition follows a specific developmental course, it is possible to determine from the presence of enamel hypoplasias at the specific time period in which the stress took place in the individual. This time period is often during the period of weaning (Goodman et al. 1991), though it may also occur during the time after weaning took place, while a child was adjusting to a food-based diet (Blakey et al. 1994). If the individual underwent two or more serious events, it is possible for there to be multiple hypoplasias on a single tooth.

All permanent dentition was investigated for the presence of enamel hypoplasias, though enamel hypoplasias are most visible on the incisors and canines. Therefore, the anterior teeth provide the best representation of metabolic stress (Hillson 1996; Larsen 1997). However, differential preservation, archaeological recovery and postmortem tooth loss may lead to difficulty of observation of enamel hypoplasias among individuals and skeletal samples. Enamel hypoplasias were coded as follows, based on Buikstra and Ubelaker (1994):

0= absence;

1= linear horizontal grooves

2= linear vertical grooves

3= linear horizontal pits

4= nonlinear arrays of pits

5= single pits.

3.F.4: Dental Calculus

Dental calculus (tartar) results from the mineralization of dental plaque. It is formed by the deposition of layers of protein on teeth. The protein layer is colonized by various species of bacteria, which excrete compounds that, when combined with saliva, harden the protein layers into calculus, trapping all materials into this hardened matrix. In addition to protein, the protein matrix traps food particles and living and dead microorganisms (Ortner and Putschar 1985). Dental calculus was coded according to standard procedures (Buikstra and Ubelaker 1994) as follows:

0 = absent

1 = small amount

2 = moderate amount

3 = large amount

9 = unobservable

In addition to coding the amount of calculus present, I also coded which side of the tooth the calculus was on, buccal/labial or lingual.

Dental calculus is a useful analytic tool for the reconstruction of diet. Not only does calculus contain food remains and other particles that were in the mouth of an individual, the deposition of protein is evidence of a diet high in protein (Goodman and Armelagos 1984). The greater the amount of calculus present, the greater the estimated reliance on protein in the diet. When there was enough calculus for collection, I scraped off the calculus using a dental tool, and stored the calculus in a sterile plastic bag until it was processed at the University of Missouri. After processing, the samples were observed under a microscope for plant phytoliths, starch grains and any other remains that would inform on the diet of the individual. The methodology for processing the calculus samples at the University of Missouri is detailed below.

Armitage (1975) published the first paper on extracting phytoliths from dental calculus on ungulate teeth recovered from an archaeological site. However, while methods have been refined since that time, it was not until the 1990s that researchers began to investigate dental calculus from bioarchaeological remains to reconstruct diet. In addition, all of the work with dental calculus was for phytolith analysis, with no attempt to recover starch grains.

Phytoliths are microscopic silica bodies which form in the cells and cell walls of stems, leaves, reproductive parts, and underground parts of plants, as a result of absorption of soluble silica present in ground water (Pearsall 2000; Piperno 1988, 2006). The silica solidifies into forms whose shape conforms to that of the host cell. The various shapes taken by phytoliths are often diagnostic of specific taxonomic groupings of plants such as families, genera, or species.

For this study calculus samples from 14 individuals were analyzed. The samples were processed by Karol Chandler-Ezell at the paleoethnobotany laboratory at the University of Missouri. Sample processing initially consisted of a three-day methodology, which was later adjusted. A brief summary is presented below. The complete methodology is presented in Appendix B.

A processing procedure was designed to avoid damage to starch grains that may have been stuck in the calculus matrix. Initially the samples were rinsed in distilled water and sonicated to “break up the matrix”, centrifuged, pipetted, and had dilute HCl added to react with the sample. The sample was rinsed with distilled water, pipetted, and allowed to dry through evaporation. After this initial process, the calculus had not completely dissolved. All samples had 10% HCl added for four days, rinsed twice, then treated with 27% H_2O_2 for 24 hours, then rinsed to remove all of the H_2O_2.

The slides were mounted in a 100% glycerol solution, two drops of glycerol to 45 microliters of extract. Once mixed it was covered with a cover slip and sealed with fingernail polish to keep the mixture from leaking.

Chandler-Ezell and I performed full scans of the slides. Each full row of the slide was scanned. All items seen on the slide were counted and described. Items were identified to the finest taxonomic class possible (Dietz et al. 2003a, b).

3.G: Stature

The measure of stature is an important variable in the comprehensive evaluation of health (Larsen 1997, Steckel and Rose 2002; Steckel et al. 2002a, b). Larsen (1997) clearly describes the strong association between stress and stature, with environmental factors the major variable in stature variability among recent historical populations. Basically, individuals with poor nutrition and/or disease do not reach their genetic growth potential. Numerous research projects (i.e. Cohen and Armelagos 1984; Lambert 1993; Pechenkina et al. 2007; Steckel and Rose 2002; Ubelaker 1994) show that a byproduct of the adoption of agriculture as a subsistence strategy, especially with maize as a staple dietary component, is a decrease in realized adult stature. This is due at least in part to the poor nutritional quality of maize and other domesticated plants when compared to the broad-spectrum diet of earlier foraging populations (Huss-Ashmore et al. 1982; Larsen 1997). Poor quality of diet associated with agriculture can lead to chronic malnutrition, leading to shorter stature of agricultural populations when compared to foragers from the same geographic region (Pechenkina et al. 2007; Ubelaker 1994). In the case of disease, an individual must divert resources to fight off the disease that would have otherwise been used for growth. Poor nutrition and disease often work synergistically, with malnutrition making a person more susceptible to disease, or illness impacting a person's ability to adequately ingest or process adequate nutrients (e.g. Steckel et al. 2002a).

The measurement of adult stature can provide a measure of stress, as growth disruptions will prevent an individual from realizing genetic growth potential. A population that was shorter in comparison to other populations could be considered to be under stress (i.e. Steckel and Rose 2002). All long bones were measured with an osteometric board. When available, the femur was used, as this is the most reliable bone for estimates of stature (Krogman and Iscan 1986; Trotter 1970). Data will also be presented for the tibia and humerus. When the femur was not available, stature was estimated using the tibia and/or humerus. Comparisons of stature across populations or by sex are conservative, since variance is reduced by using regression formulas (Benfer 1997; Pechenkina et al. 2007).

3.H: Skeletal Pathology: Indicators of Stress and Disease

This section describes the methods of analysis of skeletal elements for the presence of lesions indicating illness, disease, injury or other nonspecific indicators of stress (NSIS). All lesions were recorded and photographed following standard methods (Buikstra and Ubelaker 1994). The location of the lesion, type of lesion (when possible), extent, severity, and level of healing were recorded. Pathologies were coded and recorded in narrative form. Genetic anomalies were also recorded, described and photographed when discovered.

3.H.1: Porotic Hyperostosis/Cribra Orbitalia

Porotic hyperostosis (PH) and cribra orbitalia (CO) refer to skeletal lesions apparent on the cranial vault bones (PH) and the roofs of the eye orbits (CO) (Stuart-Macadam 1987, 1989, 1992). These lesions could result from iron-deficiency anemia (Huss-Ashmore et al. 1982; Stuart-Macadam 1988; Stuart-

Macadam and Kent 1992); however, other factors, such as intestinal parasites, malaria, and infectious disease, can cause these characteristic lesions (Angel 1966; Mensforth et al. 1978). Artificial cranial deformation can also cause porotic hyperostosis, especially along pressure points (Aufderheide and Rodriguez-Martin 1998). The severity and extent of the lesions can often determine if the lesions were due to hemolytic anemia or nutritional anemia (Goodman and Martin 2002). However, it is argued that most cases of anemia in the New World were the result of iron deficiency, not congenital anemia (Benfer 1990; Blom et al. 2005; Schultz et al. 2001). In the Andean region, a high population prevalence of PH or CO may be associated with environmental stressors, such as parasites or infectious disease (Blom et al. 2005), or environmental events, such as El Niño (Farnum 2002). In this study, lesions of porotic hyperostosis and cribra orbitalia were scored according to their location, severity, and the amount of osseous remodeling.

Lesions of the orbits, the frontal, parietal, temporal, and occipital bones were described and coded according to the various degrees of expression based on standard coding methods (Buikstra and Ubelaker 1994). The severity of the lesions were noted, and the lesions were scored on a continuum of active lesions at time of death to completely healed at time of death. An attempt to link the lesions with a specific disease diagnosis such as anemia was not made; rather, lesions were interpreted as an indication of stress on the individual.

3.H.2: Skeletal Lesions

Infectious disease is one of the major causes of human mortality in antiquity. It is likely that infectious disease and diarrhea were the greatest causes of infant and child mortality (Grauer and Stuart-Macadam 1998). However, most of the people inflicted with infections will not have evidence of their disease recorded on their skeletons (see Chapter 5 for discussion of this topic). When infection is chronic, it can affect bone. The bone responds to the infectious disease by proliferation or formation, or by bone resorption or destruction (Ortner 2003; Ortner and Putschar 1985). Depending on the type of infection, the bone can be affected on the bone surface (periostitus) or as osteitus or osteomalecia deep in the inner surface of the bone (Ortner 2003). Lesions on bone can result from smaller, isolated events, or from more systemic or generalized disease. However, trauma or some other insult can also lead to bone lesions if bacteria penetrate the skin, especially on bones such as the tibia that are near the skin and don't have protection from fat and muscle (Ortner 2003).

The frequency of periosteal lesions is often employed in studies of health in antiquity as measures of morbidity, but the overall prevalence of infections in prehistoric samples of human remains still requires careful paleopathological study (e.g. Wood et al. 1992). Some studies have maintained that an increase in the frequency of periosteal reactions is associated with an increase in the stress experienced by prehistoric populations (Larsen 1997; Powell 1988). In Perú, adult systemic lesions increased dramatically after the Late Preceramic and peaked in the Initial Period, then declined in the Early Intermediate Period (Vradenburg 2001).

All visible bones were examined for evidence of skeletal lesions, though particular attention was given to the tibia as it is the most common site of infectious lesions (Ortner 2003). The location, severity, size, and level of 'healing' for each lesion was noted. Bilateral presence of equally expressed periosteal lesions is usually taken as indicative of systemic infection, possibly a trepenome (Vradenberg 2001).

3.H.3: Degenerative Joint Disease

Degenerative joint disease (DJD) was identified by the presence of a breakdown of bone or osteophytic activity and marginal lipping on the articular surfaces of bones and joints (Buikstra and Ubelaker 1994; Ortner and Putschar 1985; Roberts and Manchester 1995; Steinbock 1976). All visible bones were analyzed for degenerative joint disease, including all bones of the hands and feet, according to standard methods (Buikstra and Ubelaker 1994). The side and joint location were identified and recorded. The severity of DJD was recorded and described, as was the type of DJD, such as marginal lipping, joint erosion, pitting and porosity or eburnation. For all paired skeletal elements, such as femurs, I recorded DJD for each element. This allowed for potential interpretation of preference in using one skeletal element (handedness, for example) in repetitive activities. For the vertebrae, the location by vertebrae and aspect (superior vertebral rim, inferior vertebral rim) of osteophytosis was recorded in the paleopathology narrative. The severity of vertebral osteophytosis, in the form of elevated rims, curved spicules, or fusion, was also noted. In severe cases osteophytosis led to fusion of the vertebral column, such as ankylosing spondylysis, and was specifically noted, described, and photographed.

3.H.4: Schmorl's Nodes

According to Larsen (1997), Schmorl's nodes are pronounced indentations on the top and bottom surfaces of the vertebral body, expecially frequent in the lower vertebrae (see also Schmorl and Junghanns 1971). These depressions develop when the cartilagenous discs separating the vertebrae rupture due to pressures on the back, usually from heavy mechanical loads on the back from heavy lifting and carrying (Larsen 1997). Schmorl's nodes are also associated with other occupational activities with extended episodes of bouncing, such as riding on horseback or on a snowmobile (Capasso, Kennedy and Wilczak 1999). In this study all vertebral bodies were analyzed for presence of Schmorl's nodes. If present, the affected vertebra was recorded, as was the location (superior vs. inferior).

3.H.5: External Auditory Exostoses

External auditory exostoses (EAE) are bony growths within the auditory meatus that can appear as irregular bony masses, sessile or pedunculate (Capasso, Kennedy and Wilczak 1999), although even among divers, the penetrance of this trait is low. In extreme cases they can cover the whole auditory canal, likely affecting hearing (Ortner 2003). External auditory exostoses are associated with habitual diving, especially in cold water (Okumura et al. 2007; Standen et al 1997). All individuals over about age 13 at time of death were examined for evidence of external auditory exostoses. If an EAE was detected, which meatus was noted (right or left side), as was the location and size of the EAE on the meatus.

CHAPTER 4: RESULTS

This chapter presents results of the within-site section of the test of the principal hypothesis. Comparative data will be introduced in Chapter 5. Each topic will be presented in its own section. Results will be discussed in Chapter 5 and used to discuss the hypothesis, goals and objectives outlined in Chapter 1.

Each topic for which I present results will have its own sample size. This is due to the variable nature of skeletal preservation, archaeological recovery of human skeletal remains, and mortuary practices of how people at Chongos buried their dead. For example, if an analyzed skeleton did not have a skull, it obviously was not possible to analyze that individual for any aspect of dental health, cribra orbitalia or porotic hyperostosis. Further, individuals which had most skeletal elements naturally mummified did not permit extensive analysis.

4.A: Cross Tabulations

Where possible, the data in Chapter 4 will be presented in aggregate, providing population-level prevalence for all topics described above. Comparisons by age and sex will be presented. In Chapter 5, I will compare my results to results from sites along coastal Perú, some of which are contemporary with Chongos. Sites were selected based either on their geographic or temporal proximity to Chongos. Unfortunately, comparative sites are not available from the Pisco River valley, or even the adjacent river valleys dating to the EH/EIP. Thus, comparison groups that have been systematically examined following established standards (Buikstra and Ubelaker 1994) will come from the central coast of Peru and the Nazca region of the south coast of Peru. Each comparison site will be described in Chapter 5. Statistical comparisons are done using Chi-square, Fisher's Exact test and t-tests.

4.B: Population Structure

Of the 50 individuals presented in this analysis, 29 were old enough and had a complete enough skeleton for adult sex estimation. The other 21 individuals were subadults age nine or younger at their time of death and their sex was not estimated. Of the 29, 15 were males and 14 were females. The mean age at death of the Chongos skeleton collection is 18.3 years. Table 4.1 shows the distribution of individuals by age and sex. For each individual, the midpoint of their estimated age-at-death was used for placement in the table. For example, an individual with an estimated age-at-death of 25-30 is assigned a midpoint of 27.5 years. This method will be used throughout this chapter for presentation and analyses of results by age. Differences by age and/or sex for any topic will be presented below and discussed in greater detail in Chapter 5. The percentage of subadults, 42%, is typical for skeletal collections with good preservation.

Table 4.1: Age and Sex Distribution of Chongos Skeletal Material

Age	Male (n[1])	Female (n)	Subadults (n)	Total
0-10	N/A	N/A	21	21
11-19	4	4		8
20-29	4	4		8
30-39	4	2		6
40-49	0	3		3
50+	3	1		4

[1] n = number of individuals represented

4.C: Trauma

All adults and subadults were examined for evidence of skeletal trauma. Not all skeletal elements were analyzable due to the presence of soft tissue. For those individuals with soft tissue remains, rather than coding for an absence of trauma, the skeletal elements covered with hair and/or soft tissue were coded as N/A, not applicable. This is because I was not able to accurately estimate the presence or absence of trauma using macroscopic methods (visual observation), and radiographic investigation of the skeletal elements was beyond the scope of this project.

Skeletal trauma affected 13 skeletal elements of 50 individuals available for study, mostly in the form of fractures. The skeletal elements with evidence of trauma, the type of trauma observed, and the most common skeletal elements involved are presented in table 4.2.

Twelve individuals had evidence of trauma. Specifically, six males, four females, one child and one infant had evidence of trauma (table 4.3). Four of the 12 individuals had trauma that was unhealed, with one of the four having one type of trauma that was unhealed and one type that was healed (BP1820 burial

1, a 50-60 year-old male with healed fractured ribs and unhealed cuts on the parietal and frontal). The most affected skeletal element was the ribs, with four individuals having at least one rib fractured. Ten percent of the individuals had fractures involving the arm or hand. Otherwise, trauma affected only one or two individuals at each skeletal element.

Table 4.2: Inventory of Skeletal Elements Affected by Trauma

Skeletal Element	Type of Trauma	Healed (Y/N)	Total by sex and age
Frontal	Cut	N	Male – 17-19 Male – 50-60
Parietal	Cut	N	Male – 50-60
Crania	Greenstick Fracture	N	Subadult – 1-2
Mandible (right)	Fracture	N	Subadult – 4-5
Cervical Vertebrae	Fracture	Y	Male – 25-30
L5/S1	Fracture	Y	Male – 25-30
Ribs	Fracture	Y	Female – 45-55 Female – 25-30 Male – 50-60 Male – 25-30
Humerus (right)	Fracture	Y	Female – 30-39
Ulna (right)	Fracture	Y	Male – 25-30
Radius (right)	Fracture	Y	Male – 25-30
Elbow – healing made it impossible to know which bone(s) were initially affected	Unknown	Y – range of motion severely affected	Male – 50-55
3rd metacarpal	Fracture	Y	Male – 17-19 Male – 30-35
Phalanges (feet)	Fracture	Y	Female – 40-50 Male – 20-24

I used a Fisher's Exact test to determine if there was variation by sex in the number of individuals who had evidence of trauma. There is no statistically significant difference by sex at Chongos in the number of individuals having trauma ($p = 0.7$). This means the risk or likelihood of having trauma was not significantly higher for males or females living at Chongos, although males exhibited trauma more often.

Table 4.3: Percentage of individuals with Trauma to One or More Skeletal Element

Males	Females	Subadults
40% (6 of 15 males)	28.6% (4 of 14 females)	9.5% (2 of 21 subadults)

Both subadults with trauma presented with unhealed trauma. The child, BW 1500 burial 11, aged 4 to 5 at the time of death, had a fractured right mandible. This fracture likely was related the main cause of his or her death. The complete skeletal analysis of this child will be discussed in greater detail in Chapter 5.

The greenstick fracture of the cranium occurred in an infant, BW 1500 burial 10, aged 1 to 2 at the time of death. It is possible that this fracture was associated with active cranial deformation, the pressure applied to the skull in the deformation process causing the fracture.

4.D: Dental Health

As stated in Chapter 3, all dental health data presented are based on permanent dentition. For those individuals with mixed dentition, meaning they had some deciduous and permanent dentition, only the permanent dentition and tooth crypts associated with permanent dentition were used in this analysis.

4.D.1: Caries

At Chongos the overall rate of carious permanent dentition (the number of permanent teeth with at least one caries) with at least one caries was very high, 21.3% (84 caries in 395 analyzed teeth), affecting 18 individuals (6 females, 12 males). The rate was slightly higher in females than males (26% vs. 18.4%,), and in general increased with age. There was an average of 4.8 caries per person at Chongos, suggestive of an agricultural society (> 4.1 caries/person, Rose et al. 1984).

Six of the eight (75%) females analyzed had at least one carious permanent tooth. There was an average of 5.6 caries per female. This number is skewed by one individual, BY 1800 burial 11, age 25-30, who had 26 total caries on 23 teeth.

Twelve of the 14 (85.7%) males analyzed had at least one carious permanent tooth. There was an average of 4.3 caries per male. As was the case with the females, one individual skewed the results. Male BP 1820 burial 1, age 50-60, had 30 total caries on 22 analyzed teeth.

Analyses were conducted using Chi-square to test for variation in the number of carious teeth by sex, and using Fisher's exact test for the number of individuals with at least one carious permanent tooth. The difference by sex in the number of carious teeth analyzed approaches statistical significance (χ^2 = 2.8, p = 0.09, 1df). This result means that women were more likely to have had carious permanent teeth, but the difference is not large (table 4.4). When I tested for potential sex differences by the number of individuals who had at least one carious permanent tooth, the results were, as one might expect, not statistically significant ($p = 0.6$). Overall, these results show that though there was no statistically significant difference by sex in the number of individuals at Chongos who had at least one carious permanent tooth, females at Chongos were more likely to have a greater number of carious permanent teeth.

Table 4.4: Number of Caries by Sex

	Teeth with caries	Teeth with no caries
Female	39	111
Male	45	200
Total	84	311

I tested variation in the rate of carious permanent dentition by age for each sex using the Chi-square statistic. I also present results when both sexes were combined.

Based on the Chi-square test, ($\chi^2 = 26.92$, $p < .0001$, 3df) there is significant variation by age in the rate of carious permanent dentition among females (table 4.5, Figure 4.1). To test if the variation was based on the outlier mentioned above, BY1800 burial 11, age 25-30, I withheld her from the total and reran the Chi-square. Though the Chi-square result was smaller, it remains statistically significant ($\chi^2 = 9.67$, $p = 0.02$, 3df).

I did a Spearman's correlation to test if the variation described above was directional, i.e. if there was an increase in the number of carious teeth with age. The result of the Spearman's R is not significant ($r = .57$, $n = 8$). With a sample of eight individuals, it would be necessary to have an R value of .62 for a significant p-value of 0.05. This result indicates that although there is significant variation among females in caries rate by age, the caries rate does not increase in a linear fashion with age. Since teeth affected by caries tend to be lost antemortum, the percentage of carious teeth in older individuals would not expect to increase. The increase in frequency in later years over the third decade suggests considerable presence of the cariogenic bacterium *Streptococcus mutans* and the dietary and preparation factors which lead to caries.

Table 4.5: Caries Prevalence and Rate for Females

Age	Number of carious teeth	Analyzed teeth	Caries rate
12-19	8	94	8.5%
20-30	20	25	80%
31-45	8	25	32%
46+	3	6	50%
Total	39	150	26%

Based on the Chi-square test, (χ^2 = 29.8, p < .0001, 3df) there is significant variation by age in the rate of carious permanent dentition among males (table 4.6, Figure 4.2). To test if the variation was based on the outlier mentioned above, BP1820 burial 1, age 50-60, I withheld him from the total and reran the Chi-square. Though the Chi-square result was smaller, it remains statistically significant (χ^2 = 14.04, p = 0.003, 3df), indicating an increase in the number of carious teeth with age.

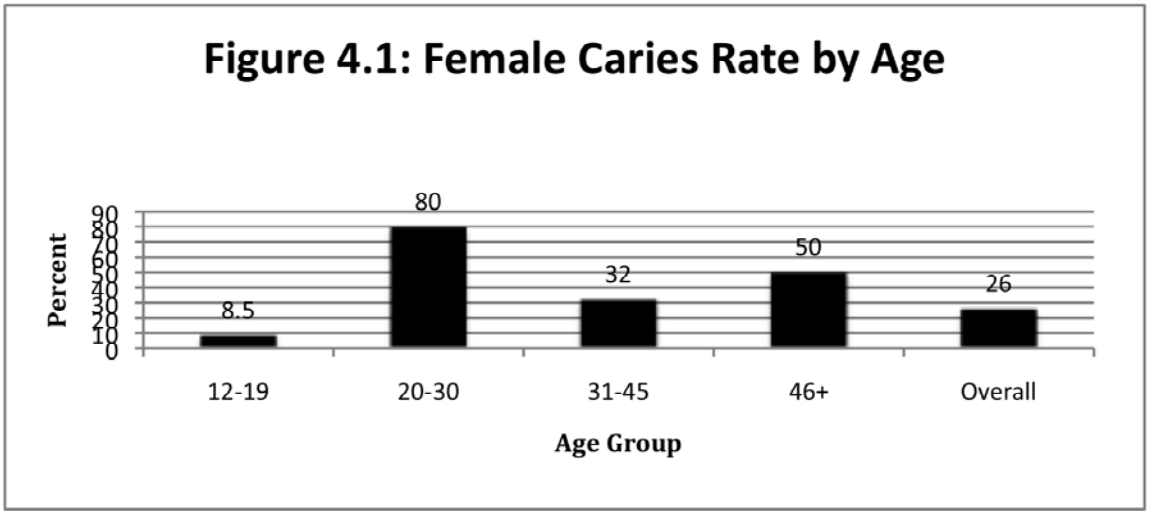
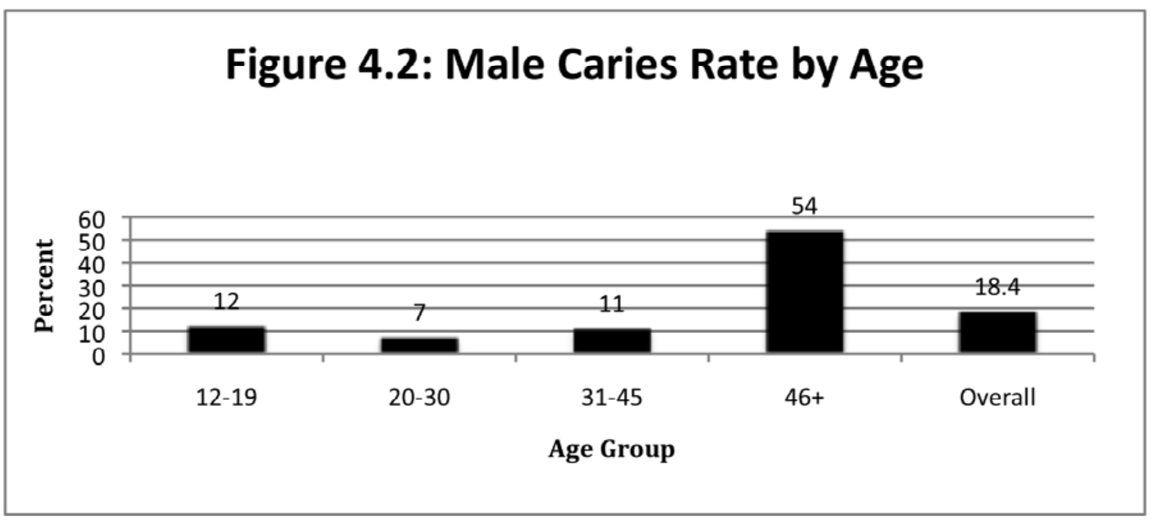


Table 4.6: Caries Prevalence and Rate for Males

Age	Number of caries	Analyzed teeth	Caries rate
12-19	8	67	12%
20-30	6	86	7%
31-45	5	44	11%
46+	26	48	54%
Total	45	245	18.4%

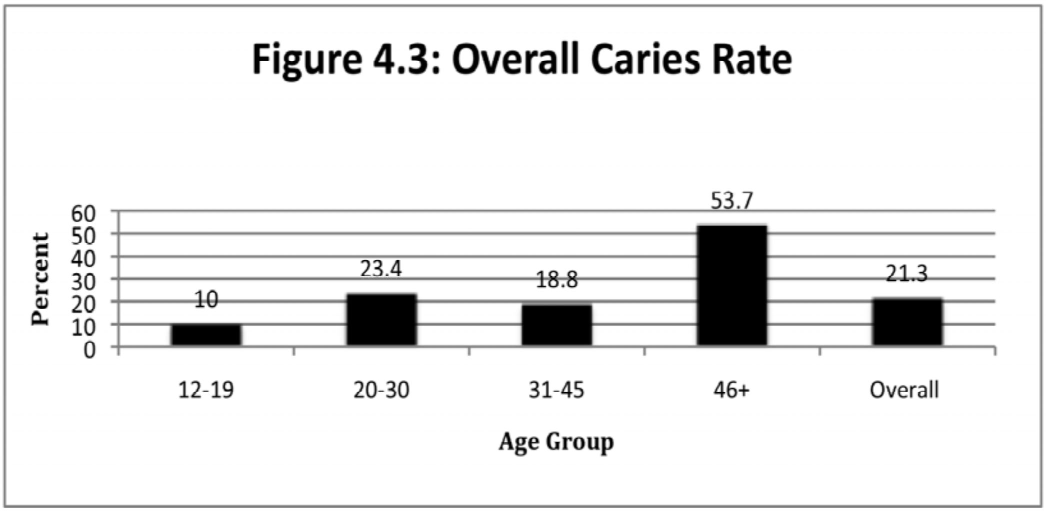


I did a Spearman's correlation to test if the variation described above was directional, i.e. if there was an increase among males in the number of carious teeth with age. The result of the Spearman's R more closely approaches significance (r = .41, p = .07, 12 df, one-tailed) for males than for females. The joint probability for both males and females is quite significant (0.07 x 0.10 = 0.007), so there is a general trend of caries to increase with age, suggesting that wear did not exceed caries formation as individuals aged.

The results for both sexes (table 4.7, Figure 4.3) combined also shows significant variation by age based on the Chi-square test ($\chi^2 = 26.58$, $p < .0001$, 3df). I removed the male and female outlier and reran the analysis. The results still show statistically significant differences in the rate of carious permanent dentition by age ($\chi^2 = 22.19$, $p < .0001$, 3df). The results of the Spearman's correlation (r = .46, p = 0.015, 20 df, one-tailed) indicate that caries rate among the adult population as a whole at Chongos statistically significantly increases with age.

Table 4.7: Caries Prevalence and Rate for Total Population

Age	Number of caries	Analyzed teeth	Caries rate
12-19	16	161	10%
20-30	26	111	23.4%
31-45	13	69	18.8%
46+	29	54	53.7%
Total	84	395	21.3%



In all analyses, there are statistically significant results showing variation in the rate of permanent dentition with caries by age. This result occurred for males and females, and when the sexes were combined. The Spearman's result showed that when the sexes were combined, the caries rate increased significantly with age. The increase in the number of permanent dentition with at least one caries with age for both males and females is consistent with lifetime exposure to cariogenic bacteria based on a diet high in cariogenic foods, i.e. rich in carbohydrates. Carious dentition was present among both males and females, demonstrating early and sustained exposure to cariogenic foods. These results will be discussed in more detail in Chapter 5.

4.D.2: Abscesses

Eighteen abscesses were identified out of 614 analyzed tooth crypts, an abscess rate of 2.9%. The abscess rate was slightly higher in females than in males (3.7% vs. 2.5%, table 4.8). Abscess rates were higher among older females, with no difference between males.

Table 4.8: Rate of Abscesses by Age and Sex

Age	Female (n)	Male (n)	Total (n)
12-30	0.033 (5/153)	0.025 (6/237)	0.028 (11/390)
31+	0.047 (3/64)	0.025 (4/160)	0.03 (7/224)
Total	0.037 (8/217)	0.025 (10/397)	0.029 (18/614)

n= number of abscesses/tooth crypts analyzed

Four of the eight (50%) females analyzed had at least one abscess, with an average of 2.0 abscesses per abscessed female. One female, BY 1800 burial 11, age 25-30, had half of the abscesses, with one female having two abscesses, and two others having one each. This individual also had the highest caries prevalence among females.

Five of the 14 (35.7%) males analyzed had at least one abscess, also with an average of 2.0 abscesses per abscessed male. As was the case with the females, one individual, BY 1800 tomb 6, age 20-24, had half of the abscesses, with one male having two abscesses, and three males having one abscess each.

Analyses were conducted to test for variation by sex and age in abscess rates. This was done using Chi-square and Fisher's exact test. There was no statistically significant difference by sex in abscess rate, analyzed by number of abscesses by Chi-square analysis (χ^2 = .32, p = 0.57, 1df) and number of individuals having at least one abscess by Fisher's Exact test (p = 0.66). When the number of abscesses were pooled by age and analyzed, there was also no statistically significant difference based on Chi-square analysis (χ^2 = .05, p =

0.82, 1df), demonstrating no age or sex biases in abscess rates and perhaps the processes that increase the likelihood for the development of abscesses.

4.D.3: Enamel Hypoplasias

Twenty-two individuals had at least one enamel hypoplasia (EH), out of 27 analyzed (81.5%). Twenty-one individuals could not be analyzed because of a lack of available permanent dentition, either because they were too young to have developed permanent dentition or because permanent dentition was missing. Twelve of 15 males (80%) and seven of nine females (77.8%) analyzed had evidence of EH. Fisher's exact test was used to test for variation by sex in the presence of EH. The result ($p = 0.64$) is not significant. Of note is that all three subadults analyzed had evidence of EH (ages 4-5, 6-7, 8-9).

I conducted an independent t-test of individuals with enamel hypoplasia and mean age at death (MAD) to test if the Chongos population with enamel hypoplasia was more likely to die than those with no enamel hypoplasia. The MAD of individuals with enamel hypoplasia was 26.7 years, 33.9 for those without enamel hypoplasia. There is no statistical difference in MAD by enamel hypoplasia ($t = -0.85$, $p = 0.2$, 25 df, one-tailed test). I also used an independent t-test to determine if there was a difference in stature between individuals with and without enamel hypoplasia. The mean stature for individuals with enamel hypoplasia was 152.1 cm using the femur, 154.7 cm using the tibia (see table 4.12 and 4.13), and 157.2 cm for the femur and 159.5 for the tibia for those without enamel hypoplasia. I analyzed each stature estimate independently (femur and tibia). There was no statistical difference in stature using the femur ($t = -1.28$, $p = 0.11$, 13 df, one-tailed test), though there is a trend toward taller individuals not having enamel hypoplasia. Using the tibia, there is also not quite a statistical difference in stature ($t = -1.32$, $p = 0.11$, 12 df, one-tailed test), though this result also shows a trend with taller individuals not having enamel hypoplasia. Since MAD and stature are independent variables, it is possible to combine their probabilities. The result shows a signifianct effect of LEH on health-related outcome ($0.20 \times 0.11 = 0.02$).

4.E: Dental Calculus/Phytolith Analysis

Data are presented on 14 individuals. Table 4.9 shows the individuals included in the analysis. The data are pooled over sex and age.

The samples did not yield a high prevalence of phytoliths or starch (Dietz et al. 2003b). However, diagnostic phytoliths were recovered. For example, a faceted sphere diagnostic of Cucurbitaceae fruits was recovered, which resembles phytoliths from bottle gourd.

A number of materials that are general indicators of plant tissue were also recovered. These include schlerids, plant transport tissue, dicotyledon epidermis, and charred remains. The plant transport tissues identified were sieve elements (phloem), and are typical of plant stems, leaves, fruits and roots. The clumps of sieve elements observed were most similar to comparative samples of fruit tissue. Large pieces of cellulose were recovered, which trapped items such as charred remains and epidermal short cells from Chloridoid grasses. Chloridoid grasses prefer warm/dry conditions. Cellulose is the main constituent of plant walls in higher plants and is also found in fungi. The charred material suggest cooked fragments of epidermal tissue.

Examples of sinuous edged grass epidermal long cells were recovered. The context of the dental calculus suggests that the grass was economic, and either eaten or grasped between the teeth. Rondels characteristic of a Bambusioid or Arundinoid tropical grass were recovered. Plants of this type near Chongos include reed or cane.

Table 4.9: Individuals Used in Phytolith Analysis

Individual	Sex	Age
BW 1500 burial 4	Female	45-55
BY1800 tomb 2	Male	50-59
BY1800 burial 1	Female	20-30
BP1800 burial 1	Male	25-35
BY1780 burial 2	Male	13-15
BY 1780 bags 25 &26	Male	50-55
BO 1800 burial 4	Male	17-19
BW1500 bag 14	Female	18-20
BY1780 burial 4	Male	19-21
BW1500 burial 15	Female	35-44
DE 100-120 sector IV	Female	12-13
BY 1780 burial 5	Male	20-24
BY 1800 tomb 4	Male	30-35
BY 1800 burial 11	Female	25-30

The starch grains were of a smooth, spherical morphotype. A starch grain was also found of a slightly elongated morphotype, with lamellae. The starch grains showed damage. In addition to the plant remains, evidence of animal remains was also found. Microscopic mammal hairs were found in the samples;

Guinea pig (*Cavia porcellus*) is a likely source since it is easy to ingest hair while eating an animal grilled over a fire. Chitin was also recovered, which is a polysaccharide comprising chains of a glucose derivative, used to strengthen the supporting structures of invertebrates and fungi. The bodies found are similar to marine invertebrates. There has been no study of the macro-remains of plant and animal tissue associated with the burials or middens.

4.F: Skeletal Pathology

4.F.1: Porotic Hyperostosis/Cribra Orbitalia (Indicators of Anemia)

Of 31 individuals analyzable for anemia, as expressed as porotic hyperostosis and/or cribra orbitalia (PH/CO), 23 (74.2%) had evidence for one or both pathologies. Sixteen individuals could not be analyzed due to either lack of crania or because soft tissue covered the crania and eye sockets.

Eight of the 11 analyzed males (72.7%) had one or both pathologies. Half (3 of 6) of the analyzed females had one or both pathologies. Tables 4.6 and 4.7 separate the population by their pathologies.

Fourteen individuals (46.7% of analyzed population) had evidence of cribra orbitalia. Sixteen individuals (53.3% of the analyzed population) had no evidence of CO, while 17 individuals could not be analyzed due to either the lack of a skull or the presence of soft tissue covering the skull.

The mean age at death (MAD) of the individuals with CO at the time of their death is 12.6 years of age. The MAD of the individuals without CO at the time of their death is 24.7 years of age, almost twice as long. I also calculated the MAD of adult individuals (age 18 or older). The adult MAD at Chongos is 32.4 years of age. The difference between MAD was analyzed using an independent t-test. Adult individuals with CO had a MAD of 26.9 while those without CO had a MAD of 36.6.

The difference between MAD for all individuals (adults and subadults) at Chongos with and without CO is statistically significant ($t = -1.96$, $p = 0.03$, 28 df, one-tailed test), while there is no statistically significant difference in adult MAD of the Chongos skeletal population with and without CO ($t = -1.31$, $p = 0.1$, 13 df, one-tailed test). These results show that CO has a negative impact on survivorship among all individuals at Chongos, though the impact appears to be greater among subadults.

For most individuals (12 of 14, 85.7%) with evidence of CO, the lesions were still at least partly active. Nine of the 14 individuals (64.3%) had CO lesions that were completely active at the time of their death. All eight subadults with CO had completely active lesions at the time of their death, while two individuals who had completely healed lesions were adult males (18-19 years and 50-59 years).

Seventeen individuals (54.8% of analyzed population) had evidence of porotic hyperostosis (PH). Fourteen individuals (45.2% of the analyzed population) had no evidence of PH, while 16 individuals could not be analyzed due to either the lack of a skull or the presence of soft tissue covering the skull.

The MAD of all individuals (adults and subadults) with PH at the time of their death is 18.03 years of age. The MAD of the individuals without PH at the time of their death is 19.1 years of age. Both ages are very close to the MAD for the entire Chongos skeletal collection, 18.3 years of age. The MAD for adults (age 18 or older) is 36.9 for those with PH (7 individuals), and 30.2 for those without PH (8 individuals)

The difference between MAD was analyzed using an independent t-test. There was no statistical difference when comparing the MAD of all individuals at Chongos with and without PH ($t = -0.17$, $p = 0.43$, 29 df, one-tailed test), nor was there a statistical difference when analyzed by MAD for adults with and without PH ($t = +0.94$, $p = 0.18$, 13 df, one-tailed test). Based on the results, there is no relation between age at death and having PH. In short, having porotic hyperostosis does not increase an individual's risk of dying sooner.

Aufderheide and Rodriguez-Martin (1998) found that the act of cranial deformation could promote PH. However, Pechenkina and colleagues' (2007) data showed no support for increased PH among individuals with cranial deformation living along the Peruvian coast. Chongos may be an exception to their finding.

Thirteen of the 17 individuals (76.5%) at Chongos of all ages who had PH had cranial deformation, two did not, and two had fragmentary, incomplete crania making it impossible to determine if they had artificially modified crania. Of the 13 individuals with cranial deformation, 11 (84.6%) had PH clearly associated with cranial deformation. The association is clear because porosity is only located along the pressure points applied to the crania for artificial modification. These results support the hypothesis of Aufderheide and Rodriguez-Martin (1998), that it is the pressure of binding that causes some kinds of porosity in crania, which can be distinguished by their patter.

However, two individuals had PH along pressure points in addition to PH in other locations on the skull. Both individuals were males, BY1780 burial 3, aged 50-55 years, and BY 1800 tomb 2, aged 50-59 years.

Nine of the 14 individuals (64.3%) who did not have PH had artificially modified crania, four had no modification, and one had a fragmentary, incomplete cranium making it impossible to determine if they had an artificially modified crania.

I conducted a Fisher's Exact Test to determine if there was variation in the presence of PH by cranial deformation (table 4.10). Based on the results, there is no statistically significant association between the presence of cranial modification and PH ($p = 0.36$, one-tailed test). Thus, while several individuals buried at Chongos had clear association between cranial modification and PH with respect to the patterning of the lesions, there was no statistical association between whether the crania were modified or not. This result is consistent with Pechenkina and colleagues' findings (2007). This difference between these two different results will be discussed in greater detail in Chapter 5. While it is clear that deformation does not necessariy cause porosity (Table 4.10), when it does occur, the porosity closely follows the deformation apparatus as it pressed the skull.

Table 4.10: Presence of Porotic Hyperostosis by Cranial Deformation

	Cranial Deformation	No Cranial Deformation
Porotic Hyperostosis	13	4[1]
No Porotic Hyperostosis	9	5[1]

[1] Number includes individuals with fragmentary and/or incomplete crania making determination of deformation impossible

4.F.2: Skeletal Lesions

Table 4.11 shows the bone count of skeletal elements with evidence of periosteal lesions. Of 50 individuals analyzed, 23 (46%) have skeletal lesions on at least one skeletal element, 16 (32%) had no evidence, and three (6%) were unable to be analyzed. Eight individuals (16%) had other types of lesions that are described in other sections of this chapter, such as cribra orbitalia, porotic hyperostosis or external auditory exostoses.

The most common skeletal element affected was the tibia, with 13 of the 23 (56.5%) individuals having at least one tibia affected. Ten of the 13 (76.9%) individuals had lesions on both tibias, potentially showing evidence for systemic infection, as was common at Villa el Salvador and Cardal (Vradenburg 2001).

Seven of the eight (87.5%) individuals with an affected femur had bilateral lesions, additional evidence for a systemic infection, especially among the six individuals who had both femurs and both tibias affected. This pattern is normally interpreted as that of a treponemal infection (Vradenburg 2001) Most individuals (19 – 82.6%) who had skeletal lesions had them on more than one skeletal element.

Table 4.11: Inventory of Skeletal Elements with Lesions

Skeletal Element	Total by age and sex	Bilateral lesions Present/Absent
Tibia (13 individuals)	Female – 35-45 Female – 25-30 Female – 20-30 Female – 12-13 Female – 45-55 Male – 17-19 Male – 20-24 (2) Male – 25-30 Male – 50-55 Male – 50-59 Subadult – 4-5 Subadult – 1.5-2.5	Absent Absent Absent Absent Present Present Present Present Present Present Present Present
Femur (8 individuals)	Female – 25-30 Male – 20-24 Male – 50-55 Male – 16-18 Male – 50-59 Male – 25-30 Male – 17-19 Subadult – 1.5-2.5	Absent Present Present Present Present Present Present Present
Acetabulum (3 individuals)	Female – 20-30 Female – adult Female – 25-30	Present Present Present
Crania (4 individuals)	Female – 25-30 Male – 25-30 Subadult – 4-5 Subadult - .5-.75	N/A N/A N/A N/A
Humerus	Female – 25-30 Female – 12-13	Absent Absent
Fibula	Male – 25-30 Subadult – 8-10	Present Absent
Os coxae	Female – 25-30	N/A
Radius	Male – 25-30	Absent

N/A = skeletal elements are not bilateral

When separated by sex, 11 of the 14 females (78.6%) had lesions on at least one skeletal element. The most common skeletal element affected was the tibia, with five individuals affected, one of whom with both tibias affected. Only one female had a skeletal lesion on her femur, and was not affected bilaterally.

Eight of the 15 males (53.3%) analyzed had evidence for skeletal lesions. The most common skeletal element affected was the tibia, femur and dental arcade, with each being affected in six individuals. All males with skeletal lesions on the tibia are affected bilaterally, as are all males with lesions on the femur.

I used a Fisher's exact test to test if there was a significant difference between the likelihood of males or females to have skeletal lesions (table 4.12). The result was not statistically significant ($p = 0.15$, one-tailed test), but females were more likely to have lesions on at least one skeletal element.

Table 4.12: Number of Individuals with Presence of Periosteal Lesions by Sex

	Periosteal Lesions	No Periosteal Lesions
Female	11	3
Males	8	7

It is interesting to note that males appear to be more affected by skeletal lesions in the lower body than females, especially in the femur. Of 11 adults with skeletal lesions in the tibia, six were males and five were females (54.5% male). However, six of the seven adults with lesions on the femur were males (85.7%). As described above, males were also more likely to be affected bilaterally.

I tested for statistically significant differences in the likelihood of males or females to have bilateral lesions on the tibia or femur. Five females and six males had skeletal lesions on the tibia (table 4.13). All of the males with lesions on the tibia had bilateral lesions, while only one of the five females had bilateral lesions. The difference was statistically significant using Fisher's exact test (p = 0.015, one-tailed test), with males statistically significantly more likely to have bilateral lesions on the tibia than females.

Table 4.13: Number of Individuals with Bilateral Lesions on the Tibia, by Sex

	Bilateral	Not Bilateral
Female	1	4
Male	6	0

Only one female had lesions on the femur, and it was not bilateral. All six males with lesions on the femur had bilateral lesions (table 4.14). Based on Fisher's exact test, this difference is not statistically significant (p = 0.14), though the results seem to indicate that males are more likely to have bilateral lesions on the femur than females, as they do on the femur. However, infection could easily cross the knee joint, so the two are probably not measuring different infections.

Table 4.14: Number of Individuals with Bilateral Lesions on the Femur, by Sex

	Bilateral	Not Bilateral
Female	0	1
Male	6	0

Several individuals had skeletal lesions on a number of skeletal elements. Two individuals in particular (BO1800 burial 4 – male 17-19 years old; BY1800 burial 11 – female 25-30) will be discussed in greater detail in Chapter five due to the number of skeletal elements with lesions. They may have had a systemic infection that affected their entire body. One individual, BW1500 burial 11, age

4-5, had bilateral lesions on the tibias and all elements of the cranium. These lesions may have been associated an infection resulting from a fractured jaw. This individual will also be discussed in greater detail in Chapter 5.

4.F.3: Degenerative Joint Disease

Table 4.15 shows the bone count of skeletal elements with evidence of degenerative joint disease (DJD). Of 50 individuals analyzed, 25 (50%) have DJD on at least one skeletal element, 21 (42%) had no evidence, and four (8%) were unable to be analyzed. One individual, BP1800 burial 1, a male aged 25-35, did not have any evidence of DJD. However, most of his skeleton was hidden through natural mummification and only a few elements were available for inspection.

The most common skeletal element affected was the vertebral column, with 14 individuals (56%) affected in their lumbar vertebrae, 13 (52%) affected in their thoracic vertebrae, and 13 (52%) affected in their cervical vertebrae. Other common elements affected included long bones, with the femur (52% of individuals with DJD affected in this element), humerus (48%), tibia (44%), ulna (44%) and radius (36%) regularly affected. Other skeletal elements that were commonly affected among those with DJD include the os coxae (44%), scapula (40%), temporo-mandibular joint TMJ (36%), ribs (36%) and the bones of the feet (28%). Of the 25 individuals with DJD, only four (16%) had DJD on one element. All others had DJD on at least two skeletal elements. One individual (a 18-20 year old female) had DJD on two lumbar vertebrae. The other three individuals had DJD in the TMJ. All of these individuals were young (age 5-6, 12-13, and 13-15 at time of death), and had artificial cranial deformation.

Only two individuals too young for a sex estimation had evidence of DJD. One, BP1820 burial 7, age 5-6, is the individual with DJD in his or her TMJ. The other individual, BW1500 burial 11, age 4-5, had DJD in four skeletal elements: TMJ, cervical vertebrae, mandibular condyles and the clavicle. This individual had a broken mandible, with the DJD a possible result of the trauma. This individual will be described in more detail in Chapter 5.

Table 4.15: Degenerative Joint Disease by Element Affected

Skeletal Element	Males affected	Females affected	Total[1]
Lumbar Vertebrae	7	7	14
Thoracic Vertebrae	6	6	13
Cervical Vertebrae	8	4	13
Femur	6	7	13
Humerus	5	7	12
Tibia	7	4	11
Os Coxae	4	7	11
Ulna	5	6	11
Scapula	6	4	10
TMJ	4	3	9
Ribs	6	3	9
Radius	3	6	9
Feet	4	3	7
Fibula	2	3	5
Sacrum	1	3	4

[1] = total number reflects males, females and subadults with DJD in affected skeletal element.

When separated by sex, 12 of the 14 females (85.7%) had DJD on at least one skeletal element. Two of the 12 (16.7%) only had DJD on one skeletal element (1 on the lumbar vertebrae, 1 on the TMJ). The most common skeletal elements affected were the lumbar vertebrae, os coxae and femur, with each being affected in seven females. Other commonly affected skeletal elements include the humerus and thoracic vertebrae (6 females each), ulna and radius (5 females each), and the tibia and cervical vertebrae (4 females each).

Eleven of the 15 males (73.3%) had DJD on at least one skeletal element. One of the 11 (9.1%) only had DJD on one skeletal element (TMJ). The most common skeletal element affected was the cervical vertebrae, with eight males affected. Other commonly affected skeletal elements include the tibia and lumbar vertebrae (7 males each), femur, ribs, scapula and thoracic vertebrae (6 males each).

Table 4.16 shows the mean age at death (MAD) of the males and females who had DJD by element. As can be seen from the table, the MAD of females is consistently lower for each affected skeletal element, with the exception of cervical vertebrae and the sacrum (only one male affected).

I conducted a t-test for each skeletal element, comparing the differences in mean age at death (MAD) of the males and females who had DJD by element. The t score and degrees of freedom (df) for each t-test are provided in Table 4.16. There are no statistically significant differences by sex in MAD by skeletal element.

I conducted a Fisher's exact test on each skeletal element with a difference of two or more individuals affected to test for significant differences in DJD by sex. For example, eight males had DJD in their cervical vertebrae compare to four females. The results of these tests are displayed in table 4.17

below. There are no statistically significant differences in the prevalence of DJD on any skeletal element, though on the cervical vertebrae the result approaches statistical significance, with males more likely to have DJD than females.

Table 4.16: Mean Age at Death of Individuals With and Without Degenerative Joint Disease

Skeletal Element Affected	Female with DJD	Female without DJD	Male with DJD	Male without DJD	Female/Male DJD t-test t value
Lumbar Vertebrae	36.5	28.1	38	21.9	t = -0.21 12 df
Thoracic Vertebrae	36.9	23.25	38	21.9	t = -0.15 11 df
Cervical Vertebrae	39.25	25.1	37.3	20.4	t = 0.24 10 df
Femur	33.4	24.8	34.3	26.1	t = -0.12 11 df
Humerus	33.5	24.6	33.8	21.7	t = -0. 18 10 df
Tibia	34.1	27.1	39.1	20.9	t = -0.64 9 df
Os Coxae	34.8	23.4	42.4	25	t = -0.76 8 df
Ulna	39.3	21.4	44.4	21.9	t = -0.77 9 df
TMJ	26.5	29.8	35.8	27.1	t = -0.66 5 df
Scapula	28.5	29.7	36.9	24.4	t = -1.12 8 df
Ribs	35.7	27.3	36.5	27.8	t = -0.09 7 df
Radius	36.9	23.25	38.2	24.9	t = -0.16 7 df
Feet	34.8	27.6	48	22.6	t = -1.53 5 df
Fibula	39	26.4	41	25.7	t = -0.88 5 df
Sacrum	37.3	26.9	27.5	29.6	t = 0.95 2 df

Table 4.17: Male/Female Difference in Degenerative Joint Disease by Skeletal Element

Skeletal Element	Fisher's Exact Test p-value
Cervical Vertebrae	0.1
Tibia	0.7
Os Coxae	0.41
Humerus	0.68
Scapula	0.41
Ribs	0.21
Radius	0.4
Sacrum	0.59

4.F.4: Schmorl's Nodes

Six individuals, 3 males and 3 females, had Schmorl's nodes. These six individuals had 33 affected vertebrae, an average of 5.5 per person. Thoracic and lumbar vertebrae were equally affected (28 thoracic vs. 15 lumbar) (table 4.18). Two individuals had 20 Schmorl's nodes, with individual BY1800 tomb 3, a 25-30 year old male, having 11 Schmorl's nodes, and individual BY1800 burial 11, a 25-30 year old female, having nine Schmorl's nodes. One individual, BY1780 burial 5, a 20-24 year old male, had three possible Schmorl's nodes, located on thoracic vertebrae 6-8. It is notable that most affected were young adults, an unexpected finding.

4.F.5: External Auditory Exostoses

One individual, BY 1780 burial 4, a male aged 19 to 21 years at the time of death, had visible external auditory exostoses (EAE). There was one EAE in each ear canal, with each being small but robust. No other individual from the skeletal collection was affected. However, even in a fishing village like Paloma, relatively few individuals showed auditory osteomas, although all were males (Benfer 1990).

Table 4.18: Presence and location of Schmorl's nodes by age and sex

Individual	Sex	Age	Affected vertebra(e)	Total (n)
BY1800 burial 11	F	25-30	Thoracic: 8-12; Lumbar: 1-4	9
BW1500 burial 15	F	35-44	Thoracic: 3-4	2
BY1500 burial 5	F	40-50	Lumbar: 1-5	5
BY1780 burial 5	M	20-24	Thoracic: 12, possible 6-8; Lumbar: 1-3	4, 3 possible
BY1800 tomb 3	M	25-30	Thoracic: 5-12; Lumbar: 1-2, 4	11
BW1500 burial 3	M	30-35	Thoracic 11-12	2

4.F.6: Adult Stature

Table 4.19 shows the adult stature for each adult at Chongos (n=21) as estimated by the revised Genoves formula (Genoves 1967) for Mesoamericans (del Angel and Cisneros 2004). Stature is only presented for those individuals who had at least one complete femur, tibia and/or humerus available for measurement of maximum length. Two individuals, both females, have a stature estimate based on total humerus length, as a complete femur or tibia was not available. If the element was not available or if taphonomic issues prevented accurate measurements, it was not measured and an N/A is presented in the table. Table 4.20 combines the data presented in table 4.19 by sex, showing the mean stature and range by sex, age and long bone.

Table 4.19: Long Bone Measurements and Stature Estimates Using the Revised Genoves Formulas

Individual	Sex	Age	Femur[1]	Tibia[1]	Humerus[1]
BO 1800 burial 4	M	17-19	152.3	N/A	N/A
BY 1780 burial 4	M	19-21	157.8	161.8	N/A
BY1800 tomb 6	M	20-24	156.2	158.5	N/A
BY1780 burial 5	M	20-24	152.6	156.7	N/A
BY1800 tomb 3	M	25-30	154.9	156.9	N/A
BU1460 tomb 6	M	20-40	154.1	158.8	N/A
BP1800 burial 1	M	25-35	159.9	N/A	N/A
BW1500 burial 3	M	30-35	151.2	154.3	N/A
BY1800 tomb 4	M	30-35	159.8	163	N/A
BY1780 burial 3	M	50-55	160.3	160.2	N/A
BY1800 tomb 2	M	50-59	N/A	155.5	N/A
BP1820 burial 1	M	50-60	155.7	158	N/A
BY1780 burial 1, bag 23	F	18-19	146.9	153.2	N/A
BW1500 bag 14	F	18-20	148.6	151.7	N/A
BR1440 trench 1	F	20-24	144.4	N/A	N/A
BY1800 burial 1, bag 3	F	20-30	N/A	N/A	154.2
BY1800 burial 11	F	25-30	146.4	149.4	N/A
BU1460 burial 4.1	F	30-39	N/A	N/A	163.8
BW1500 burial 15	F	35-44	147.4	148.9	N/A
BP1800 burial 3	F	35-45	134.7	141.8	N/A
BW1500 burial 4	F	45-55	143.8	146.7	N/A

[1] = all stature estimates are given in centimeters (cm)

The stature estimate using the femur was consistently smaller than the estimate using the tibia, so this population had slightly different body proportions than did the Mesoamerican population from which the regression formula was developed. This was true when the same individual had a complete femur and tibia. The humerus showed greater variation, with the younger female having a stature estimate that was with the range computed for the femur. However, the stature estimate of the older female using only the humerus is a definite outlier. Her stature estimate is taller than any male age and sex subgroup. Her result is taller than the estimate for the tallest male, 163.8 cm to 163 cm.

Table 4.20: Long Bone Measurements and Stature Estimates

Age and Sex group	Femur – mean stature (cm) [n]	Range (cm)	Tibia – mean stature (cm) [n]	Range (cm)	Humerus – mean stature (cm) [n]	Range (cm)
F 18-29	146.6 (4)	144.4-148.6	151.5 (3)	149.4-153.2	146.75 (1)	N/A
F 30+	142 (3)	134.7-147.4	145.8 (3)	141.8-148.9	163.8 (1)	N/A
F Mean	144.6 (7)	134.7-148.6	148.6 (6)	141.8-153.2	155.3 (2)	146.75-163.8
M 18-29	154.8 (5)	152.3-157.8	158.4 (4)	156.7-161.8	N/A	N/A
M 30+	156.8 (6)	151.2-160.3	158.3 (6)	154.3-163	N/A	N/A
M Mean	155.9 (11)	151.2-160.3	158.4 (10)	154.3-163	N/A	N/A

Sexual dimorphism among the Chongos skeletal population is not strong. Based on the femur, the sexual dimorphism at Chongos is 7.8%, while using the tibia the sexual dimorphism is 6.6%. However, the stature difference from both the femur and the tibia is approximately 10 cm (11.3 cm from the femur, 9.8 cm from the tibia). This difference is statistically significant between males and females for the femur ($t = +6.11$, $p < 0.0001$, 16df, one-tailed test) and the tibia ($t = +5.79$, $p < 0.0001$, 14df, one-tailed test) using an independent t-test. Males buried at Chongos were significantly taller than females.

Table 4.21: Long Bone Measurements and Stature Estimates – individuals with no Cranial Deformation

Individual	Sex	Age	Femur[1]	Tibia[1]	Humerus[1]
BY1780 burial 1, bag 23	F	18-19	146.9	153.2	N/A
BW1500 burial 15	F	35-44	147.4	148.9	N/A

[1] = all stature estimates are given in centimeters (cm)

Two females presented in table 4.19 did not have artificial cranial deformation, while all males did. These individuals are presented separately in table 4.21, because the difference in cranial deformation may reflect an ethnic or geographic distinction between them and their counterparts at Chongos (Pechenkina and Delgado 2006). Their stature estimates are at or above average for the females in the Chongos skeletal collection (table 4.20). This result will be discussed more in Chapter 5.

CHAPTER 5: DISCUSSION

5.A: Introduction

This chapter discusses the results of the Chongos data presented in Chapter 4 in relation to the hypotheses and research objectives presented in Chapter 1. This chapter is organized in the same way as Chapter 4, with the hypotheses and research objectives discussed in each section for each series of results. The Chongos data are also compared to previously published data from sites along the central coast or Nasca valley of Perú. These sites will be introduced briefly in 5.A.2. I also will describe five individuals excavated from Chongos (5.G), presented in greater detail to highlight specific evidence of activity pattern, direct evidence of pathology or trauma, or a lifetime of exposure to trauma and/or disease causing events.

5.A.1: Research Design and Objectives

At the end of each section of this chapter I will discuss the Chongos data in comparison with available comparative bioarchaeological data in relation to the hypothesis, research objectives, and questions presented in Chapter 1. My main hypothesis is that the individuals buried at Chongos derived the bulk of their calories from agriculture. My research goals were to provide the first bioarchaeological description of the human skeletal remains recovered at Chongos and from the lower Pisco River valley. This project also represents one of the few bioarchaeological projects in the south central coastal region. The project had four research objectives to support my hypothesis and research goals. These were to:

1. analyze diet
2. describe non-specific indicators of stress
3. compare results by sex, discussing potential implications of the results on gender differences in diet and/or activity patterns
4. compare the Chongos results with published collections from similar time periods and/or similar ecological zones.

I end the chapter by summarizing all results.

5.A.2: Sites Compared in the Chapter

In this chapter I compare results from the Chongos material with other sites from coastal Perú (Table 5.1). Each site or series of sites is briefly described below.

5.A.2.a: Paloma

Paloma is a Preceramic period village located at the northern edge of the Chilca river valley along the central coast. It is approximately 3.5 km from the

Pacific coast (Benfer 1984, 1990, 2007; Benfer and Gehlert 1980; Quilter 1989). There were three occupation levels at Paloma spanning over 3000 years, although human remains occurred over the last 2000 (Benfer 1984, 1990). The individuals buried at Paloma were foragers, reliant mostly on marine resources. The Paloma burial collection contains 201 analyzed individuals (Benfer 1990). Mortuary analysis suggested little to no social stratification (Quilter 1989). The material from Paloma used in this chapter come from Pechenkina et al. (2007) and Vradenburg (2001).

Table 5.1: Chronology, Size and Location of Skeletal Collections Discussed

Site	Period[a]	Dates[b]	Location	No. of Individuals
Paloma	Middle Perceramic	6500-4750	Chilca Valley, Central Coast	201
Cardal	Initial Period	3400-2900	Lurin Valley, Central Coast	48
Villa el Salvador	Early Horizon/Early Intermediate	2400-1800	Lurin Valley, Central Coast	181[c]
Huaca Pucllana	Early Intermediate	1800-1300	Rimac Valley, Central Coast	25
Los Médanos, La Marcha, El Pampón	Early Intermediate/Middle Horizon	2000-1000	Las Trancas Valley, South Coast	272

a = adapted from Kellner 2002, Pechenkina et al. 2007, and Vradenburg 2001
b = all dates are BP – before present
c = the number of individuals presented for Villa el Salvador (VES) will differ, as VES studies with different sample sizes have been published (i.e. Pechenkina et al. 2007; Rhode 2006; Vradenburg 2001). The differences in sample size have to do with the number of skeletal remains analyzed at the time of publication and the type of data being presented.

5.A.2.b: Cardal

Cardal is located in the lower Lurin Valley, and occupied during the late Initial Period. The site is a U-shaped civic/ceremonial center. Cardal had a mixed subsistence strategy of horticulture and foraging, evidenced by several domesticated plants present at the site (Umlauf 1988), along with wild plants and significant marine resources (Rhode 2006; Tykot et al. 2006), as well as domesticated animals (Llama and guinea pig) (Umlauf 1988, Vradenburg 2001). Burger and Salazar Burger (1991) hypothesized that Cardal was an egalitarian society with some individuals interred in a manner that suggested special standing. However, Vradenburg (2001) points out that domestic and skeletal data support a more defined social structure with some individuals having higher status. He believes the social structure at Cardal could have represented a simple chiefdom. The material from Cardal comes from analyses done by Pechenkina et al. (2007) and Vradenburg (2001).

5.A.2.c: Villa el Salvador

Villa el Salvador (VES) is located in the Lurin Valley near the oracle site of Pachacamac. VES is located 1.5 km from the Pacific coast (Stothert 1980). The site itself is largely comprised of a cemetery, although some architecture remains. The individual burials presumably came from Pachacmac, but possibly also from unknown occupation sites in the region.

Like Chongos, VES dates to the EH/EIP, and was influenced by the Topará ceramic tradition (Stothert 1980; Vradenburg 2001; Pechenkina and Delgado 2006). Like the Pisco River, the Lurin river flows year round, providing a steady source of fresh water. Residents in the river valley had access to cane, bushes and thorny trees, much like at Chongos. The cemetery was excavated in the 1970s (Stothert 1980) and then later in the early 1990s (Delgado 1992, 1994), both times as salvage operations. The skeletal materials are currently curated at the museum at Pachacamac, though much of the analysis that is presented below was done when they were at La Casona at San Marcos University in Lima.

Stothert (1980) reports the possibility that VES contains both elite and non-elite burials. Interment methods appear similar to that found at Chongos – the dead were buried in a flexed position, wrapped in cotton textiles, with many individuals buried with grave goods.

The subsistence strategy of the individuals buried at VES can not be known precisely, because their village context is unknown. However, floral and faunal remains recovered at the cemetery suggest an agricultural base perhaps supplemented by foraging (marine and terrestrial) (Rhode 2006; Stothert 1980). Based on the similarities between VES and Chongos in ceramic tradition, time of occupation, and location in a river valley near the ocean, comparisons between Chongos and VES seem valid.

Recently (Pechenkina and Delgado 2006; Rhode 2006) two separate but related hypotheses were posited to explain the differences found in the cemetery population at VES. First, Pechenkina and Delgado (2006) hypothesize that the cemetery at VES contained two different social groups who came from different geographic zones, likely a native coastal group and an upper valley or highlands immigrant group. Health differences among the groups corresponded to differences in cranial deformation. The practice of cranial deformation would have been used as an ethnic identifier.

Second, Rhode (2006) found clear differences in muscle markers from VES burials. The differences fell into two distinct activity patterns consistent with a farming or fishing model developed with other collections. His results showed a roughly even split of males with activity patterns indicative of fishing and farming. About ¾ of the females had muscle markers consistent with fishing. Rhode's (2006) findings support the hypothesis of Pechenkina and Delgado (2006) that two distinct groups were present at VES. However, he hypothesizes that the two groups are fishers and farmers. These people would have largely concentrated on only one subsistence, and entered into trade relationships to acquire other food resources. The VES cemetery would have been a regional cemetery where several villages, and peoples representing at least two subsistence strategies, buried their dead.

To date 238 burials have been recovered from VES (Delgado 1994). Previous studies (i.e. Pechenkina and Delgado 2006; Pechenkina et al. 2007; Vradenburg 2001) report on the number of analyzed skeletons from VES that were available at that time. Rhode's (2006) study required complete skeletons, which yielded a smaller sample size.

5.A.2.d: Huaca Pucllana

Huaca Pucllana is a large administrative and ceremonial center dating to the Lima culture at the end of the EIP (Stumer 1954; Burger 1989). Located in the Rimac valley, the site lies in the Lima suburb of Miraflores. The burials excavated at Huaca Pucllana are thought to be elites or females sacrificed upon the death of an elite. All materials excavated at Huaca Pucllana are curated or on display on site. Material from Huaca Pucllana used in this chapter comes from Pechenkina and colleagues (2007).

5.A.2.e: Nasca

Kellner (2002) presented a bioarchaeological study of skeletal remains from the Julio C. Tello skeletal collection excavated in the Las Trancas valley of the Rio Grande de Nasca drainage. She analyzed material from Early, Middle and Late Nasca (EIP) as well as the Middle Horizon, investigating temporal changes on skeletal health indicators and their relationship to environmental and social changes in the region. The three sites she analyzed are Los Médanos (n = 184), La Marcha (n = 42), and El Pampón (n = 46). Each cemetery has skeletons from each time period. Kellner hypothesizes that all sites engaged in a mixed subsistence strategy of intensive agriculture supplemented by marine resources acquired by trade.

In summary, of the comparison sites, Villa el Salvador is most like Chongos. Similarities between the sites include time period of occupation, influence by the Topará ceramic tradition, and proximity to the Pacific coast and a river with constant water flow. The sites differ in the interpreted use strategy. Villa el Salvador is hypothesized to have been a cemetery site, with few architectural remains, while Chongos is a major habitation site with public spaces that were likely used for administrative/ceremonial purposes. Comparison of the bioarchaeology among all the sites is nonetheless of some utility.

5.B: Trauma

The presence of trauma in a population can inform the level of violence (e.g. Walker 1989) or accidents (e.g. Lovejoy and Heipl 1981). Based on the iconography of the region, Paracas Necropolis (Topará) is a time of increasing violence. Images on textiles and ceramics point toward violence in the form of trophy skulls, warfare, execution, and the taking of prisoners. Violence is one of the outcomes of increasing social complexity in the region (Kellner 2002; Proulx 2008) and time period (Moseley 1992a).

As presented in Chapter 4 (Table 4.2), 12 individuals from the Chongos skeletal collection had evidence of trauma on at least one skeletal element. Two of those individuals were subadults, with one child having a greenstick fracture likely caused by the process of cranial deformation, and another child having a fractured jaw (see 5.G below). Of 10 adults, six males (out of 15 – 40%) and four females (out of 14 – 28.6%) had trauma. Two of the six males had evidence of trauma on the crania, a 50-60 year old male with cuts on the frontal and parietal bones and a 17-19 year old male with a cut on the frontal bone. The cuts were unhealed on both individuals. All other types of trauma were post-cranial, and all were healed at the time of death.

Kellner (2002, Tables 8.2 & 8.3) found post-cranial trauma to be less common than cranial trauma. Like at Chongos, the most common post-cranial trauma among the Nasca samples is the ribs, with 44% of the post-cranial trauma. In the Chongos sample 40% of the adults with trauma had healed rib fractures.

Kellner (2002) found evidence for cranial fractures in each Nasca time period. Males were more likely to be affected than females. Cranial trauma was greatest during Late Nasca times at the end of the EIP.

Vradenburg (2001, Table 24) found that of 36 analyzed crania from VES, 53% (10 of 19) of the males and 6% (1 of 17) of the females had at least one cranial compression fracture. One of the 10 males with a compression fracture did not indicate healing, a peri-mortem injury that may have directly contributed to his death.

At Chongos there is no evidence for compression fractures, showing a distinction with VES to the north and the Nasca sites to the south. For both VES and the Nasca sites, interpersonal aggression was common, and more likely to affect males than females. Jurmain and Kilgore (1998) state that skeletal collections containing many individuals with cranio-facial trauma are indicative of interpersonal aggression, especially when compared to trauma in the post-cranial skeletal remains. Vradenburg and Kellner's data are also consistent with other studies finding that a higher prevalence of cranial injuries will occur among males (Jurmain and Kilgore 1998; Walker 1989). Based on my results and comparing them with Vradenburg's (2001) and Kellner's (2002) results, it appears that interpersonal violence was not a serious problem, at least for those who were buried at Chongos. An alternative explanation could be that victims of interpersonal violence were buried in another location. Vradenburg (2001) hypothesized that the lack of peri-mortem compression fractures at VES was because male victims of interpersonal violence who died away from their homes were buried in another location.

It is interesting to note the amount of post-cranial trauma at Chongos in comparison to Nasca. If post-cranial trauma is usually the result of an accident (Jurmain and Kilgore 1998), this implies that the area in and around Chongos presented a more dangerous location for subsistence activities. Males and females appear equally likely to experience accidental trauma, implying equally treacherous activity patterns and occupational conditions. Chongos is located in a relatively flat area whle Nazca has many hills. Unfortunately, Vradenburg (2001) did not present data on post-cranial trauma, preventing comparison of VES and Chongos post-cranial trauma.

5.C: Dental Health

5.C.1: Caries

The overall rate of carious permanent teeth (21.3%) at Chongos is very high, at the upper end of the range of agriculturalists (Turner 1979), implying a reliance on starchy carbohydrates and the presence of cariogenic bacteria, usually *Streptococcus mutans*. Caries rate was higher among females than males, as is usually the case in agricultural peoples. Caries rates from Chongos and other sites in Perú are presented in table 5.2. For Huaca Pucllana and Paloma only total caries rates are provided (Pechenkina et al. 2007).

Table 5.2: Frequency of Carious Lesions

Site	Male[1]	Female[1]	Total[1]
Chongos	.18 (245)	.26 (150)	.21 (395)
Villa el Salvador[2]	.14 (451)	.27 (360)	.195 (811)
Huaca Pucllana[3]	N/A	N/A	.0724 (332)
Cardal[3]	.04 (176)	.05 (153)	.045 (335)
Paloma[3]	N/A	N/A	.004 (704)

[1] = caries rate is given first with the number of analyzed teeth in parentheses
[2] = data from Vradenburg (2001)
[3] = data from Pechenkina and colleagues (2007)

The caries rate at VES is similar to that found at Chongos ($\chi^2 = 0.42$, $p = 0.52$, 1df), and virtually identical for females ($\chi^2 = 0.01$, $p = 0.92$, 1df), implying that both were reliant on agricultural products for their subsistence. Of course, VES was utilized by at least two different groups who differed by activity (occupational) pattern and/or by ethnicity, but they may not have differed in diet. Caries rates at Cardal and Huaca Pucllana were much lower, and consistent with mixed or horticultural societies, for which there is evidence at Cardal but not Huaca Pucllana, except its propinquity to the sea. The result for Huaca Pucllana is interesting because the site was occupied much later than Cardal. Perhaps the diet of the inhabitants of Huaca Pucllana was different due to their high social status, resulting in the relatively low caries rate in comparison to contemporary sites to the south. Paloma, the only true fisherman site of those listed in table 5.2, has the lowest caries rate, consistent with Turner's (1979) findings for foraging groups. Edwards (1984), who analyzed the Paloma teeth, found only three caries out of 704 analyzed teeth.

Vradenburg (2001) found significant differences in the caries rate between males and females at VES. My results for Chongos are similar to Vradenburg's, with females having a significantly higher rate of carious teeth than males. The difference in caries rates between Chongos and VES is not statistically significant ($\chi^2 = 0.42$, $p = 0.52$, 1df). Vradenburg also reported that females at VES had 5.7 caries per adult, while males had 3.1. This too is consistent with a society reliant on agriculture (Rose et al. 1984), and is similar to the Chongos results. At Chongos females averaged 5.6 caries per adult, with males averaging 4.3.

Almost 82% of the adults at Chongos had at least one caries (table 5.3). The percentage of males with at least one caries is slightly higher than females. Overall, more males at Chongos were directly affected by caries, but the females who had caries had more caries. At VES Vradenburg (2001) reported that 89% of adults had at least one carious lesion, with females (94%) having a higher rate than males (85%). The rates are higher for VES than for Chongos due to the higher rate reported for females (75% for Chongos, 94% for VES). However, Vradenburg did not report how many individuals were used in determining these rates, which precludes comparing the results from VES and Chongos statistically.

Kellner (2002) reported the number of individuals with at least one caries from the EIP and Middle Horizon Nasca river drainage. I compared her results to those found at Chongos using Fisher's exact test, comparing Chongos to each Nasca group individually. I did not use Kellner's overall results, as they included subadults and/or indeterminate adults. Rather, I added the male and female results to get an overall adult rate to compare to the overall Chongos rate. These results are presented in Table 5.4.

Table 5.3: Percentage of individuals with Carious Lesions

Time Period/Site	Percent with carious lesions	N
Chongos	81.8	18/22
Female	75	6/8
Male	85.7	12/14
Early Nasca	44.4	4/9
Female	33.3	1/3
Male	50	2/4
Middle Nasca	51.9	14/27
Female	40	2/5
Male	68.8	11/16
Late Nasca	40.9	9/22
Female	50	5/10
Middle Horizon	54.4	43/79
Female	52.8	19/36
Male	66.7	22/33

According to the results presented in Table 5.4, there is no sex-based statistical difference in the caries rates between Chongos and any of the Nasca sites. The difference between Chongos and Late Nasca, close together in time, approaches significance for males ($p = 0.07$). When males and females were combined to a single group, near statistically significant differences were found between Chongos and the Early Nasca and Middle Horizon groups, with significant differences observed between Chongos and Late Nasca, presumably because of differences between males. Overall, adults at Chongos were more likely to have at least one carious lesion than adults living in the Nasca river drainage with the exception of the Middle Nasca. This suggests a higher carbohydrate diet at Chongos.

Table 5.4: Chongos/Nasca Difference in Number of Individuals with at Least One Caries

Site/Sex comparison	Fisher's Exact Test p-value[1]
Chongos/Early Nasca – pooled for sex	0.07[2]
Female	0.49
Male	0.2
Chongos/Middle Nasca – pooled for sex	0.185
Female	0.29
Male	0.4
Chongos/Late Nasca – pooled for sex	0.03[2]
Female	0.37
Male	0.07[2]
Chongos/Middle Horizon – pooled for sex	0.07[2]
Female	0.43
Male	0.29

[1] = p-values are based on a two-tailed probability
[2] = result approaches statistical significance and in one comparison, exceeds it.

The sites at Nasca also saw a general increase in percentage of older adults who had at least one caries across age groups (Kellner 2002, Table 6.2). This is also consistent with the Chongos results (Table 4.7). At Chongos caries rates varied significantly by age and sex. Even after taking out two potential outliers the results remained statistically significant, demonstrating a population-wide effect for differences in caries rate by age. When males and females at Chongos were combined, the significant differences between age groups showed that caries rates increased with age. The increase in caries rate implies the cumulative exposure of adults to starchy carbohydrates and cariogenic bacteria. The continuous exposure increases the likelihood that an individual will develop at least one carious lesion in a lifetime.

5.C.2: Abscesses

Caries can lead to abscesses (Larsen 1997). Therefore, we should expect a population-level increase in the number of abscesses with an increase in caries rate.

The abscess rate at Chongos is 2.9% (Tables 4.8, 5.5). As is the case with caries, the abscess rate is higher among females than males, though the difference is not statistically significant. One half of the females (4 of 8) analyzed had at least one abscess, while 35.7% (5 of 14) of the males had at least one abscess. These rates are similar to the abscess rates reported by Kellner (2002, Table 6.1 and 6.2, also Table 5.5 below). However, Kellner found that the percentage of males that had at least one abscess was slightly higher than females.

The woman with the most abscesses at Chongos, BY 1800 burial 11, is also the woman with the most caries. This result is consistent with Larsen's (1997) statement that caries can lead to abscesses. The male with the most abscesses, BY1800 tomb 6, age 20-24, had a very high caries rate of 60%. However, he only had five teeth available for examination. It is possible that his caries rate would have been even higher had the other teeth been available for investigation. The male with the second most abscesses, BP 1820 burial 1, age 50-60, is the male with the highest caries rate. For the Chongos collection, it appears that abscesses and caries are closely correlated, and typical for a high carbohydrate diet.

Table 5.5: Percentage of individuals with Abscess(es)

Time Period/Site	Percent with abscess(es)	N
Chongos	**40.9**	**9/22**
Female	50	4/8
Male	35.7	5/14
Early Nasca	**33.3**	**4/12**
Female	25	1/4
Male	33.3	2/6
Middle Nasca	**34.5**	**10/29**
Female	33.3	2/6
Male	47.1	8/17
Late Nasca	**44.4**	**12/27**
Female	45.5	5/11
Male	53.9	7/13
Middle Horizon	**33.3**	**31/93**
Female	36.4	16/44
Male	41.7	15/36

5.C.3: Enamel Hypoplasias

Over 80% of the individuals at Chongos with permanent dentition had at least one enamel hypoplasia (EH) (table 5.6). This result is indicative of episodes of acute stress on children at Chongos during the EH/EIP. This result is much higher than Kellner (2002, table 5.1) reports for Nasca sites. Based on her data, the Middle Horizon sample has the highest percentage of individuals with EH at 17.7%. I compared her results to those found at Chongos using Fisher's exact test, comparing Chongos to each Nasca group individually. Both the Chongos and Nasca overall results include subadults and/or indeterminate adults. These results are presented in table 5.7.

Table 5.6: Percentage of individuals with Enamel Hypoplasia(s)

Time Period/Site	Percent with abscess(es)	N
Chongos	**81.5**	**22/27**
Female	77.8	7/9
Male	80	12/15
Early Nasca	**11.1**	**1/9**
Female	0	0/3
Male	25	1/4
Middle Nasca	**14.8**	**4/27**
Female	0	0/5
Male	18.8	3/16
Late Nasca	**9.1**	**2/22**
Female	10	1/10
Male	0	0/9
Middle Horizon	**17.7**	**14/79**
Female	13.9	5/36
Male	18.2	6/33

According to the results presented in table 5.7, there are strong statistically significant differences in the percentage of individuals from Chongos that have at least one enamel hypoplasia and individuals from Nasca, with a significantly higher number of people from Chongos having at least enamel hypoplasia. Every test but one yielded a statistically significant result, Chongos significantly higher than Nasca, with the weakest difference between males from Chongos and the Early Nasca, approaching statistical significance with a p-value of 0.07. These results clearly show a difference in the percentage of individuals with enamel hypoplasia, with individuals from Chongos more likely to have at least one enamel hypoplasia.

Vradenburg (2001, table 19) reports data on the number of analyzed teeth that have EH. He found that 42% of the teeth analyzed from VES have at least one EH, with males (44%) having a higher percentage than females (39%). At Cardal 16% of the teeth analyzed had at least one enamel hypoplasia –

percentages for males and females was not given. At Chongos 33% of the teeth analyzed had at least one enamel hypoplasia, with males (33%) having a higher percentage than females (28%). Vradenburg (2001) hypothesizes that the higher frequency of EH teeth among males may reflect greater episodes of stress during early childhood, especially around the time of weaning.

Table 5.7: Chongos/Nasca Difference in Percentage of Individuals with Enamel Hypoplasia

Site/Sex comparison	**Fisher's Exact Test p-value[1]**
Chongos/Early Nasca – pooled for sex	0.0003[2]
Female	0.05[2]
Male	0.07
Chongos/Middle Nasca – pooled for sex	0.000002[2]
Female	0.02[2]
Male	0.001[2]
Chongos/Late Nasca – pooled for sex	0.000000037[2]
Female	0.0055[2]
Male	0.0003[2]
Chongos/Middle Horizon – pooled for sex	0.00000000041[2]
Female	0.0005[2]
Male	0.00007[2]

[1] = p-values are based on a two-tailed probability
[2] = result is statistically significant

At Chongos three subadults were analyzed for enamel hypoplasia, and all three had at least one enamel hypoplasia on their permanent dentition. This may reflect enough systemic stress on these individuals from the time of weaning that they were unable to survive to adulthood. If these differences are not due to interobserver error, they make clear that children at Chongos were exposed to occasional severe stresses when teeth were growing, starting with the interuterine period and continuing for the first 12 years of life.

5.C.4: Summary

The dental health of the people buried at Chongos is consistent with an agricultural base although marine protein was also available. Caries rates are consistent with published rates for agricultural groups (Turner 1979) and are consistent with agricultural or suspected agricultural groups along the coast of Perú. There is an association among individuals at Chongos having a high abscess and caries rate. The enamel hypoplasia data suggests population-wide acute childhood stress at Chongos, equally affecting boys and girls. However, the prevalence of enamel hypoplasia in so many adults at Chongos demonstrates that many children were able to survive the episode(s) of stress that affected them and remain strong enough to survive to adulthood.

Caries rates are slightly higher at Chongos than at VES, but the difference is not statistically significant. As presented above, Rhode (2006) has shown convincingly that one of the two groups buried at VES was a group of fishermen, while Pechinkina and Delgado hypothesize that the two groups may represent differences in status. As reported, presumably Vradenburg's (2001) earlier analysis drew specimens from both groups. Therefore it is unknown whether the dental disease profiles of fishers and farmers would be identical. Possibly the fishers and farmers in the end had the same diet due to exchange, but this hypothesis remains for future research.

Given the myriad of similarities between VES and Chongos, it may be preliminary to state that the high caries rate at Chongos supports my hypothesis that the individuals buried at Chongos were agriculturalists. It may be that they were farmers, but it is equally likely that they were fishers who utilized trade networks to acquire agricultural products, and that those products made up the bulk of diet. It is also possible, much like what is hypothesized for VES, that Chongos represents not just a village-level cemetery population, but a regional cemetery that was utilized by more than one distinct group.

The number of individuals at Chongos who have at least one caries is statistically significantly higher ($p = 0.03$) than the Late Nasca group, and approaches statistical significance when compared with the Early Nasca and the Middle Horizon (both $p = 0.07$). When the population was separated into smaller groups of males and females, only one result even approached statistical significance, with Chongos males having a higher percentage of individuals with at least one caries than Late Nasca males ($p = 0.07$). The populations living in the Nasca river drainage were agriculturalists during the EIP and into the Middle Horizon. Though I found statistically significant, or approaching statistically significant, differences between caries rates, with Chongos being higher than most Nasca groups, the percentage of individuals from Nasca with at least one caries is still quite high, and indicative of a population reliant on agriculture (Turner 1979).

Vaughn (2000) found clear evidence of marine products in Early Nasca residential middens. Kellner (2002) believes that the presence of marine foods in Nasca residential sites supports a mixed subsistence strategy not completely dependent on maize agriculture, even though her caries data indicate populations with an agricultural subsistence strategy. If Kellner is right and the Nasca populations had a mixed subsistence strategy of agriculture combined with marine resources, the statistically significant differences found between Chongos and Nasca may reflect that individuals at Chongos relied more heavily on agriculture as a subsistence strategy.

Caries rates for Chongos and VES vary by sex, with females having a higher percentage of carious teeth than males at both sites (table 5.2, also Vradenburg [2001]. This result may be due to dietary differences between the sexes at the sites or even differential access to food, with females consuming a diet higher in starchy carbohydrates. It could also be that females have more carious lesions due to stress associated with pregnancy and lactation (Pechenkina et al. 2007). The latter hypothesis is supported by recent research by Lukacs (2008). He argues the increased fertility associated with agricultural communities increased the difference in caries rates between males and females. The hormone, salivary and dietary changes that occur during pregnancy and that contribute to increased caries rates in females are accentuated by the increased demands on women's reproductive systems by having additional pregnancies. More work needs to be done to test the applicability of Lucacs' hypothesis.

The significant difference in caries rate by sex at VES is interesting in light of Rhode's (2006) finding at VES. He found that there was almost a 50/50 split among males, half being farmers and half fishers. However, over 75% percent of analyzed females had activity patterns consistent with fishing. Rhode did acknowledge that the difference in result could be due to the sample that he took, one not representative of the VES cemetery population as a whole. But, if his result is not due to sampling, this could mean that males and females were engaged in different subsistence strategies, with females more likely to fish. Given the similarity of my Chongos results with VES, it is necessary to consider a similar sex-linked difference in activity patterns at Chongos as an alternative to my hypothesis that all of the burials at Chongos were likely farmers in life, supplementing their diet with marine and perhaps terrestrially foraged resources.

The percentage of individuals with at least one enamel hypoplasia at Chongos is significantly higher than reported by Kellner (2002) for sites from the Nasca river drainage. The percentage of teeth analyzed with at least one enamel hypoplasia is similar to what Vradenburg (2001) reported for VES. Based on the number of individuals at Chongos with at least one enamel hypoplasia, it appears that there was population-wide stress on weaning-age children, affecting both boys and girls. However, the number of adults with enamel hypoplasia also shows that most individuals were able to survive the stress and live to adulthood (mean age at death of individuals with enamel hypoplasia = 26.7 years, mean age at death of individuals without enamel hypoplasia = 33.9 years, $t = -0.85$, $p = 0.2$, 25df). Comparing the results of Vradenburg (2001) and Kellner (2002) it also appears that the level of stress at Chongos was closer to the central coastal populations than the populations living in the Nasca river drainage. The similarity in weaning-age stress between

Chongos and VES may reflect dietary, subsistence, or cultural similarities among the populations, or some combination of the three.

In summary, the dental health data from Chongos and the comparison sites suggests that the Chongos skeletal collection relied on agricultural products for the majority of their calories. The caries rates, frequency of abscesses and enamel hypoplasias are consistent with agricultural groups. The data from Chongos show higher rates than coastal sites in Perú of known marine foragers or of mixed horticulturalists/mixed foragers, and are similar to or higher than sites from coastal Perú that are suspected to be reliant on agricultural product for the majority of their calories. Other data suggest a larger marine component.

5.D: Phytolith Analysis

The phytolith data presented in section 4.E show evidence of plant use, such as seeds, fruits and possibly roots. There is also evidence of industrial plant use, with the presence of these plant materials in calculus indicating the use of teeth as tools.

These results are consistent with a society dependent on economic plant foods for most of their calories. However, the presence of mammal hair and marine invertebrates in the calculus also shows that the people buried at Chongos had meat in their diet. In fact, the trace element data described in section 4.E and discussed in section 5.F provides evidence for the presence of marine resources in the diet, though not at the same level of sites such as

Paloma, who were marine foragers with the vast majority of their calories coming from marine resources. Therefore, the microscopic analysis of Chongos calculus remains does not falsify the question posed by this dissertation, whether the Chongos population received the bulk of their calories from agriculture.

The animal parts in the dental calculus do not clearly support my original hypothesis that the people buried at Chongos were farmers, at least not farmers who received all of their calories from vegetable produce. But, the evidence of a mixed subsistence strategy could support a modified form of the hypothesis, one related to economy more than diet, with the Chongos inhabitants being full-time farmers, but relying on trade to acquire the non-agricultural food products found in the calculus.

5.E: Skeletal Pathology

5.E.1: Porotic Hyperostosis/Cribra Orbitalia (Indicators of Anemia)

5.E.1.a: Cribra orbitalia

Slightly less than half of the individuals from Chongos had evidence of childhood anemia, cribra orbitalia (CO) (section 4.F.1). As can be seen in table 5.8, this result is less than reported by Vradenburg (2001) for VES and Pechenkina and colleagues (2007) for Huaca Pucllana, and more than reported by Kellner (2002) for all time periods in the Nasca river drainage. However, Pechenkina et al. (2007) reported VES data with a larger sample size than what was available for Vradenburg. Their data are closer to that found at Chongos.

I conducted Fisher's exact test to determine if there were significant differences between the results from Chongos and the comparison sites presented in table 5.8. I compared Chongos to each group individually. When available, I also compared the males, females and subadults from Chongos to their comparison sites. All results are in table 5.9. I used Chi-square for the Chongos/Middle Horizon comparison because I had adequate cell size. For VES (Vradenburg and Pechenkina et al.), Huaca Pucllana and Paloma, only adult data is used for the overall prevalence of cribra orbitalia. Therefore, for my comparisons with those sites I pooled only male and female data from Chongos.

Among the central coastal sites, significant differences occurred between the adult populations of VES (Vradenburg's [2001] data) and Huaca Pucllana, the male populations of VES (both groups) and the subadults from Paloma. For all adult samples, the central coastal sites had a statistically significantly higher prevalence of CO than did Chongos. The subadults from Paloma had a statistically significantly lower prevalence of CO than the comparison group from Chongos.

The comparison between Chongos and the Nasca sites shows statistically significant differences at the population level for every time period, with the Chongos population having a significantly higher prevalence of CO. However, when I compared the males, females and subadults from Chongos to their comparison groups from Nasca, the results were not consistently significant. The only statistically significant differences were between Chongos and Middle Nasca subadults, Chongos and Late Nasca females, and Chongos and Middle Horizon females and males. In all instances the Chongos sample was significantly more likely to have higher prevalence of CO than the sample from Nasca.

These results show that Chongos was significantly more affected by cribra orbitalia than all populations from Nasca, reflecting a greater burden of anemia (table 5.9). However, the greater presence of adults with CO at Chongos than at Nasca may reflect the greater likelihood of that population to be able to live with anemia contracted in childhood. On the other hand, the central coastal sites have a greater burden of anemia than does Chongos. This appears especially true for the VES male population, who had a significantly higher prevalence of CO than Chongos males. This results suggests a high parasite load among males at VES that was not evident at Chongos.

The prevalence of CO at Chongos is higher among subadults than adults. This result is consistent with the comparison groups with the exception of Early Nasca and Paloma. CO is associated with childhood stress, and normally occurs early in life as a result of severe anemia, which can result in premature death (Larsen 1997; Pechenkina et al. 2007; Steckel and Rose 2002).

Despite the differences by subpopulation, the population-level similarity is interesting due to similarities between VES and Chongos. Both cemeteries were used during the same time period, ceramics recovered at the sites indicate influence by the Topará ceramic tradition, and both are located near the ocean in a river valley where the river flows year-round. Similarities between the Initial

Table 5.8: Prevalence of Cribra Orbitalia

Time Period/Site	Percent affected	Number affected
Chongos – pooled over sex	**46.7**	**14/30**
Female	50	3/6
Male	27.3	3/11
Subadults	61.5	8/13
Villa el Salvador[1, 3] – pooled over sex	**72**	**26/36**
Female	58	10/17
Male	84	16/19
Villa el Salvador[2,3] – pooled over sex	**46**	**28/60**
Female	37	12/32
Male	61	16/26
Subadults	86	36/42
Huaca Pucllana[3] – pooled over sex	**67**	**12/18**
Cardal	**32**	**7/18**
Female	29	2/7
Male	38	3/8
Subadults	67	2/3
Paloma[3] – pooled over sex	**30**	**21/69**
Subadults	18	8/44
Early Nasca – pooled over sex	**7.1**	**1/14**
Female	0	0/4
Male	12.5	1/8
Subadults	0	0/2
Middle Nasca – pooled over sex	**5.6**	**2/36**
Female	0	0/6
Male	5.9	1/17
Subadults	9.1	1/11
Late Nasca – pooled over sex	**12**	**3/25**
Female	0	0/8
Male	7.7	1/17
Subadults	50	2/4
Middle Horizon – pooled over sex	**9.8**	**9/92**
Female	6.8	3/44
Male	3.0	1/33
Subadults	28.6	4/14

[1] = from Vradenburg (2001)
[2] = from Pechenkina et al. (2007)
[3] = results are for adults only

Table 5.9: Difference in the Percentage of Individuals with Cribra Orbitalia

Site/Sex comparison	**Fisher's Exact Test p-value[1]**
Chongos/Villa el Salvador[3] – pooled over sex	0.016[2]
Female	1.0
Male	0.0045[2]
Chongos/Villa el Salvador[4] – pooled over sex	1.0
Female	0.66
Male	0.08[2]
Subadults	0.106
Chongos/Huaca Pucllana – pooled over sex	0.09[2]
Chongos/Cardal – pooled over sex	0.765
Female	0.59
Male	1.0
Subadults	1.0
Chongos/Paloma – pooled over sex	0.77
Subadults	0.0045[2]
Chongos/Early Nasca – pooled over sex	0.015[2]
Female	0.2
Male	0.6
Subadults	0.2
Chongos/Middle Nasca – pooled over sex	0.0001[2]
Female	0.18
Male	0.27
Subadults	0.013[2]
Chongos/Late Nasca – pooled over sex	0.008[2]
Female	0.055[2]
Male	0.27
Subadults	1.0
Chongos/Middle Horizon – pooled over sex	$\chi^2 = 17.78$, $p < 0.0001$, 1df[2,5]
Female	0.02[2]
Male	0.04[2]
Subadults	0.13

[1] = p-values are based on a two-tailed probability
[2] = result is statistically significant, or approaches statistical significance
[3] = data from Vradenburg (2001)
[4] = data from Pechenkina et al. (2007)
[5] = due to larger cell size, Chi-square was used instead of Fisher's exact test

Period Cardal site and Chongos also exist. Cardal, like VES, is located in the Lurin river valley, and had a mixed subsistence strategy. It is interesting that although there were significant differences between caries rates between Chongos and Cardal, there is no difference in rates of CO.

Pechenkina and colleagues (2007) found that at VES the probability of children with CO dying was higher than for children who didn't have CO. This result is consistent with the Chongos results, where the mean age at death (MAD) of individuals with CO was significantly lower than for those who didn't have CO. These results are similar what Blom and colleagues (2005) reported for other sites along the central coast of Perú. However, the Chongos data are different from what Blom and colleagues (2005) reported for the south coast of Perú, which included samples from the Pisco valley. Blom and colleauges found that CO rates along the south coast were lower when compared to the central coast, and that there was no difference in CO prevalence by age, thus no evidence for CO being associated with a lower MAD.

The data from VES and Chongos suggest that iron deficiency anemia was a significant contributor to mortality among subadults and younger adults at Chongos, just as it was at VES. In a recent survey, Cohen and Crane-Kramer (2007b) found that world-wide the frequency of CO during prehistory varied by time and location. In the New World, they found that the frequency of CO increased over time in the North American samples that were surveyed, as well as in Perú. Frequencies were high and steady in Chile.

5.E.1.b: Porotic Hyperostosis

Just over half of the individuals from Chongos had evidence of porotic hyperostosis (PH), another indicator of anemia, but one that can be mimicked by the effects of cranial deformation (section 4.F.1). As one can see in table 5.10, this result is similar to that reported by Pechenkina and colleagues (2007) for Huaca Pucllana, and for both VES results (Pechenkina et al. 2007; Vradenburg 2001), but higher than all other sites.

In the same manner as presented above for CO, I conducted Fisher's exact test to determine if there were significant differences between the results from Chongos and the comparison sites presented in table 5.10. I compared Chongos to each group individually. When available, I also compared the males, females and subadults from Chongos to their comparison sites. All results are in table 5.11. I used Chi-square for the Chongos/Middle Horizon comparison because I had adequate cell size. For VES (Vradenburg and Pechenkina et al.), Huaca Pucllana and Paloma, only adult data is used for the overall prevalence of cribra orbitalia. Therefore, for my comparisons with those sites, I pooled only male and female data from Chongos.

Among the central coastal sites, significant differences occurred between the total population and male population at Cardal, and the adult and subadult population at Paloma. There was no difference between Chongos and VES or Huaca Pucllana.

The effects of a chronic disease like PH on the acute diseases that presumably killed most people from Chongos are quite similar to those reported for VES. At Chongos, the MAD of individuals with PH was not significantly lower from those with no PH. Pechenkina and colleagues (2007) do not report any differences in the probability of dying at VES based on the presence of PH, implying that PH did not have a noticeable effect on mortality. Taken in isolation, this result alone suggests that Chongos people were not more stressed as adults than those from VES.

Just as I reported above in the case of CO, the comparison between Chongos and the Nasca sites shows statistically significant differences at the population level for every time period, with the Chongos population having a significantly higher prevalence of PH. However, when I compared the males, females and subadults from Chongos to their comparison groups from Nasca the results were different from that seen for CO. Males from Chongos had a statistically significantly higher prevalence of PH than every Nasca population. Among subadults, only the Early Nasca population did not have statistically significantly differences from Chongos, again with the Chongos population having statistically significantly higher prevalence than the Nasca populations. Among females, there were no statistically significant differences between Chongos and the Nasca populations. Again, these results support the presence of a greater burden of anemia at Chongos when compared to each time period at Nasca. Possibly the results are confounded by different kinds and frequencies of cranial deformation (Guillen 1992). The greater frequency of PH among the adult populations may also demonstrate a greater ability of the Chongos population to have lived with a high parasite load or extreme deformation.

As mentioned in Chapter 4, the Chongos frequency of occurrence data do not support Aufderheide and Rodriguez-Martin's (1998) proposal that cranial deformation is a major contributing factor to the presence of PH on crania from

Table 5.10: Prevalence of Porotic Hyperostosis

Time Period/Site	Percent affected	Number affected
Chongos – pooled data	**54.8**	**17/31**
Female	33	2/6
Male	63.6	7/11
Subadults	57.1	8/14
Villa el Salvador[1] – pooled data	**50**	**18/36**
Female	35	6/17
Male	63	12/19
Villa el Salvador[2,3] – pooled data	**48**	**29/61**
Female	40	12/30
Male	58	17/30
Subadults	59	22/37
Huaca Pucllana[3] – pooled data	**59**	**10/17**
Cardal	**13**	**4/30**
Female	8	1/12
Male	11	1/9
Subadults	22	2/9
Paloma[3] – pooled data	**6**	**4/69**
Subadults	14	5/36
Early Nasca – pooled data	**7.7**	**1/13**
Female	0	0/4
Male	12.5	1/8
Subadults	0	0/2
Middle Nasca – pooled data	**0**	**0/39**
Female	0	0/8
Male	5.9	0/17
Subadults	9.1	0/12
Late Nasca – pooled data	**3.3**	**1/30**
Female	0	0/11
Male	6.7	1/15
Subadults	0	0/4
Middle Horizon – pooled data	**5.1**	**5/98**
Female	9.1	4/44
Male	2.8	1/36
Subadults	0	0/16

1 = from Vradenburg (2001)
2 = from Pechenkina et al. (2007)
3 = results are for adults only

Table 5.11: Difference in the Percentage of Individuals with Porotic Hyperostosis

Site/Sex comparison	Fisher's Exact Test p-value[1]
Chongos/Villa el Salvador[3] – pooled data	1.0
Female	1.0
Male	1.0
Chongos/Villa el Salvador[4] – pooled data	0.66
Female	1.0
Male	0.74
Subadults	1.0
Chongos/Huaca Pucllana – pooled data	1.0
Chongos/Cardal – pooled data	0.001[2]
Female	0.515
Male	0.03[2]
Subadults	0.197
Chongos/Paloma – pooled data	0.000025[2]
Subadults	0.0035[2]
Chongos/Early Nasca – pooled data	0.006[2]
Female	0.47
Male	0.059[2]
Subadults	0.47
Chongos/Middle Nasca – pooled data	0.0000000034[2]
Female	0.165
Male	0.0003[2]
Subadults	0.002[2]
Chongos/Late Nasca – pooled data	0.000009[2]
Female	0.11
Male	0.003[2]
Subadults	0.09[2]
Chongos/Middle Horizon – pooled data	$\chi^2 = 37.74$, $p < 0.0001$, 1df[2,5]
Female	0.146
Male	0.00004[2]
Subadults	0.0005[2]

[1] = p-values are based on a two-tailed probability
[2] = result is statistically significant
[3] = data from Vradenburg (2001)
[4] = data from Pechenkina et al. (2007)
[5] = due to larger cell size, Chi-square was used instead of Fisher's exact test

the Perúvian coast. I found no statistically significant difference in the prevalence of PH among those with and without cranial deformation. These results are consistent with those reported by Pechenkina and colleagues (2007). However, inspection of the Chongos crania showed that some porosity coded as PH actually tracked the impressions left by the deformation bands. Removing those as inappropriately scored would suggest that Chongos deformed individuals actually suffered from less PO than those with no cranial deformation. If deformation was, as is usually found to be the case, a marker of higher status, then the interpretation of these percentages is confounded. If cranial deformation among the individuals buried at Chongos were a marker of high status, perhaps the high levels of PO among high status individuals supports the premise of Wood and colleagues (1992) in the osteological paradox. In such a scenario, the presence of skeletal lesions indicates the ability of the high status individuals to live even after long-term exposure to stress resulting in the development of PO.

Pechenkina and colleagues (2007) hypothesize that the high levels of CO and PH in coastal sites reflects a high parasite load precipitated by the introduction of maize agriculture along the coast of Perú. While maize is strongly associated with caries, it is not the only crop grown in coastal Perú during the EH/EIP. Plant food items actually recovered from Chongos burials include peanuts, maize, sweet potato and manioc. Thus, maize was not the sole source of agricultural resources at Chongos, nor the only carbohydrate. The similarities between many central coastal sites and Chongos would support the hypothesis of the people buried at Chongos having a predominantly agricultural source for the bulk of their calories. The significant differences between Paloma and Chongos would also support this finding, as Paloma was occupied before the establishment of maize agriculture along the Perúvian coast, and engaged in a foraging subsistence strategy, although with five cultigens playing a minor role (Benfer 1999).

5.E.2: Skeletal Lesions

Almost half of the individuals from Chongos had skeletal lesions on at least one skeletal element (section 4.F.2). This rate is similar to what Kellner (2002, table 11.3) reported for the entire Nasca collection (44%). However, the Chongos rate is much higher than she reported for the Nasca samples that date to the EIP (27.9%). Kellner also reported that slightly under one quarter of the tibia from Nasca had skeletal lesions, which is consistent with the results from Chongos (26%).

Periosteal lesions can arise from infections from cuts in the skin, where frequency is obviously related to lifeway. However, when the lesions are bilateral and dispersed, it may be the result of systemic treponemal infection (Vradenburg 2001).

Vradenburg (2001) argued that a virgin-soil disease spread throughout the central coast of Perú during the Initial Period, demonstrated by increased evidence for systemic infection among the Cardal skeletal collection. He hypothesized that this new disease state had its origin in the Chavin cultural sphere, with the source of the disease ultimately coming from the Amazon. Such an unknown disease would have resulted in social upheaval severely affecting the structure of the society. The virulence of the disease strain decreased over time, and by the EH/EIP the impact of the disease was greatly compromised. The VES skeletal population showed evidence of systemic infection that could have been the virgin-soil disease hypothesized by Vradenburg (2001), but was present at much lower levels than during the Initial Period.

Pechenkina and colleagues (2007) reported data on the frequency of individuals with evidence of systemic infection, defined as bilateral periosteal lesions. Their data are summarized below in table 5.12, along with data from Chongos. As in previous sections in this chapter, the Chongos data most closely resemble those reported for VES. Kellner (2002) also reports higher levels of osteoperiostitis among the Early Nasca, who overlap temporally with Chongos and VES. The frequency of males with evidence of systemic infection at Chongos is statistically significantly higher than for females, as it was at VES (Pechenkina et al. 2007; Vradenburg 2001). One of the two subadults with evidence of systemic infection is the child who had the broken jaw (see 5.G). Vradenburg (2001) hypothesized that there was a shift in the epidemiology of treponemal infection leading up to the EIP, with chronic treponematosis endemic in adult populations. However, there was no direct evidence for treponematosis at Chongos other than bilateral lesions on tibiae. Neither Pechenkina and colleagues (2007) nor Vradenburg (2001) found any evidence that the presence of the disease increased the likelihood of death during adulthood.

Along both the central and south coast of Perú systemic infection appears to have affected males more than females, perhaps indicating that males had more direct contact with people outside their immediate region, if the infection was similar to yaws or pinta, where touch transmitted the disease. However, tibias are the most common skeletal element affected bilaterally. These bones are often affected by accidents. The anterior tibia, especially on the proximal end, has very little soft tissue protecting the bone. Therefore, any type of accident that broke the skin on the tibia could result in a lesion on the bone. Blood could transfer the disease from the bone to its antimere, although one would expect a weaker response in the tibia and a more generalized response throughout the skeleton. When blood transfers the disease, the increased incidence of bilateral lesions indicative of systemic infection among males could reflect a higher probability of males having some type of accident or trauma that directly affects the tibia rather than increased contact with outsiders. At Chongos I noted that the strength of periosteal lesions was usually equivalently strong on each tibia. This suggests that the infection was passed through the blood, quickly affecting both sides of the body.

The lesion data may support my hypothesis that the skeletal collection from Chongos represented farmers who supplemented their diet with marine resources or through foraging. However, this is dependent on the validity of Vradenburg's (2001) analysis and interpretation of his results. The rates of systemic infection at Chongos are similar to that described by Vradenburg (2001) and Pechenkina and colleagues (2007) for VES. Vradenburg (2001) argued that VES was protected from the impact of the Amazonian disease strain partly because of their location in the lower Lurin river valley. The lower valley provided the potential for greater agricultural production than did the middle and upper valley, and the proximity to the Pacific Ocean offered the possibility for marine resources to supplement their diet. Vradenburg (2001) states that the difference in animal protein may have provided the individuals buried at VES more protection against disease than at Tablada de Lurin in the middle Lurin valley, which had less animal protein in their diet. The disease strain would have resulted in a low-level chronic condition along the coast. Vradenburg hypothesizes that the disease would have spread mainly through warfare and trade, both of which would have brought males from different polities into close contact. If the effects of the Amazonian disease strain were felt along the south central coast of Perú, then the rates of systemic infection at Chongos would argue for a similar subsistence pattern at Chongos as what was hypothesized by Vradenburg for VES, namely intensive agriculture supplemented with animal protein.

Table 5.12: Prevalence of Individuals with Generalized Periosteal Lesions

Site	Adult freq. (n[b])	Female freq. (n)	Male freq. (n)	Subadult[a] freq. (n)
Chongos	0.28 (29)	0.07 (14)	0.47 (15)	0.2 (10)
Cardal	0.50 (16)	0.62 (8)	0.28 (7)	0.75 (12
Villa el Salvador	0.23 (82)	0.11 (46)	0.53 (36)	0.00 (38)
Paloma	0.22 (87)	0.18 (40)	0.28 (40)	0.11 (57)
Huaca Pucllana	0.03 (34)	0.00 (14)	0.05 (20)	0.00 (18)

[a] = Pechenkina et al. (2007) considered anyone under the age of 20 to be a subadult. At Chongos all individuals who were old enough to have a sex estimation were considered adult.
[b] n = number of individuals

I am skeptical of the disease hypothesis that Vradenburg posits, at least regarding interpretation of the Chongos infection data. In general the results from VES (and Chongos) are the opposite of the results from Cardal – at VES males were more affected by generalized periosteal lesions, where females were more affected at Cardal, which Vradenburg argued was severely affected by a virgin-soil disease that originated from the Amazon. Also, the sample size was quite small for Cardal, as it is for Chongos. Above I hypothesized that the higher rate of systemic infection among males indicated more contact with potential disease vectors. What would account for the rate observed at Cardal, where more females were affected, and children were especially affected?

Another source of skepticism relates to the osteological paradox (Wood et al. 1992). If VES was 'protected' from the invading disease that so heavily affected the individuals from Cardal, then that would mean that the lower presence of systemic infection at VES would indicate healthier individuals. While Vradenburg's (2001) interpretation is consistent with most critiques of the osteological paradox (i.e. Cohen 1994; Goodman 1994), it does not account for the increase in systemic infection in later time periods that caused males to be less healthy during the EH/EIP than in the Initial Period. Perhaps it is increased contact with merchants or other traders.

Three of the individuals from Chongos with evidence of systemic infection are described in greater detail in 5.G below.

5.E.3: Degenerative Joint Disease

Half of the individuals from Chongos had DJD on one or more skeletal elements, with females more likely to be affected than males, though the difference was not statistically significant. The most common skeletal elements affected were the bones of the vertebral column. All long bones were commonly affected as well, with the femur and humerus most commonly affected (section 4.F.3). Kellner (2002, Table 11.5) found that among the Nasca the elbow and knee joints were commonly affected by DJD. She found no sex differences in joints affected by DJD. At Chongos, the only skeletal element that had statistically significant differences by sex was the cervical vertebrae.

One skeletal element that I would like to discuss in more detail is DJD of the temporomandibular joint (TMJ). Nine individuals (36%) from Chongos had DJD in the TMJ. It appears that, at least at Chongos, DJD of the TMJ is associated with cranial deformation. Eight of the nine affected individuals (88.9%) had artificial cranial modification. Both affected subadults had artifical cranial deformation. Three of the four individuals who had DJD on only one skeletal element were young, and were only affected at the TMJ.

The only reported pathology usually associated with artifical cranial deformation is PH on the pressure points of the deforming apparatus (Allison et al. 1981; Torres-Rouff 2002). However, recent research (Mendonça de Souza et al. 2008) shows that the process of cranial deformation can lead to a variety of pathologies and even death. The case Mendonça de Souza and colleagues describe is an infant who was undergoing active cranial deformation at the time of death. The child had necrosis and lesions on the skull as a direct result of the process of cranial deformation. The authors posit that the use of the deforming apparatus on the child led to six different types of changes in the skull and probably death.

Another pathology that associated with artificial cranial deformation but is underreported is DJD on the TMJ, especially among younger individuals. This supports yet another pathology associated with artificial cranial deformation. Though artificial cranial deformation is normally believed to only affect the crania and not facial form (i.e. Buikstra and Ubelaker 1994; Torres-Rouff 2002), I believe that the movement of the cranial vault also affected the TMJ, affecting the angle for the insertion of the mandibular condyles into the TMJ. My findings may be supported by the findings of Rhode and Arriaza (2006), who found that artificial cranial deformation affected facial dimensions, generally in the direction of the cranial modification. The slight change in angle could lead to premature DJD in the TMJ, affecting individuals in their teens or even younger. The subadult who had the broken jaw also had DJD at the TMJ. Though the child had artificial cranial modification that could have resulted in early DJD at the TMJ, it is also possible that such an early manifestation of DJD at that location is due to the trauma to the jaw. Pechenkina and Benfer (2002) suggested that TMJ could result from a single event that stressed the joint excessively. The likelihood of masticating particles of rock originating from stone batanes and manos used in food preparation or pieces of shell from shellfish would have been strong, whether the diet were primarily agricultural or marine. However, I did not observe chipped posterior teeth that would have accompanied the results of such chewing. Because of this, the parsimonious hypothesis to explain DJD at the TMJ is gradual stress resulting from a bad occlusal angle due to cranial deformation. However, the subadult with the broken jaw probably represents an exception, as the trauma to the jaw likely adjusted the alignment of the jaw, leading to the early onset of DJD.

The mean age at death (MAD) of individuals at Chongos with DJD was generally higher than for those with no DJD (table 4.16). This result is likely due to the cumulative nature of activity patterns that lead to DJD, although see Pechenkina and Benfer (2002). The presence of DJD implies that the individual lived long enough to have their repetitive activities begin to degenerate skeletal joints. However, the MAD of females with DJD was consistently lower than the MAD of males with DJD. This pattern of greater longevity of males was not seen when MAD was recalculated for males and females without DJD. The consistency of females with DJD dying at a younger age than their male counterparts with DJD suggests that the presence of DJD is a contributing factor in premature death among females.

5.E.4: Schmorl's Nodes

The presence of Schmorl's nodes in skeletal remains signals that heavy loads were supported on the back (Blau 2007; Capasso et al. 1999; Larsen 1997;

Schmorl and Junghanns 1971). Only six of 29 adults (20.7%) at Chongos had evidence of Schmorl's nodes. This result is higher than reported for contemporary society (Pfirrmann and Resnick 2001), likely suggesting a labor pattern of consistently and systematically carrying heavy loads on the back (Larsen 1997). Three males and three females had Schmorl's nodes, indicating no sexual division of labor in carrying heavy loads. However, I think it is worth highlighting that the most affected individuals were all younger adults at the time they died (table 4.11). The number of Schmorl's nodes on these individuals must have meant that they not only supported heavy loads on their backs, but that this was a habitual activity, although it is possible that one extreme lift could have resulted in herniation of the vertebra. The presence of the Schmorl's nodes may have signalled the morbidity of these individuals, contributing to their early death, or perhaps because of class differences in access to resources.

5.E.5: External Auditory Exostoses

The presence of external auditory exostoses (EAEs) in a population is a strong indicator for the action of cold water, and in coastal Perú for a marine-based subsistence strategy (Benfer 1990; Okumura et al. 2007; Standen et al. 1997). However, low levels of EAEs in a population may be the result of different kinds of stresses or ear pathologies (Ponzetta et al. 1997). A review by Hutchinson and collagues (1997) found that a variety of conditions can stimulate EAEs in an individual, including prolonged exposure to cold water. Based on their review and the water temperatures that are necessary to stimulate EAEs, Hutchinson and colleagues' (1997) results supports the cold water hypothesis for central and southern coastal Perú.

Benfer (1990) found that there was a moderate presence of EAEs at Paloma, in each case, a male, suggesting that marine foraging activities (diving for shellfish, swimming in bays to net fish, and/or riding in small fishing vessels) would stimulate the development of EAEs (Rhode 2006). Therefore, if the people buried at Chongos also engaged in fishing, I would expect a low to moderate prevalence of EAE in the skeletal population.

One individual, BY1780 burial 4, a male aged 19 to 21 years at the time of death, is the only adult from Chongos (29 adults, 3.45%) with a visible EAE. He had one EAE in each ear canal. This frequency is close to lying within the range reported by Ponzetta et al. (1997), 4-4.7% for coastal groups of presumed fishing subsistence. The EAEs in this individual may be due to other types of stressors or pathologies, and not because of spending a lot of time in the water (Hutchinson et al. 1997; Ponzetta et al. 1997). It is also possible that this one individual spent much time in the water to develop bilateral EAEs (Rhode 2006). It is possible that he was a fisher and was buried at Chongos, representing a fisherman in the cemetery population. Rhode's (2006) finding that the Villa El Salvador cemetery was comprised of fishers and farmers, based on the pattern of entheses, makes this finding of interest. However, individual BY1780 burial 4 had artificial cranial deformation, which is not consistent with Rhode's findings for VES, where fishers did not have artificially deformed skulls.

Though EAEs provide clear evidence for maritime activities, it is not the only evidence for fishing. Rhode (2006) found that in the females he analyzed with activity patterns consistent with fishing, they did not have EAEs. The literature shows that EAEs are much less common in females than males (Capasso et al. 1999; Okumura et al. 2007; Standen et al. 1997). Rhode suspects that these females fished from the shore, either with hook and line or by throwing nets.

The low prevalence of EAEs at Chongos lies almost within the range established by Ponzetta and colleagues (1997) to indicate fishing. So, the presence of even one individual with EAE provides evidence for a mixed economic strategy present among those buried at Chongos. It may be that this male was a fisher from the nearby Pacific coast who was buried at Chongos for some reason. He may have been a farmer who fished in his spare time, and spent enough time in the water to develop EAEs in both ears, although this is an extreme expression. He may have been from another region, died at Chongos and was buried there. However, the style of cranial deformation this male had is consistent with that found along the south central coast of Perú during the EH/EIP. It is also possible that the presence of a young male with EAEs in both ears represents the cemetery at Chongos being used by more than one group, including fishers and farmers, in much the same way as Rhode (2006) argues for the cemetery at VES. In short, with just one individual with EAEs in the Chongos skeletal collection, any number of competing hypotheses to explain his presence in the skeletal collection are possible.

5.E.6: Adult Stature

Variation in adult stature can reflect population-based variation in environmental factors (Larsen 1997; Pechenkina and Delgado 2006; Steckel and Rose 2002; Steckel et al. 2002a). The amount and quality of nutrition and disease load are mitigating factors in an individual reaching their maximum potential height. At a population level, a shorter population may reflect a population that suffers from chronic nutritional deficiencies and/or a high disease load. Within a population, differences may be attributable to chronic diseases acquired in childhood whose marks persist in adult skeletal materials, as we have seen above for Chongos.

The stature results from Chongos cannot be statistically compared with the central coastal or Nasca sites because I used a different stature formula from the other investigators. However, the Chongos stature estimates (table 4.13) are consistent with the EIP populations reported by Pechenkina and colleagues (2007, table 7.5). The stature estimate for Paloma is about 10 centimeters taller for both males (165.1 cm to 155.9 cm) and females (155.2 cm to 144.6 cm), indicating a higher animal protein diet through childhood for the Paloma population as compared to the Chongos population. Pechenkina and colleagues (2007) found that Paloma long bone lengths were statistically significantly longer than all other sites from the central coast of Perú. Worldwide, fishermen, with their access to animal protetin, tend to be tall.

The adult stature at Chongos is taller than that reported by Pechenkina and colleagues (2007) for the earlier Initial Period site of Cardal (150.6 cm for males, 142.7 cm for females). This would be a surprise if the Cardal burials are from elite individuals associated with the U-shaped ceremonial center. However, the authors also hypothesize that the burials may represent captives or other low-status individuals who may not have had adequate nutrition to reach their maximum stature. Vradenburg (2001) argues that the population buried at Cardal was affected by an infectious treponemal disease strain that originated in the Amazon. The greatly expanding population at and around Cardal during the Initial Period may have maintained the viability of the disease pathogen at Cardal. The increased disease load at Cardal may have depressed the realized stature of the population. The fact that population groups were more dispersed during the EIP would have minimized the impact of this disease.

The stature results from Chongos show a population that was a bit short compared with sites from the central coast. Stature can be associated with health status, with shorter populations resulting from poorer health status than taller populations (Larsen 1997; Pechenkina and Delgado 2006). The Chongos result may reflect poorer health status due to poor nutritional status for the entire population or a high pathogen load resulting in endemic disease in the region. Likely it is a combination of the two, with people at Chongos being exposed to a high pathogen load and occasional bouts of nutritional stress. Episodic el Niños bring drought or inundations for farmers and loss of easily netted fish for fishers (Benfer et al. in press). Since protein in childhood is the best predictor of adult stature (e.g. Larsen 1997; Ortner 2003; Steckel and Rose 2002), the shortness of adults at Chongos argues against a very strong component of marine animal protein in the total calories consumed by children. The high prevalence of enamel hypoplasia at Chongos indicates population-wide periods of stress during childhood. These periods of childhood stress may have decreased the ability of the individuals buried at Chongos to have maximized their adult stature (Steckel et al. 2002a) at the population level. However, I found no individual association between enamel hypoplasia and shorter stature, nor did I find evidence for individuals with enamel hypoplasia dying earlier than those without.

5.E.7: Summary

The CO and PH data from Chongos resemble frequencies observed in collections from the central coast that are associated with maize agriculture. However, males from the central coast had higher frequencies of CO and PH than did Chongos males. The CO and PH data for Chongos are consistently, and statistically significantly higher, than the results reported by Kellner (2002) for skeletal collections from the Nasca river drainage. These results may reflect a higher pathogen load at Chongos, persistent nutritional stress at Chongos, or contact with outsiders bringing new disease vectors. The similarity between the Chongos and VES results may be due to the temporal and cultural association of the sites, as well as the similar geographic location of the sites relative to the ocean and their respective river valleys.

In Chapter 2, I briefly described the osteological paradox (Wood et al. 1992), including its implications for paleopathology, as well as two strong critiques of how the osteological paradox was used to reinterpret existing paleopathology data (Cohen 1994; Goodman 1994). The high prevalence of CO and PH at Chongos is interesting in light of the issues of selective mortality and hidden heterogeneity raised by Wood and colleagues (1992), as well as Goodman's (1994) rebuttal of the osteological paradox. The Chongos results, where the mean age at death (MAD) of individuals with CO was statistically significantly lower than the MAD of individuals with no CO, might seem to reflect a 'healthy' population according to the osteological paradox. The fact that so many adults had lesions associated with childhood stress indicates that the individuals were strong enough to survive the stressful episode(s) during childhood and live to adulthood. Though they carried a lesion indicative of childhood stress, they died in adulthood due to a cause unassociated with CO, and probably at an age that did not reduce their fertiltiy. My results are in line with the Oneota skeletal collection Wood and colleagues (1992) used to illustrate selective mortality.

Alternatively, the CO result from Chongos clearly shows that individuals with CO died earlier than those without. Rather than interpreting the results as reflecting a 'healthy' population, individuals with lesions on their bones could reflect unhealthy individuals who were not able to successfully survive episodes of stress associated with nutritional, environmental and/or disease events. Such an interpretation would be consistent with that suggested by Goodman and

Armelagos (1988) in their presentation of enamel hypoplasia data from Dickson Mound (see also Goodman 1994). Goodman and Armelagos found that the mean age at death (MAD) of individuals with two or more enamel hypoplasias was significantly less than among individuals with no enamel hypoplasias. They interpreted these data to reflect differentiation in social status, where individuals of lower social status had poorer health and higher mortality at every stage of life.

Herein lies the paradox. Wood and colleagues (1992; Wood and Milner 1994) interpret data very similar to the cribra orbitalia data from Chongos as an example of selective mortality, more accurately reflecting the population of individuals who died at a particular time than the population of individuals who lived past a certain time period. However, Goodman and Armelagos (1988; Goodman 1994) interpreted enamel hypoplasia data with similar differences in mean age at death (MAD) as indicative of poorer health among those with lesions who died earlier. Goodman (1994) emphasized the cultural context of the burials at Dickson Mound, something he claims Wood and colleagues (1992) failed to do when outlining the osteological paradox. Rather, Wood and colleagues (1992) offered a different explanation, that in order for the individuals to have a lesion on the body, that individual had to be strong enough to survive the stress, in this case forming an enamel hypoplasia after enamel formation resumed. Based on this explanation, the lower MAD at Dickson Mound reflects strong, healthy individuals who lived beyond a stressful event during childhood. The lower MAD was the result of higher fertility, not higher mortality. The individuals at Dickson Mound with enamel hypoplasias were advantaged, not disadvantaged, because they were able to survive one or more childhood episodes of stress.

I believe the Chongos cribra orbitalia data may support the argument made by Wood and colleagues (1992), that individuals with CO represented healthy, perhaps privileged individuals who were able to survive one or more episodes of childhood stress. However, I do have one reservation with this interpretation. As described in Chapter 4, all eight subadults with CO at Chongos had completely active lesions at the time of their death. So, even though these individuals were able to survive one or more stress episodes long enough to develop lesions, these subadults still did not survive the stress episode long enough for the lesions to begin to heal. Of the six adults with CO, one had completely active lesions, three had lesions that were at least partly active, and two individuals had completely healed lesions, meaning that five of the adults survived the stress event, two of them surviving for quite some time. It is interesting to note that both individuals with healed lesions were males, perhaps reflecting preferred status of males in the population (see section 6.A.1).

Perhaps the eight subadults represent individuals who were moderately healthy. Wood and colleagues (1992) argue that less healthy individuals should have fewer lesions on their bones because they were so frail that they died before lesions could form. Because the subadults from Chongos had active lesions at the time of their death, it could be that they were healthy enough to survive long enough to develop lesions, but not healthy enough to survive the stressor that led to the CO. Therefore, the presence of CO on subadults would reflect healthier subadults who were able to at least live for some time after exposure to a stressor, long enough for lesions to develop.

Males from Chongos are more affected by systemic infection than females. This is true of all comparison sites from the central coast with the exception of Cardal. However, Cardal may be a unique situation due to the possibility of its early exposure to an infectious treponemal disease from the Amazon (Vradenburg 2001). Vradenburg speculates that the decrease in systemic infection along the central coast reflects decreases in population density and therefore the number of possible vectors to transmit the disease. He also suggested that by the EH/EIP the populations along the central coast had co-evolved with the disease, therefore the effects of the disease would not be as severe on the later skeletal collections. The similarity of systemic infection between VES and Chongos supports similar economic, environmental and cultural influences.

Degenerative joint disease (DJD) in the temporomandibular joint (TMJ) occurs in individuals with cranial deformation. Among younger individuals with cranial deformation with no other evidence of DJD on the skeleton, DJD of the TMJ occurred. It appears that the process of artificial cranial modification changed the alignment of the TMJ just enough to adjust the placement of the mandibular condyles in the TMJ, resulting in the premature development of DJD.

The MAD of females with DJD is consistently younger than males with DJD on the same skeletal element. This result may also reflect the osteological paradox (Wood et al. 1992). Females appear less able to cope with DJD on the skeleton, and consistently die at a younger age than their male counter parts. However, there is no difference between males and females in the presence or severity of Schmorl's nodes. This result indicates that females were able to engage in activities that request consistent bearing of heavy weight on the back. Though several young adults from Chongos developed Schmorls' nodes, females were not more likely to develop them than males.

The individuals at Chongos were of a similar height as central coastal sites dating to roughly the same time periods. They were taller than people from Cardal, hypothesized to have been under tremendous stress from an endemic disease. They were shorter than people from Paloma, who had a low pathogen load, little evidence of nutritional stress, and a very high protein diet as fishers. The stature data suggest that the Chongos population lived in an environment with occasional episodes of nutritional stress, likely due to El Niño, a problem still today, and a low-level but persistent pathogen load. The stature data are consistent with the enamel hypoplasia data presented above.

The skeletal pathology data do not completely support my hypothesis of the individuals at Chongos being farmers who obtained nearly all of their calories from crops. While most results are consistent with agricultural populations (e.g. CO, PH, skeletal lesions, DJD, and stature) some results indicated that the Chongos skeletal collection was not exclusively farmers. One adult male had external auditory exostoses (EAE) in both ears, evidence of habitual exposure to cold water. While there is no clear evidence that this individual was not a farmer, the presence of EAEs suggests that his occupation centered on marine foraging.

This result suggests that the cemetery at Chongos may hold burials that include fishers who lived nearby.

5.F: Mineral and Isotope Analysis of Human Hair

I received approval from the National Institute of Culture in Perú to export hair samples from Chongos individuals to the United States for additional research. The hair samples thus far have been analyzed by two different researchers. First, the samples were analyzed for trace element composition by Rebecca Bergfield, who used the Chongos samples as part of the data to support her master's thesis in anthropology at the University of Missouri (Bergfield 2007). I briefly describe her methods and summarize her results. However, I direct the reader to her thesis for a more detailed discussion of her methods, results, and conclusions.

Second, Rob Tykot and his student Anne Metroka at the University of South Florida analyzed the hair samples for stable carbon and nitrogen isotopes. This project was the focus of a recent poster presentation at an international archaeometry conference (Tykot et al. 2008). I will present and discuss these results below.

In the field, I wore latex exam gloves at all times to minimize the potential for human contact with the samples. The hair was cut using a scalpel, when possible including a portion of the scalp to ensure the root of the hair was included. The sample was wrapped in toilet tissue or paper towel and enclosed in a sterile sample bag. The hair was covered in sand and dust while interred – individuals were buried wrapped in textiles, which did not fully protect the individuals from the elements once buried.

In the lab, Bergfield used plastic tweezers and rulers to manipulate the samples, stainless steel scissors and spatulas less often (Bergfield 2007). The samples were cleaned in acetone and sonicated in distilled water. This process was repeated until the sample was clean. The samples were then air dried.

The samples were digested by placing them in tubes with pure HNO_3 and microwaving for 20 minutes. When possible, the hair samples were cut into 1-inch segments to allow for temporal analysis of trace element composition. Bergfield assumed that each inch of hair represented two months of growth. Therefore, the hair samples represent relatively short-term dietary patterns and/or variation, reflecting the diet of the individual for a few months up to about two years before the person died (Tykot et al. 2008). After microwaving, the sample was cooled, and the resulting liquid was moved to a centrifuge tube with 2% HNO_3, and centrifuged. The resulting liquid was then analyzed for trace element analysis at the University of Missouri Research Reactor (MURR) under the supervision of R. Jeffrey Speakman. The results were log transformed, missing values were estimated, and factor analysis was performed using SPSS.

Bergfield (2007) conducted trace element analysis of hair on 37 samples from Chongos. Her results provide solid evidence for a strong marine component to the diet of individuals living at Chongos (Bergfield 2007, Figure 14). The lower the Barium/Strontium (Ba/Sr) ratio (more negative) in an individual, the greater the percentage of marine resources in the individual's diet. Bergfield found that males had a lower Ba/Sr ratio than did females, which indicated that males had a higher percentage of marine resources in their diet than did females. However, marine resources clearly made up an important component of female diet as well. Chongos had a higher ln Ba/Sr ratio, indicating a lower marine component in the diet than did Buena Vista, a Late Preceramic/Initial Period collection located 40 km up the valley from the Pacific coast. However, the difference is not statistically significant. Chongos does have a lower ln Ba/Sr ratio than Huaca Malena, a largely Middle Horizon population that was intensively agricultural. Following Burton and Price (1990), the result indicates a higher marine component in Chongos than in later peoples. Burger and Salazar-Burger (1991) report that marine resources remained a strong component of the diet at the Initial Period site of Cardál on the central coast based on stable isotope study.

Bergfield (2007) found a significant difference in the Ba/Sr ratio between location and sex when comparing results from Chongos, Huaca Malena and Buena Vista. Overall, for all sites, males ate more marine resources than women as indicated by their lower Ba/Sr ratios. This result may reflect differential access to resources, with females consuming less protein overall and more agricultural produce than males. Many bioarchaeologists have hypothesized a similar dietary pattern (e.g. Cook and Hunt 1998; Larsen 1984, 1997; Peterson 2002; Weaver 1998), with males consuming more protein and females more carbohydrates. The question, of course, is how were the males acquiring the fish. They don't all appear to have been fishing, as evidenced by only one male having EAEs, although the frequency of auditory osteomas even in fishing populations is not much higher than the percent observed at Chongos. However, they may have been fishing from the shore, which wouldn't have resulted in EAEs, but would have resulted in other changes to the skeleton (Rhode 2006). They could have been trading agricultural products for the fish (Rostworowski 1977). If the males were the ones directly involved in trade activities, it is likely that they would be able to eat more fish than the females, who would be left behind to tend to the household and the crops. Of course, Bergfield's (2007) data could also reflect the presence of both fishers and farmers in the skeletal collection, with the Chongos skeletal collection reflecting the same patterns of use as Rhode (2006) hypothesized for VES.

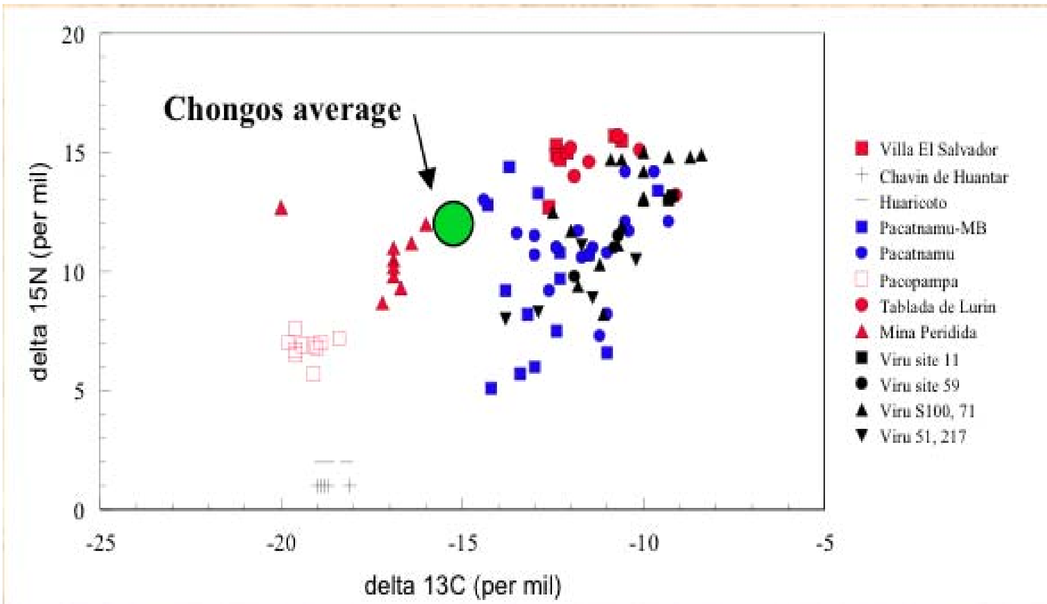
The hair samples processed and analyzed by Tykot and Metroka (Tykot et al. 2008) address significant short-term dietary variation through stable carbon and nitrogen isotope analysis. Such variation can inform on the consumption of both seafood (as measured by higher levels of Nitrogen 15) and C4 plants such as maize (as measured by higher levels of Carbon 13). Individuals with more positive 15N numbers are interpreted to have a higher marine component to their diet. Individuals with a less negative 13C numbers are interpreted to have a higher percentage of C4 plants in their diet, usually in the form of maize. The hair samples were processed in such a way as to address diet both within and between individuals. Seven individuals were analyzed.

The hair samples were initially cleaned to remove any contaminants. Once cleaned, the samples were cut into one-centimeter segments, with enough mass (1 mg) to provide both C and N isotope results (Tykot et al. 2008). The one-centimeter segments allowed for the analysis of short-term, i.e. monthly, dietary variation. For individuals with long segments of hair, it was possible to look at seasonal dietary variation over the last 1-2 years of their life.

The one-centimeter hair segments were weighed into tin cups, and analyzed on a Finnigan MAT Delta Plus XL stable isotope mass spectrometer, using a Costech CHN multi-sampler (Tykot et al. 2008). All sample processing and analysis took place at the University of South Florida.

The overall average isotope values for the Chongos individuals are similar to those from other coastal sites in Perú (Figure 5.1). However, the individual results show variation between individuals, indicating significant dietary variation among the individuals buried at Chongos. There was also significant short-term variation for some individuals, showing seasonal variation in diet (Tykot et al. 2008) (Figure 5.2). Paloma, fishermen with a very high marine component to their diet, which would fall into the range of marine vertebrate eaters (Benfer 2008, Figure 10), are located in Figure 5.2. The figure clearly indicates two or possibly three clusters of points, one of which, in the upper right, probably were eating a great deal of fish. The mean for the Paloma sample (Benfer 2008) is presented to mark a diet that was overwhelmingly marine-based.

Figure 5.1: Chongos Average C and N Isotope Levels, Compared with Other Sites from Perú



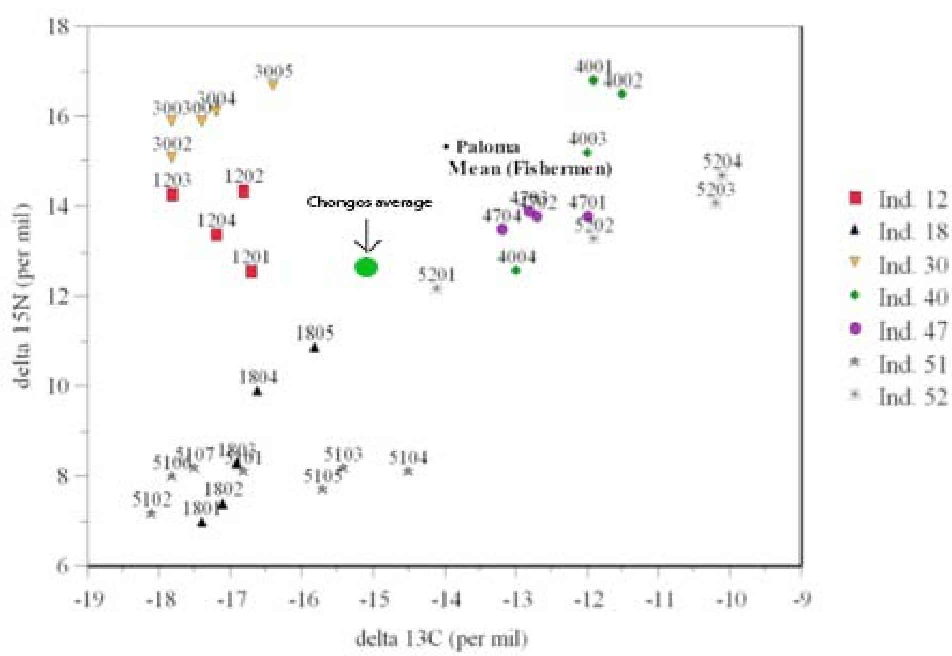
from Tykot et al. (2008)

Individuals 18 and 51 have low nitrogen isotope values, indicative of a mostly terrestrial diet. However, individual 18 has short-term variation in both C and N isotope values, with high values suggesting seasonal variation in seafood consumption. Individual 51 has no short-term variation in N isotope values, but the short-term increases in C isotope level may indicate seasonal variation in maize or other C4 plant consumption (Tykot et al. 2008).

Individuals 12 and 30 have lower carbon isotope values with high nitrogen values. These results indicate major consumption of freshwater fish. Short-term variation within individual 12 suggests some maize (C4) consumption in the diet. Individuals 40, 47 and 52 have very high carbon and nitrogen values, which indicates consumption of higher trophic level marine foods (e.g. higher on the food chain – larger animals and/or predators) (Tykot et al. 2008).

The results of this study demonstrate substantial variation in the diet of individuals buried at Chongos. Individuals also showed variation, sometimes extreme, in their diet by season. Tykot and colleagues (2008) initially interpreted these results to reflect the real possibility for a mixture of people buried at Chongos (see Chapter 6). Could individuals 30 and 40 be fishers who consumed a diet almost exclusively of marine resources? Could individual 51 be a farmer who only consumed the crops that were harvested at a particular time? Of course, it is also possible that the differences in diet reflected in Figure 5.2 reflect differential access to resources based on status and/or gender (see Chapter 6). However, the sex of the individuals from Chongos was not assigned for Tykot and Metroka's analysis.

Figure 5.2: Carbon and Nitrogen Isotope Data by Individual, Chongos



modified from Tykot et al. (2008)

5.G: Individual Case Studies

In this section I highlight five individuals from Chongos. They are described in detail due to the fact that they were severely affected by numerous indicators of stress, and due to excellent preservation, it is possible to observe the pattern clearly, and possibly to hypothesize the cause of death.

5.G.1: BW1500 burial 11

This subadult was aged 4-5 at the time of death. This individual did not undergo cranial modification. It appears that this individual died due to complications from a broken mandible. The mandible was broken on the right side. The fracture occurred at about the second incisor or canine, and had evidence of healing, indicating that the child lived for some time after the initial trauma. All deciduous teeth appear to have been lost as a result of the trauma, as there was new cancelous bone observed in the crypts.

According to Ortner (2003), fractures of the long bones heal more quickly than in other bones, and children heal more quickly than adults. The time for a fracture to heal depends on six variables, including the bone involved, the severity of the break, and the health and nutritional status of the individual (Ortner 2003). On average, cortical bone in healthy children heals in about six weeks. Primary callus formation begins in about one week after a bone is fractured (Ortner 2003). Individual BW 1500, burial 11 had primary callus on his or her jaw, demonstrating that it was in the process of healing at the time of death. However, the presence of severe cribra orbitalia (see below) may indicate that the child was under severe nutritional stress, which would have likely delayed the healing process. A delayed healing process may also indicate that this individual lived longer than six weeks after fracturing his or her jaw.

The other teeth also appear to have been affected from the broken mandible. Several maxillary teeth had chipped enamel, perhaps caused by the force of the trauma that broke the mandible.

The subadult also had a number of pathological reactions. All bones of the skull had active periosteal reactions. The severity of the reaction increased the closer the bone was to the site of impact on the mandible. For example, periosteal reaction was moderate to severe on the left side of the mandible and the right maxilla, while it was mild along the parietal bones and the left temporal. Generally lesions occur more quickly the more severe the trauma, and tend to be more severe closer to where the trauma occurred (Ortner 2003). While the periosteal reaction is related to the mandibular trauma, it is impossible to rule out other factors that could have contributed to the development of such lesions, such as disease.

The trauma to the mandible may have led to other pathologies as well. The child had degenerative joint disease (DJD) at the temporo-mandibular joint (TMJ), which could have resulted from the trauma to the mandible (Katzberg et al. 1985; Kumar et al. 2007; Yun and Kim 2005). The trauma to the face also appears to have caused a whiplash effect, with the head snapping back violently, which could have caused the DJD in the cervical vertebrae (Winkelstein et al. 2000). This condition was not seen in any other young people at Chongos. In fact the next youngest person at Chongos with DJD in their cervical vertebrae was a male age 20-24. The only lesions on the skull that may not have been associated with the trauma to the mandible is active, moderate to severe cribra orbitalia. However, the presence of periosteal reaction on the frontal bone along the eye orbits indicates that the cribra orbitalia may not have occurred until after the fracture to the mandible.

Post-cranial pathology also appears to be the result of the trauma to the mandible. The child had DJD on both clavicles, with greater severity on the right clavicle, under the location of the trauma. The force that broke the mandible appears to have moved the articulation of the clavicles on the manubrium, and at the time of the child's death the clavicles were forming new joints on the manubrium. The only other pathological skeletal elements were the tibias. There was active bilateral periosteal reaction, which may have been transmitted by blood from the trauma to the mandible. Since they were equivalently reactive, this argues for at least some of the bilateral expressed periosteal lesions on tibias being from generalized distribution through the vascular system rather than a systemic disease.

Ortner (2003) identified seven potential complications of fractures. One of these is infection, which I believe was instrumental in the death of this child. A major infectious threat to life for those with fractures is pus-forming (suppurative) organisms. These organisms can spread from the fracture site to the blood stream, causing septicemia and ultimately death (Ortner 2003).

Though the child lived for a time after the trauma to the mandible, it appears that the fracture ultimately caused this child's death. At the time of death the child had evidence of active, in some cases moderate to severe, lesions all over his or her body. It is possible that the child developed septicemia as a result of the fracture, leading to the active lesions all over his or her body. In summary, the force of the blow to the mandible knocked out all of the teeth on the right side of the mandible, caused DJD in the TMJ, and knocked the clavicles out of alignment with the manubrium.

5.G.2: BO1800 burial 4

This male was age 17-19 at the time of his death. He had annular artificial cranial modification. He had three teeth with enamel hypoplasias and two teeth with caries. The upper incisors were crowded. There was no evidence for cribra orbitalia or porotic hyperostosis. He was slightly shorter than the average male buried at Chongos, an estimated 152.3 cm based on the length of his femur (table 4.13).

This individual suffered from a severe systemic infection. He had moderate to severe periosteal reactions over more than half of his arms and legs, with the clavicles and scapula also affected. The periosteal reaction also occurred on his feet, with evidence in his tarsals, metatarsals and phalanges.

Both os coxae were also affected. While there was some evidence of healing, most of the affected areas remained active at the time of death.

The systemic infection affecting this young man may not have been the cause of his death. This man had a vertical line on the frontal bone of the skull, measuring 38.1mm along the left side of the bone. The line appears to be perimortem. It is possible that this line is the result of a violent blow to the head. The location on the left side of the frontal bone is consistent with violent encounters, as most people are right handed and thus would strike their opponent on the left side. If this is true, though the young man obviously suffered from a severe systemic infection, he may have died from a blow to his head.

5.G.3: BY1780 burial 4

This male was age 19-21 at the time of his death. He too had annular artificial cranial deformation. He had five teeth with enamel hypoplasias and two of 30 teeth with caries. He had mild cribra orbitalia in the left orbit that was healed, and mild active porotic hyperostosis on both parietal bones. The PH occurred along the lambdoid suture and may have been associated with his cranial deformation. There is no other evidence of stress or trauma on the skeleton. He was taller than the average male buried at the Chongos cemetery, with an estimated height of 157.8 cm from the femur and 161.8 cm from the tibia (table 4.13).

This young man is highlighted because he may have been a fisher. This individual had mild external auditory exostoses (EAE) in both auditory meatuses. This individual is the only skeleton analyzed at Chongos with an EAE. The presence of EAE in the ear suggests considerable time spent in cold water, either diving and/or with his head near the water surface (Okumura et al. 2007; Standen et al. 1997). This would be consistent with a person diving for shellfish, swimming nets out into the ocean for net fishing, or even paddling the small reed fishing boats commonly used for fishing expeditions. This individual also had very robust humeri, which can also be evidence of marine foraging (Benfer 1990; Rhode 2006).

5.G.4: BY1800 burial 11

This female was age 25-30 at the time of her death. She had annular artificial cranial deformation. She was about average height compared to the other females buried at Chongos, with an estimated height of 146.4 cm from the femur and 149.4 cm from the tibia (table 4.13). She underwent stress as a child, as evidenced by five enamel hypoplasias in eight observed teeth. She had poor dental health, with 26 total caries in 23 observed teeth (20 teeth were affected). She had two certain and two possible abscesses. She had severe alveolar resorption, especially for a person her age. It is because of the severe alveolar resorption that I coded two abscesses as possible. The resulting infection that occurred from one of these abscesses is likely what killed her. I will first describe the stress and trauma that affected this woman before I describe the infection that likely caused her death.

This woman had a healed break of the left sixth rib, one of only four females from Chongos with evidence of skeletal trauma, and one of only two that had trauma to the ribs. She had the most Schmorl's nodes of any female with nine, affecting T8-12 and L1-4. She also had DJD over these vertebrae, indicating consistent heavy lifting. DJD is present in the TMJ, and is mild along all the articulation points of all long bones, including the insertion points at the scapula (glenoid fossa) and the os coxae (acetabulum). DJD was also present in the sacro-iliac joint. There was apical activity on the auricular surface of the os coxae possibly indicative of relatively recent childbirth. The pubic symphysis confirmed this suggestion.

Possible squatting facets were present on both legs, impacting both the talus and the distal tibia. Weaving and/or processing food are the most likely activities requiring her to be habitually in this position. She had thickening of the scapular border and a flared distal metaphysis of the left humerus. DJD was greater on her left arm, though it was present in both arms. Based on the bony changes, it appears that she engaged in repetitive activities with her upper body, perhaps more so with her left arm, possibly indicating weaving (Capasso et al. 1999).

This woman had a systemic infection. She had bilateral periosteal lesions in her tibias, and was the only woman at Chongos with lesions on her femur. She had lesions on both humeri and both os coxae. All lesions were mild and expressed bilaterally. The systemic infection likely originated with an abscess on her left maxilla. She had severe periodontal disease over her whole maxilla, perhaps exacerbated by the abscesses. From the maxilla infection stains lead into the frontal and both parietal bones. The infection stain could be seen ectocranially moving along the coronal suture.

5.G.5: BY1800 tomb 2

This male was age 50-59 at the time of his death. He had artificial cranial deformation in the annular style, and was shorter than average compared to other males buried at Chongos, with an estimated height of 155.5 cm from the tibia (table 4.13). He was quite gracile, with muscle markings similar to that seen in females. This male was selected for greater discussion because he had poor oral health, he had a systemic infection, and was impacted by DJD over much of his body. Though all older individuals from Chongos had some oral pathology, periosteal lesions and DJD, this male is atypical for older individuals from Chongos.

Three of his canines were present, with two having enamel hypoplasias. Three of four first premolars also had EH, indicating consistent stress on him when he was a boy. In fact, 83% of the teeth analyzed for EH on this individual were hypoplastic. This stress likely impacted his short realized stature, but not his life-span since he lived such a long life. He had poor oral health with six caries on 21 analyzed teeth, second highest among males, and significant calculus accretion.

This man experienced no trauma, but was significantly affected by DJD and infectious lesions, indicating a systemic infection. He also had cribra orbitalia, though it was healed for some time before his death, and active mild porotic hyperostosis on his right parietal near lambda at the time of his death.

This man had DJD over most post-cranial skeletal elements. He experienced severe DJD along the vertebral column with possible spondylolysis at L5/S1. In the appendicular skeleton DJD was mild to moderate, with the lower body more affected than the upper body. DJD in the TMJ was more pronounced on the left side, likely due to asymmetry of the skull caused by cranial deformation. Osteophytosis and eburnation at the TMJ is moderate to severe, likely making mastication uncomfortable.

There is evidence for systemic infection. He had periodontal disease over the entire dental arcade of the maxilla, with reactive bone up into the nasal bones. He had bilateral lesions on the tibia and femur, most severe on the right side. He also had lesions on the right humerus.

5.H: Conclusions

The evidence supports my hypothesis that the skeletal collection from Chongos was derived from a population of agriculturalists that supplemented their diet with marine resources and perhaps through terrestrial foraging. Data on oral health are consistent with agricultural populations, and are significantly different from skeletal collections of known marine foragers and mixed horticulturalists/foragers. Several indicators of stress, especially for subadults, are consistent with those of agricultural groups, such as enamel hypoplasia, cribra orbitalia (CO) and stature. Mean age at death for people with CO was statistically significantly lower than for those with no CO. Phytolith, mineral content and stable isotope analysis of hair also support my hypothesis. These data clearly show evidence for the presence of agricultural and marine resources in the diet. Though the mineral data from Bergfield (2006) showed a greater marine component to the diet than comparison sites, the isotope data from Tykot et al. (2008) are similar to other coastal Peruvian sites such as Mina Perdida, whose people are hypothesized to have been farmers who supplemented their diet with marine resources (Tykot et al. 2006). These data, especially the hair analysis, also clearly show the individual variation in diet, with the stable isotope data showing evidence for seasonal variation in diet. The trauma data may not support my hypothesis, as contemporary sites along the coast of Perú that had a mixed agriculture and marine subsistence strategy had evidence for violent trauma. Though the mode of subsistence and violence may not be causal, it is notable that VES to the north and Nasca to the south both had evidence for violent trauma while Chongos had none. A young male also had bilateral external auditory exostoses (EAEs), evidence of prolonged exposure to cold water, and perhaps occupation as a marine forager.

Several bioarchaeological differences exist between males and females at Chongos. There is a statistically significant difference in caries rate, with females having a higher caries rate than males. Males also consumed more marine proteins, though marine resources also made up an important part of the diet of females. Females with degenerative joint disease (DJD) had a consistently younger mean age at death than males.

Though there is a clear pattern for the Chongos skeletal collection being farmers who derived the majority of their calories from agricultural produce and supplemented their diet with marine resources, the bioarchaeological data appear consistent with the hypothesis of either Rhode (2006) or Pechenkina and Delgado (2006). Both of these approaches suggest mixed use cemeteries where individual differences may reflect differences in occupation (Rhode 2006), status and/or ethnicity (Pechenkina and Delgado 2006).

CHAPTER 6: CONCLUSIONS

I based this dissertation on the hypothesis that the Chongos skeletal collection reflected the current interpretation of inhabitants of Topará habitation sites (Peters 1997; Proulx 2008), namely that these individuals carried out diversified irrigation agriculture, supplemented by fishing and perhaps hunting. My main goal for this research project was to provide a bioarchaeological description of the Chongos skeletal collection. A secondary but important goal was to place the Chongos collection in the broader context of the south central Andean coast and the Early Horizon/Early Intermediate Period in Perú.

In addition to my main hypothesis, this project centers on four research objectives. These research objectives were designed to supply results to either support or refute my main hypothesis that the individuals buried at Chongos were irrigation agriculturalists, supplemented by fishing and perhaps hunting. Table 6.1 summarizes the results from Chongos in relation to the original hypothesis and research objectives.

It is not surprising that my initial research hypothesis was supported. Coastal sites in Perú have had simultaneous evidence of cultigens and marine resources for the past 5,000+ years (e.g. Benfer 1990; Moseley 1992b). However, there is substantial evidence to support the notion that the Chongos population both consumed a more agriculturally-based diet and engaged in activities consistent with farming. Most bioarchaeological data are consistent

Table 6.1: Summary of Results

Research question/statement	Result	Evidence for	Evidence against
Hypothesis: The people buried at Chongos derived their primary subsistence from irrigation agriculture, supplemented by fishing and perhaps hunting	Supported	• High Caries rate • High Abscess rate • NSIS rates compared with other groups of known subsistence strategy • Enamel hypoplasia • Stature – shorter than marine foragers • Cribra orbitalia rate • Porotic hyperostosis rate • Systemic infection • Degenerative Joint Disease • Phytolith data • Ba/Sr data • C/N data • Auditory exostosis (one male)	• Trauma – no evidence for interpersonal violence
Research objective: There was no difference in the diet by sex	Not supported	• Abcess rate	• Caries rate • Enamel hypoplasia • Ba/Sr data
Research objective: There was no difference in Non-Specific Indicators of Stress by sex, with the exception of DJD	Not supported	• Trauma • DJD (showed differences by sex) • Schmorl's nodes	• Enamel hypoplasia • Systemic infection
Research objective: Compare results from Chongos with other skeletal collections from coastal Perú with known or hypothesized subsistence strategies	Supported, related to hypothesis	• Caries rates within range of agriculturalists, higher than groups of known foraging or horticultural subsistence strategy • Stature, Chongos shorter than marine foragers, similar to sites reliant on agriculture • Systemic infection • Anemia	• Trauma – no evidence of interpersonal violence

with known agricultural or suspected agricultural groups, and differ from known forager or mixed horticultural/forager groups. For example, caries rates at Chongos are quite high, well within the range expected for agricultural groups (Turner 1979). Rates of systemic infection, evidence of anemia and non-specific indicators of stress are consistent with comparison sites from the central coast of Perú that were known or suspected agriculturalists. Phytolith data and mineral and isotopic analyses of hair provide direct evidence for marine and mammalian resources in the diet. Phytolith data and isotopic analysis of hair also showed evidence of domesticated plant use, at least among some individuals. One male had bilateral external auditory exostoses (EAEs), a common indicator of marine foraging populations where, nonetheless, frequency of the trait is low. Finally, the patterns of trauma are inconsistent with my hypothesis. The Nasca samples to the south (Kellner 2002) and Villa el Salvador (VES) to the north (Vradenburg 2001), both contemporary with Chongos and thought to have had a similar subsistence strategy as Chongos, both have evidence of trauma consistent with interpersonal violence. The rise in interpersonal violence is thought to be a reflection of increased population growth and increased reliance on agriculture as a major source of calories in the diet (Kellner 2002; Proulx 2008; Vradenburg 2001). The Chongos collection has no evidence of interpersonal violence. As mentioned in Chapter 5, the lack of evidence for interpersonal violence at Chongos may reflect differential burial practices, with individuals who died as a result of interpersonal violence being buried in another location, either at the location where they died or in a burial location that reflected the potential status of being a warrior, perhaps the Paracas peninsula. Differential burial practices would have to be practiced for all warriors, including those who experienced skeletal trauma and lived for a time after the trauma. The lack of trauma could also support the existence of a primitive state where warfare among adjacent valleys was controlled by a political structure.

The bioarchaeological evidence from Chongos did not support the research hypothesis of there being no difference in the diet by sex. I found a statistically significant difference in caries rate, with females having a higher percentage of teeth with carious lesions than males, suggesting less access to meat and a greater consumption of caries promoting carbohydrates. Males were statistically significantly more likely to have enamel hypoplasias than females, and had a higher prevalence of marine resources in their diet than females based on mineral analysis of hair. These results indicate a clear difference in diet between males and females, likely beginning early in life (see section 6.A below). The enamel hypoplasia data are indicative of childhood stress, which likely would include nutritional stress that occurred around the time of weaning, such as was observed at Paloma (Farnum 1996). The caries data demonstrate cumulative differences in diet that persisted through adulthood, while the Ba/Sr data reflect individual diet over the last 1-2 years before death. Males appear to have had greater access to high protein marine resources than did females.

The bioarchaeological evidence from Chongos also did not support the expectation of there being no difference in non-specific indicators of stress (NSIS) by sex, except in the case of degenerative joint disease (DJD), where I hypothesized that males would have higher rates of DJD than females. The DJD data provided partial support, however, as males had statistically significantly more DJD on the cervical vertebrae than did females. Females with DJD also had a lower mean age at death (MAD) than males with DJD on the same skeletal element. This result suggests that the effect of the repetitive activities leading to DJD have a more deleterious effect on females than males, leading to a consistently earlier death among females. This research hypothesis was also supported by the trauma and Schmorl's nodes data, which showed no difference by sex in presence or frequency. Differences in NSIS were found, and they include enamel hypoplasia and systemic infection, in both instances males being statistically significantly more affected than females. I discussed the enamel hypoplasia data above in relation to diet. However, the presence of enamel hypoplasias on the permanent dentition reflects stress on an individual during the formation of the permanent dentition, that is, during childhood (Goodman et al. 1984; Hillson 2000; Larsen 1997). The source of the stress could be dietary, environmental, physiological or cultural, but male children who lived to die as adults experienced more stressful childhoods.

Finally, I compared the bioarchaeological data from Chongos with previously published data from other coastal sites from Perú. These comparisons are consistent with my hypothesis of the Chongos skeletal collection being heavily reliant on agricultural products for the majority of their calories. Supporting data include high caries rates, lower adult stature than known marine foragers, high rates of systemic infection comparable to suspected agricultural groups, and rates of anemia that differ from known marine foragers and are similar to suspected agricultural groups. The lack of interpersonal violence at Chongos is a notable exception when compared with agricultural skeletal collections from the central coast and the Nasca river drainage.

6.A.: Interpretation of Results

The bioarchaeological data from Chongos may support the interpretation made by Peters (1997) that all Topará sites, not just Chongos, were irrigation agriculturalists whose diet was supplemented by fishing and perhaps hunting. This inference is reasonable, because it is consistent with findings from other sites from coastal Perú at this time period dating to the Early Horison (EH) and Early Intermediate Period (EIP) (Kellner 2002; Pechenkina and Delgado 2006; Stothert 1980; Vaughn 2000).

The Chongos skeletal data do show interesting variation by sex within the collection. In this section I more fully discuss potential interpretations for the observed results as they relate to gender differences. I also address potential functions of the site of Chongos, especially in relation to the similarities between the Chongos skeletal remains and the skeletal remains from Villa el Salvador.

6.A.1: Gender Differences at Chongos

As briefly described above, as well as in Chapters 4 and 5, there are numerous differences between the overall male and female population from Chongos. These include differences in non-specific indicators of stress and diet. While it is not rare in the bioarchaeological literature to find documentation of differences between males and females in skeletal populations, it is often difficult to explain why the skeletal differences occurred (e.g. Cohen and Bennett 1998; Ebert and Patterson 2006; Larsen 1997; Peterson 2002; Powell 1988; Storey 1998). Perhaps the most common reason given to explain skeletal variation by gender is the sexual division of labor (e.g. Larsen 1997; Peterson 2002). This variation may reflect differences in gender-based activities, or even gender-based status differences.

The sexual division of labor reflects habitual activities engaged in by a group, with particular activities designated as women's or men's work (Peterson 2002). One of the earliest examples of sexual division of labor along the Perúvian coast comes from Paloma. Ebert and Patterson (2006) believe a technical (economic) division of labor existed, based on the skeletal remains (Benfer 1984, 1990; Benfer and Gehlert 1980; Weir et al. 1988), associated grave goods (i.e., Quilter 1989), and the fact that only males had auditory exostoses. The lack of auditory exostoses among females indicated that only males were involved in foraging for deep-water resources. The small size of the village at Paloma suggests that the population likely engaged in community exogamy to find mates, perhaps linking to another village to arrange marriages. Benfer (2008) argues that *ayllus* (an extended family unit whose history was traced through ancestral mummies) were present during the time of Paloma, evidenced by the special treatment of their dead. The presence of *ayllus* would also have provided a specified mechanism for arranging marriages.

Ebert and Patterson (2006) believe that the division of labor that may have existed along the South American coast had more to do with activity than gender, meaning that males and females would both be active in the same basic activities. For example, within the same type of activity, i.e. marine foraging, the sexual division of labor is likely, with males more likely to engage in activities such as diving for shellfish. Females would be involved in other activities related to marine foraging. Ebert and Patterson (2006) state that once cultigens became more prevalent along the Pacific coast of Perú villages reorganized, with some individuals engaged in crop cultivation and the others engaged in marine foraging. Once this occurred, not only would there be a sexual division of labor, but there would be an economic division of labor. Because individuals could be involved in such disparate economic activities (marine foraging vs. crop cultivation), differences in division of labor could have resulted as much from economic activities as gender differences, not just in South America but around the world (e.g. Ebert and Patterson 2006). In the case of Chongos, if the cemetery was utilized by fishers and farmers, I would expect to see divisions of labor based on both gender and economic activity.

Peterson (2002) found that among the Natufian (pre-Neolithic) the sexual differences in muscle markings pointed to a strong division of labor associated with hunting and processing, with males hunting and females processing. Though the division of labor was strong, Peterson emphasized the importance of each activity, implying that females had high status. However, in the Neolithic differences in the sexual division of labor decreased, showing strong overlap in farming activities among men and women. Peterson concluded that even though the differences in muscle markings decreased with the transition to farming, there existed sharply defined gender labor roles. Because of those sharply defined labor roles, the seeds of widespread social inequality between the genders could have been sown. Peterson (2002) goes on to note ethnographic reports that show a rise in gender-typed adult work and a decrease in female status among several specific groups who have undergone the transition from hunter-gatherers to farmers in modern contexts.

However, the sexual division of labor does not necessarily mean gender subordination. This would imply that some activities are less equal than others (Peterson 2002). The reality is that for a society to function smoothly all activities are important. In an agricultural economy, such as I suspect was present at Chongos, potential divisions of labor could have been that males prepared the fields and females planted the seeds (i.e. Silverblatt 1978). In this case, the activities would have been clearly separated by gender, but both would have been equally important for a successful outcome. Modern studies in the Andes and elsewhere show that a woman's value is directly proportional to her economic contribution to the family (Johnston et al. 2002; MacDonald 1998; Silverblatt 1978), although measuring direct and indirect contributions can be difficult.

It is also possible for there to be sexual segregation in decision-making regarding spheres of activities. Among the Hidatsa of the US Great Plains, for example, women controlled decision-making regarding their activities, and males controlled theirs (Spector 1998). In such a situation, the only way to designate gender-based importance in activities would be to assign, perhaps arbitrarily, importance or value to different activities.

Another possible explanation for health differences between males and females, other than subsistence activities, is behavioral differences. Such differences could result from differential access to resources (Armelagos 1998), perhaps due to behavioral and/or cultural differences stemming from males and females being of differing social classes. Another possibility, closely related, is that either males or females are preferred in a culture, especially during childhood (Benfer 2008). Such preference would result in one gender being buffered over the other during times of stress (Stuart-Macadam 1998).

Ebert and Patterson (2006) argue that class and gender are closely related, specifically using the Inca as an example (see also Silverblatt 1978). Ebert and Patterson (2006) say that social class played a major role in the experience of a person during the Inca Empire. Among the Inca, social class affected daily life more than gender (Ebert and Patterson 2006; Silverblatt 1978).

Vogel (2003) argues that this was also the case among Moche women. Vogel (2003) discussed the presence of high-status women and goddesses among the Maya, Moche and Inka. Chavin was also considered to have goddesses based on iconographic interpretation (Burger 1992; Vogel 2003). Vogel argues that among the Maya and Moche high-status females are portrayed through iconography as having a dual political and religious role. Women may have been involved in rites and rituals dealing with encounters both on Earth and in the spirit realm. Females also worked with males to complete certain rituals that required males and females to work together to achieve spiritual wholeness.

The recovery of high status female burials among the Maya, Moche and Inka confirm that in these cultures some women had elevated status. Vogel (2003) reports on the burial of a Moche female who is interpreted to be elite based on her long life, good dental health and grave goods, among other reasons. Vogel even argues that women had equal or better access than men to positions of power. Perhaps this was due to the increasing prominence of female deities, whose presence endures on the Andean coast. However, Vogel does not make any assertions regarding the place of commoner women in relation to commoner men. She also doesn’t state, or even imply, that the high status women in these cultures were on an equal level with the high status males. Thus, although the presence of elite women in Perú is identified beginning with the Moche and continuing with Lambayeque, Wari and Inka, there is still no discussion of any gender-based equality, especially among commoners.

There is no iconography specifically detailing women along the south coast of Perú until the end of the 4th century (Ebert and Patterson 2006), after the Chongos site had been abandoned. This may mean that gender roles, especially as they relate to the improved status of women outlined above, may have developed more slowly among the south coast than occurred among the Moche. Rowe (1995) states that all elite burials at the Paracas peninsula (Cavernas and Necropolis) are elite males. This fact would imply behavioral differences by gender during the time Chongos was occupied, with a class of elite males and no documented elite females.

Behavioral differences by gender should result in consistent health differences between males and females. In my opinion, skeletal data in which some measures indicate males are more affected while other measures indicate females are more affected provide evidence *against* behavioral differences by gender. The Chongos data show such mixed results. Females had a lower mean age at death (MAD) than males if they had degenerative joint disease (DJD). However, males were more likely to have enamel hypoplasias, and systemic infection evidenced by lesions on the tibia. None of the males I analyzed appeared to be of elite status, compared with burials on the Paracas peninsula, as described by Rowe (1995).

I believe that the differences in health indicators at Chongos do not simply reflect gender differences. Rather, I believe the skeletal collection from Chongos primarily reflects differences in status, ethnicity and/or occupation. Differences in access to resources would therefore have resulted from social divisions rather than gender-based distinctions. Of course, there could still be differences in access to resources based on gender, but they would occur at a ‘local’ level, specifically within a social division. Thus, if there are gender differences in a health measure, it may represent not just a gender distinction, but also a difference in how females are treated based on status, ethnicity and/or occupation.

Examples from the Chongos data to support the idea presented above include MAD for cribra orbitalia (CO) and the trace element and isotopic analysis of hair samples. The difference in MAD for people who had CO signifies to me a population that was under stress, especially during childhood (Stuart-Macadam 1998). Because the result from Chongos included males and females in the comparison, the significant result would imply that males and females were equally under stress. Therefore, differential access to resources by gender could not be the cause of the CO result at Chongos. The result, however, could reflect differential access to resources because of occupation, ethnicity and/or status.

The data from analysis of hair show individual variation in access to marine and agricultural resources, specifically C4 plants such as maize (Figures 5.1 & 5.2). There is also seasonal variation in diet. In general females consume less meat than males (Cook and Hunt 1998), but the variation may just as likely reflect differences in diet by occupation or ethnicity and not gender.

If I am correct, the differences in health indicators observed at Chongos may reflect differences in occupation, as hypothesized by Rhode (2006), and modeled by Rostworowski (1977, 1981, 1999). It may be that if the Chongos cemetery is in fact used by individuals from more than one ethnic, status and/or occupation group, the differences in their activity patterns and health indicators would be reflected in the skeletal remains. It's very possible, therefore, that the Chongos results support either Rhode's (2006) or Pechenkina and Delgado's (2006) hypotheses. I believe Rhode's hypothesis is more likely to be correct in the case of Chongos, as I haven't seen evidence for the presence of individuals from the Andean highlands. Pechenkina and Delgado (2006) argue that the cemetery at Villa el Salvador (VES) consists of two different ethnic groups represented by a coastal group and a highland group. The presence of more than one group in the same cemetery may also support the occupational specialization described by Rostworowski, indicating that the separation of different ethnicities of farmers, fishers, artisans and merchants was in place during the EH/EIP.

If the pattern given above is correct, then it is possible to hypothesize that these occupation or ethnic/status groups interred at Chongos used an ayllu kinship strategy (Benfer 2008) to help maintain group stability (Peters 2000; Proulx 2008). Isbell (1997) argues that evidence for ayllus did not appear in the archaeological record long before the Middle Horizon. He states that by the end of Moche times ayllus may have developed, resulting in the elite burial practices in place along the north coast of Perú at the end of the EIP. However, Proulx (2008) argues for the presence of ayllus during Paracas and Nasca times along the south coast of Perú, and Benfer (2008) believes the inhabitants of Paloma were separated into ayllus. The ayllu system would have helped individuals find mates and maintain the structure and importance of their kin group and kinship structure.

To summarize, gender differences exist at Chongos, showing variation in the prevalence of non-specific indicators of stress (in childhood and adulthood) as well as dietary differences. However, the variation in these measures, with some indicators implying worse health for males while others imply worse health for females, suggests that strong gender inequality did not exist at Chongos, except in access to resources. Females and males may have been of similar status in society, as was the case among later prehistoric groups in Perú (Silverblatt 1978; Vogel 2003). Although differences by gender may reflect differences in class or ethnic group, manifest in different occupations, there does not appear to be class differences in the individuals buried at Chongos based on mortuary remains. It is not possible to distinguish possible ethnic groups and/or occupation at this time, but there is some indirect evidence that gender differences might vary by ethnic group. Thus, female fishermen, even with exchange, might have had better health than male farmers. Complete excavation of all skeletal remains at Chongos will allow future research to address these questions.

6.A.2: The Socio-Political Place of Chongos in South Central Peruvian Life

As mentioned in Chapters 1 and 2, Chongos has been understood in a variety of ways. For example, both Engel (1966) and Tello and Mejia (1979) called Chongos the most important site of monumental or habitational architecture contemporary with Paracas. When Max Uhle first saw Chongos he called the site a palace, saying that the outer wall of the site was not made for defense (Protzen and Harris 2005). Peters (1997) argues that Chongos was a major habitation site, made up of terraced, multilevel buildings with low walls. These buildings contained clusters of small rooms surrounded by the aforementioned walls. Open plaza areas separated the building complexes. The site layout of Chongos appears to be similar to one type of near-urban site that was already present in the Late Pre-ceramic and Initial Periods – a planned complex structured around plazas that may have served as important communication centers (Makowski 2008)

What would it mean to accept the interpretation of the Chongos site as an urban center? In Makowski's (2002, 2008) reviews of Andean urbanism, he describes Chongos as an urban center. Features of the site that are consistent with urbanism include: its large size of over 40 hectares; the clusters of small rooms that represented a large permanent population distinguishing the site as a town and not a ceremonial center; the presence of plazas, which represent public core space; and orthogonal layout.

Wallace (1986) argues that the Topará ceramic tradition may have been made by a state society, and Peters (1987/88, 1997) suggests that if Wallace is correct, Chongos may have been its capital (see also Silverman 1996). This represents a shift from Paracas society, which was governed politically by local chiefdoms (Proulx 2008). Peters argues that Chongos was the point of contact between the Paracas and Topará people, a metropolitan nexus of the strong cultural and economic relationships characterizing the valleys of the south coast in the late Early Horizon and earliest EIP. If Peters is correct, Chongos would have served as an administrative and presumably economic hub in the region. The importance of Chongos as a center likely would have attracted long-distance trade networks, including up to the central coast of Perú and beyond.

The fact that both Paracas and Topará traits can be seen in the earliest EIP pottery of the central coast is interesting. Only sites from the Pisco and Chincha river valleys meet this bicultural condition and Silverman (1996) suggested that these were the donor valleys that engaged in contact with the central coast. Unfortunately, the nature of the interregional contact between the central coast and the Pisco and Chincha valleys is not yet known. The intermediate river valleys, Cañete, Asia, Mala, and Chilca are not yet well understood from this time period (Silverman 1995, 1996; Peters 1997).

I believe the Chongos site functioned as an administrative center of a small state that controlled the Pisco valley, and perhaps exerted influence into the Chincha valley immediately to the north. Though it is not possible to tell if the open spaces of a site were used for ceremonial or administrative purposes, at least not without extensive excavation, the site does not appear to have had ceremonial functions. Makowski (2008) mentions that the ceremonial centers of Cahuachi and Bajo Chincha, which are located in the same region and come from roughly the same time period, contain pyramids with roofed structures at the top of the pyriamids. Chongos lacks mounds, which are another indicator of ceremonial function of a site (Wallace 1986). Wallace noted that other Topará sites had mounds, perhaps implying that the administrative and ceremonial centers were housed in different locations.

However, the political organization that has been characterized for Chongos is not much different than what Proulx (2008) described for Paracas society. One distinct difference would have been in the leadership of the state. Proulx (2008) reports that Paracas leadership came from shamans who achieved great power, with the possibility that a secular chief shared power with a shaman. The lack of mounds or pyriamids at Chongos leads me to believe that Chongos was controlled by a secular leader (or leadership group), with the powerful shamans controlling the ceremonial centers in another location. Another difference is that Proulx (2008) hypothesizes that cranial deformation represented rank for Paracas society. The skeletal data from Chongos do not support this hypothesis for Topará. Most individuals have the same kind of cranial deformation (annular). I also found no association by presence/lack of cranial deformation with health indicators. If cranial deformation were associated with rank, I would expect the highest ranked individuals to have the best health outcomes. The lack of trauma, however, could be an expected consequence of a state-level society.

There are two major questions surrounding the role of Chongos in the Pisco valley and as an influence on, and being influenced by, the Topará tradition. The first question is how did Topará move so quickly into the PIsco valley and so thoroughly replace the earlier Paracas tradition? How did the people associated with Topará accomplish such a feat? The second question is how closely associated, if at all, were the peoples associated with Topará? Did Topará represent a regional state that was controlled from some central locality, or was Topará simply a high-quality ceramic technique that many different groups adopted, reflecting nothing more than diffusion? I will address both questions below.

First, the question of replacement: Peters (1997) offers a model to explain the rapid change from Paracas to Topará ceramic material not only at Chongos but on the Paracas peninsula and throughout the south central coast of Perú. In this model Paracas-associated people were suddenly replaced by Topará associated people. The Topará invaders from the north would have simply slaughtered the local populations along their way, presumably taking many of their heads in the ritual processes of the “trophy” head cult shared by both societies at the time of conquest. The similarity between the last Paracas tradition and the first phases of Topará materials is due to the close contact between the two traditions as the Toparáns were beginning their conquest. After conquering the Pisco valley and the Paracas peninsula, the Toparáns continued to the Ica valley and into the Nasca river drainage.

This model assumes that once Toparáns arrived at a location with Paracas people, the transition began, and that the result was unidirectional. That is, Paracas traditional material would no longer be present, with Topará influence taking over completely. Also, because Topará replaced Paracas, there should not be any continuity between iconographic styles. Continuity would imply real exchange between the two populations, not just one population overwhelming and replacing another population. Another assumption is that the Toparáns were one group, a population of invaders that took over a region.

This model also assumes that the expansion of the Toparáns into Paracas territory was accomplished by a political entity that was larger and better organized than the Paracas-era polities (Peters 1997). Peters suggests that the Chongos site indicates a form of centralized power in a single habitation zone. Peters cites the consistency of two Topará ceramic phases over large distances, Jahuay 3 and Chongos, as evidence for the rapid expansion of power of the organized political entity. It is this pattern of standardizing the material culture and expanding the region under Toparán control that leads Peters to support Wallace's (1986) hypothesis that Topará was a state.

I believe that Peters' (1997) model is quite likely, with two key caveats. These distinctions speak directly to the second question regarding the role of Chongos in the Pisco valley and as part of Topará. First, the conventional wisdom (i.e. Proulx 2008) is that Paracas political organization was based on localized chiefdoms. This would imply that Paracas era iconographic materials would have continuity, but would not be identical. I would expect variation depending on the individuals making the ceramics or textiles. Confronted with outside influences such as Toparáns from the north, it is plausible that individual Paracas chiefdoms could have adopted Topará traditions simply based on the quality of material that was produced. No 'takeover' was necessary.

Secondly, a total replacement of the Paracas tradition by Toparáns implies that Topará was a large regional state identified by a new ceramic style and a different iconographic tradition. In such a political situation, I would expect that all Topará materials would have strong continuity throughout the state. I believe that Toparáns probably moved into Paracas territory and overthrew whatever force was in power, but the new leadership was localized, not part of a larger state-based power center. This localized government would have resulted in localized interpretations of the ceramic and textile traditions, resulting in the site-to-site variation that is seen in the archaeological record (Peters 1997; Wallace personal communication 1/23/09, 1/29/09). This local variation would result in innovations occurring at different speeds in different locations, if there were even any innovations. The locations with strongly associated styles could be thought of to be more closely related, and perhaps under the same local authority. Otherwise, the region and time period would be characterized as being influenced by a stylistic tradition but under political (and perhaps ceremonial) control by locally powerful elites.

Germane to this project is the connection between Chongos and Villa el Salvador (VES). As described in Chapter 5, they appear to have much in common, including similar ceramic influence, location in a river valley with permanent water flow and proximity to the Pacific ocean. After comparing the Chongos skeletal data with VES, the connection appears even stronger, since diet and lifestyle may have been quite similar. The apparent relationship between the two sites begs the question, were they under the same political, ceremonial and/or cultural influence? If so, the relationship between the two sites may be due more to cultural or political constructs than adjustments to similar environmental constraints.

The evidence is clear that Chongos and VES were both influenced by the Topará tradition (Silverman 1996; Stothert 1980). What is not as clear is if the influence had a political and/or ceremonial core. Wallace (1986) believes that a Topará state would have encompassed the entire region under Topará influence. However, as emphasized by Peters (1997) and Silverman (1996) there has been very little archaeological work in the river valleys north of, and including Cañete to search for the presence and continuity of Topará. Without firm understanding of the archaeology of the EH/EIP in the river valleys between Lurin (VES) and Pisco (Chongos) I feel it will be very difficult to clearly identify how comprehensive a single sphere of Topará influence was in the region.

Applying what we do know about Topará, I do not believe that Chongos and VES fell under the same sphere of influence. I believe each area was under different local control, and perhaps was the center of power of a local polity. Both sites were influenced by the same Topará cultural tradition, but maintained no political association. Chongos was likely the center of a small-scale state society, their sphere of influence controlling the Pisco valley, with the possibility that they also controlled part of the Chincha and Ica valleys (mid-valley) as well as the Paracas peninsula. This small state would have been able to access and control the existing exchange networks that were in place during the earlier Paracas tradition. Villa el Salvador, by contrast, is a cemetery complex that probably represents the people who built the huge pyramid complex at Pachacamac (Stothert 1980). The local control may have come from the nearby oracle site of Pachacamac, with influence coming more from the ceremonial than the political arena. It is also probable that VES was more influenced politically by the peoples of the Rimac river valley to the north than the Pisco river valley to the south.

I believe the local polities present during the EH/EIP along the coast of Perú had a similar social structure as outlined by Rostworowski (1977, 1981, 1999) for the Chincha river valley at the time of Spanish contact. The clear separation of occupational activities, as well as living arrangements, would reflect a highly specialized society that was reliant on sophisticated trade networks. Such a system would have required strong local polities for the smooth functioning not only of trade and commerce, but also the potential conflicts that could arise among different groups of people. Constant trade up and down the coast, as well as in the highlands, may have been enough to maintain cultural connections, especially for high quality goods such as Topará ceramics.

The connection between VES and Chongos reflects a number of similar adjustments. Chongos as an administrative center was a major exchange hub, and VES was very close to the enormous oracle site of Pachacamac. I believe perhaps the most important similarity between the two sites is that both cemeteries appear to have been used by more than one group. If indeed the EH/EIP had a similar ethnic and occupational make-up as decribed by Rostworowski (1977, 1981, 1999) for Chincha, then the major urban centers along the coast of Perú would have been inhabited by a number of different people. The major cemeteries, such as Chongos and VES, would have been utilized by all peoples under the control of the polity. Therefore, I believe the connection between Chongos and VES reflects a mixed-use urban cemetery and a society made-up of occupational specialists that may also represent different ethnicities. Such a social situation could support either Rhode's (2006) or Pechenkina and Delgado's (2006) hypotheses to explain the variation seen at VES. Occupational specialists would be buried in the same cemetery, though perhaps in different locations based on occupation. The groups engaged in the different occupations may have identified themselves already as different ethnic groups and used some type of body modification, perhaps cranial deformation, to clearly identify ethnicity. The ethnic groups would have used *ayllus* (Benfer 2008; Peters 1997; Proulx 2008) to maintain their kinship ties and ethnic identity.

According to Ebert and Patterson (2006), the process of state formation proceeded unevenly in South America. A consequence of this uneven development is that there was no consistency over large distances. A small state in one river valley may interact with a series of tribal groups in the next river valley. The independent development of these small tribal groups gives the possibility for the development of ethnic groups. These ethnic groups could have distinct occupations, and create regionally distinct styles in items like pottery and textiles. Perhaps this is indicative of the groups that were part of the Topará tradition. Wallace (personal communication 1/23/2009) states that he never saw a site containing 'pure' Topará pottery. Perhaps this is indicative of smaller administrative units falling under a larger tradition, with each administrative unit having total control, including the ability to vary the ceramics as necessary to meet their needs.

Makowski (2008) states that urban centers reflect the existence of social classes. At a minimum, a ruling elite had to be in place to maintain the center, oversee administrative/ceremonial functions that would take place at the center, and maintain the overall smooth functioning of the polity and its different social classes. Using Rostworowski's (1977, 1981, 1999) model as an example, fishers, farmers, merchants, and artisans could have represented different social classes. At a minimum they represented different social groups. To me the unknown is where the elites were buried. Rowe (1995) believes that the burials at the Paracas peninsula came from population centers around the peninsula, including the Pisco river valley. If he is correct, perhaps the elite from Chongos were buried at Paracas while the 'commoners' were buried at corporate cemeteries like Chongos itself. Rowe's belief that people came from all over to bury their dead at Paracas may suggest similar differences to those that Rhode (2006) found in skeletal remains from Paracas. Perhaps he analyzed people who lived in different locations and had different activity patterns, but were buried in the same place. Perhaps the VES cemetery was also purely a corporate cemetery for the lower social class(es), while the elites were buried at a place like Pachacamac that was more suitable for their elevated status.

I believe the cemeteries at VES and Chongos would have been segregated by ethnic group and/or social class, perhaps even by *ayllu*. Peterson

(2002) states that maintaining a corporate cemetery is a good way to claim and keep the ownership and inheritance of territorial resources. By creating and maintaining a kin or lineage group in a cemetery, that group is expressing their right to control the resources of the region. Basically, maintaining a lineage line in a cemetery says that that group has right to local resources that go back to the time of the ancestors.

6.A.3: Summary

The differences between males and females at Chongos may suggest early and sustained differences in access to food, population-based episodes of stress, exposure to pathogens, and activity patterns due to gender-based differential access to resources and/or division of labor. These differences suggest that males and females had very different economic and social activities at Chongos. Perhaps males were more likely to engage in trade activities, increasing their exposure to outside pathogens that could lead to systemic infection, as well as their exposure to a variety of foods, including marine resources.

However, the fact that the differences between males and females is not unidirectional, with one sex with consistently worse health, implies that health differences are also the result of other factors such as occupation, ethnicity and/or status rather than simply gender. The observed skeletal differences at Chongos reflect the presence of at least two different groups utilizing the cemetery at Chongos. I believe the presence of at least two groups living in close proximity to one another in coastal Perú supports the presence of Rostworowski's (1977, 1981, 1999) horizontal system of exchange and a fully functional *ayllu* system (Peters 1997; Proulx 2008; Silverman 1993).

The similarities between Chongos and Villa el Salvador (VES) are substantial, including cultural, temporal, and ecological similarities. Perhaps because of all of these similarities, there are strong bioarchaeological similarities as well. One notable exception is the lack of evidence for interpersonal violence at Chongos, which is interesting and warrants more research. Given the close ceramic association between VES and Chongos, I believe that the hypotheses to explain the bioarchaeological results at VES (Pechenkina and Delgado 2006; Rhode 2006; Vradenburg 2001) need to be explored in relation to the Chongos data. The VES site itself is registered as a cemetery although within sight of the huge Pachacamac complex. The Chongos site has residential and administrative components (Peters 1997; Wallace 1986); so does VES if it is in fact the cemetery for Pachacamac.

I believe the Chongos site functioned as a regional administrative center, perhaps with Chongos the capital of a small state that controlled at a minimum the Pisco valley. A function of Chongos as an administrative center was likely to serve as a regional trade center (Peters 1987-88; Silverman 1997). DeLeonardis (1997) did not find any burials in a domestic context in the lower Ica valley. Perhaps all individuals living during the EH/EIP were buried in a central burial site, not just elites interred at the Paracas Peninsula. Therefore, Chongos may reflect a corporate cemetery next to an administrative center that was not associated with any one particular residential site, or group of people. However, because Chongos was not completely excavated future research at the site may uncover elite individuals at the site. VES would represent a corporate cemetery for the Lurin valley and perhaps nearby environs.

The bioarchaeological results may also support the hypothesis of Peters (1997, 2000) that two different ceramic traditions are represented at the Chongos site. If the site was an administrative center, many different kinds of people would be coming to the site, increasing the possibility of different ceramics and/or textiles being left behind. This could also be reflected in the cemetery, with two or more groups, such as fishers and farmers, or peoples of different status and/or ethnicity. It is also possible that individuals directly associated with the habitational and/or administrative function of Chongos were not buried at Chongos. The skeletal remains that I analyzed had no evidence for differentiation by status. If elites lived at Chongos, shouldn't their burials have reflected their elite status? I believe that the elites from Chongos were buried at the nearby Paracas peninsula (Rowe 1995). However, it is necessary to emphasize that Chongos was excavated as a salvage operation, leaving a high probability that additional skeletals remain to be excavated. Future work at Chongos, including complete excavation of all skeletal remains, will allow for these and additional research questions to be addressed.

It seems that Topará arrived along the south central coast of Perú rather quickly, fluoresced and also disappeared quickly. There was a small amount of overlap between Paracas and Topará, with the latter group taking over administrative and cultural control of the former group (Peters 1997). The invading Toparáns maintained administrative control over the region, including the diverse group of occupational specialists and ethnicities. Exchange networks functioned in a similar manner as outlined by Rostworowski (1977, 1981, 1999), with strict separation of the different groups.

6.B: Proposed Future Research

The results of this project stimulated additional research questions that I hope to investigate in the future. These projects would expand the Chongos skeletal data to a more global context, focus on individual life history and improve our understanding of the bioarchaeology of the south central coast of Perú.

First, I hope to use Rhode's (2006) method to collect additional data to test for activity pattern(s) at Chongos. By using Rhode's method, I could test my interpretation that individuals from at least two different groups were buried at Chongos. Differences in activity pattern may reflect individuals with different occupational specializations, such as fishers and farmers. I would also test for differences in activity pattern by sex as a way to investigate potential differences in sexual division of labor. Individual data on diet, such as isotope, trace element and/or caries data would be compared with results using Rhode's method. At VES (Pechenkina et al. 2007) male/female differences in caries frequency are very significant, with females having more than twice as many carious lesions than males. In a multivariate analysis, Pechenkina and her collaborators (2007) found dimensions of lower body size varied significantly within gender groups, presumeably due to ethnic or class differences. A similar analysis, using Rhode's (2006) measurement of muscle development, should allow me to investigate if differences in activity pattern, interpreted as reflecting occupation, are associated with diet – for example, fishers would be expected to have a diet high in marine resources. Finally, activity pattern(s) using Rhode's method could be applied to previously collected bioarchaeological data such as CO, PH, caries rate, enamel hypoplasia, stature and periosteal lesions to determine if the overall health of one group is different from the other(s).

Second, I was surprised by the paucity of research on degenerative joint disease (DJD) at the temporo-mandibular junction (TMJ) in association with cranial deformation. Most of the studies I read while preparing this project presented DJD data on the major joints of the long bones (e.g. shoulder, elbow, knee). Other joints are often not presented. Given this limitation, I would like to explore the DJD data from other published skeletal collections in which artificial cranial deformation was practiced. In addition to investigating if the results I found at Chongos were consistent with other skeletal collections, I would also be interested to know if one type of cranial deformation were more likely to result in DJD at the TMJ, especially early onset, than other types of cranial deformation.

Third, the stable isotope analysis of Tykot and colleagues (2008) generated new questions. The results (see section 5.F) show great variation in diet among individuals, which would be expected with a heterogeneous population. It is possible that the differences in diet at Chongos represent temporal changes in diet, with dietary changes occurring over time, perhaps reflecting political and/or ideological changes that occurred at the end of the Early Horizon. Other explanations that I will explore for the observed differences in diet include dietary differences based on status, ethnicity, occupation and/or gender. I believe that Rhode's (2006) method would inform us on dietary differences as influenced by occupation.

Finally, I would like to analyze the skeletal remains housed at the Paracas museum on the Paracas Peninsula and other locations to compare the health indicators among that collection with the results from Chongos. As Rhode (2006) stated, it is typically assumed that the individuals from the Paracas Peninsula were marine foragers. However, Rhode found that individuals buried on the Paracas Peninsula were both fishers and farmers. If the groups along the coast of Perú were deeply engaged in trade networks to the point that the diets of all groups were similar, then the indicators of health should be similar for all groups. However, there should still be consistent and recognizable differences in activity pattern(s).

6.C: Summary

This project represents the first bioarchaeological investigation of the Chongos skeletal collection, the first comprehensive bioarchaeological project from the lower Pisco river valley, and one of the few from the south central

Peruvian coast. In addition to the regional contribution, this project adds to the understanding of the bioarchaeology of Early Horizon and Early Intermediate Period populations in coastal Perú. Like early ethnographies, this report provides a new datum point in understanding the lives of peoples who lived in very different worlds than exist today. This is a synchronic study, providing data that can be used for comparative cross-cultural bioarchaeological studies.

My initial hypothesis, that the skeletal population from Chongos derived from an agricultural population that supplemented their diet through marine and perhaps terrestrial foraging, was supported. Most health indicators, such as the high rate of carious lesions, evidence of anemia, high levels of systemic infection, stature, and enamel hypoplasia are consistent with populations from the Peruvian coast that have been interpreted to be reliant on agriculture for the majority of their calories. I also found evidence consistent with a population that relied on marine resources to supplement the diet with vital amino acids and minerals. This evidence includes mineral and isotope analysis of human hair, external auditory exostoses, and phytolith data.

There were statistically significant differences in caries rates by age and by sex, with caries rates increasing with age, and females statistically more likely to have carious lesions on their teeth than males. Males were also statistically more likely to have had enamel hypoplasias than females. Females with DJD were more likely to die earlier than males with DJD in the same location. These results were counter to my null hypothesis that there were no differences by sex at Chongos for diet, non-specific indicators of stress, systemic infection, or DJD.

These results suggest that the Chongos skeletal collection represents a population that experienced differential levels of stress as young people, that differential access to food began at an early age and remained throughout adulthood, had different labor patterns, or social classes and/or were exposed to different levels of pathogens.

The Chongos skeletal collection may represent a mixed population of fishers and farmers, or a cemetery utilized by different ethnicities and/or statuses. I look forward to continuing my research to address these important questions.

The larger importance of this study, besides being a contribution to bioarchaeology, lies along several dimensions. As suggested above, each new bioarchaeological study of a skeletal population provides data that permits world-wide comparisons, useful in testing the broadest level of hypothesis. For example, Cohen and Armelagos (1984) and Cohen and Crane-Kramer (2007) have been able to confirm the hypothesis that throughout the world, there was a decline in adult health with the development of intensive agriculture. This hypothesis was only testable when enough studies were produced from enough areas of the world. This study will add to the existing body of bioarchaeological data sets available for cross-cultural analyses.

Gender differences are an area of very active research among contemporary peoples. For example, there are enough ethnographies of Andean people to know that women have more prestige than is typical for most peasant societies (e.g., Isbell 1985). Has this always been true or did it develop with intensive agriculture? This study adds one bit of evidence that suggests that greater gender equality was at least beginning about 2,0000 years ago on the coast, probably due to the beginnings of intensive agriculture. Andean exceptionalism in that women have relatively high prestige for peasant farmers remains to be explained, and bioarchaeology studies, as they accumulate may be able to do this.

Finally, a major contribution of this study is the novel methods and findings. This is the first bioarchaeology dissertation that I know of that incorporates phytolith data. This study is also one of the few that uses isotopes and trace elements. The use of human hair to investigate isotopes and trace elements is also unique, with the results an encouraging sign for future chemical analyses using archaeological hair samples.

This study presented data showing one of the few potential examples of the "osteological paradox". The "osteological paradox," is that very sick individuals who died before lesions could be left in the teeth or bones will not be recognized in a skeletal sample. I have shown that by contrasting rates of traits, acquired in childhood but that can be preserved to adulthood, by adult stature and age at death as well as by comparing rates in children and adults, the "osteological paradox" can be viewed as suggesting a more careful analysis. These kinds of analyses suggest new questions. Nonetheless, Chongos is one of only a handful of examples where the osteolgoical paradox may have operated. More samples from a broad variety of habitats and social structure will permit us to investigate the conditions that so rarely lead to a paradoxical interpretation.

The results of this study are consistent with Cohen's (1989; 1994; Cohen and Armelagos1984; Cohen and Crane-Kramer 2007) hypothesis that there was a sharp decline in adult health associated with intensive agriculture. However, the evidence for great stress in the population is surprising due to the availability and, at least for some, utilization of marine sources of protein and their vital amino acids. It is unexpected for a population with this diverse of a diet to compare with mono-crop dependent (maize, rice, wheat) populations elsewhere. Yet, the effect of non-specific indicators of stress on age at death and stature is strong evidence for a sharp decline in adult health at Chongos.

Perú is the well-known exception to the origins of civilization being through farming and herding. Marine resources played a critical role in the origins but may have been less effective than meat and cheese additions to Old World diets during the subsequent developmental trajectories of civilizations. Bioarchaeology of the health and activities of peoples organized by ethnicity, language, descent group, and gender will help us understand this unique case in the origin and development of civilizations.

APPENDICES

APPENDIX A: Skeletal Recording Forms Used for Data Colletion at Chongos

SITE__________________ RECORDER________________ DATE:______________

INVENTORY N°____________________

AGE:________

Sternal end of rib:_____________________

Auricular Surface: Lt______________ Rt______________

Pubic Symphysis: Lt______________ Rt______________ (Todd)
Lt______________ Rt______________

Dental Wear: anterior:_______________ Posterior___________

Ectocraneal sutures: ____________________

Midlambdoidal	________	Midcoronal	________	Lambdoid	________
Lambda	________	Pterion	________	Sagittal	________
Obelion	________	Sphenofrontal	________	Coronal	________
Ant. Sagittal	________	Inf. Stphenotemp	________		
Bregna	________	Sup. Sphenotemp	________		

Epiphyseal closure:

Basilar	________	Pubis-Ischium	________	Prox-Ulna	________
Med Clavicle	________	Pubis-Ilium	________	Dist Ulna	________
Cervic Vert Rim	________	Ilium-Ischium	________	Femur Head	________
Thoracic Vert Rim	________	Iliac Crest	________	Great Troch	________
Lumbar Vert Rim	________	Ischial Tuber	________	Dist Fem	________
Sacrum 1-2	________	Prox Hum	________	Prox Tibia	________
2-3	________	Med Epicon Hum	________	Dist Tibia	________
3-4	________	Prox Radius	________	Prox Fib	________
		Dist Radius	________	Dist Fib	________

SEX:____________

Sciatic	________	Sacrum	________	Orbital Area	________
Auric surf	________	Fem Head	________	Mastoid	________
Preauric Sulcus	________	Hum Head	________	Occiput	________
Spubic Angle	________	Bone Robus	________	Mandible	________

DEFORMATION:______________

Inventory Pattern Coding Form

N° ________________ Age ______ Sex _______ Recorder ________________ Date _________

		Location	Surface	Side	Stage
Frontal					
Parietal	L				
	R				
Occipital					
Temporal	L				
	R				
Zygomatic	L				
	R				
Sphenoid	L				
	R				
Maxilla	L				
	R				
Mandible	L				
	R				
Mand Condyle	L				
	R				
TMJ	L				
	R				
C-1					
C-2					
C-3-6					
C-7					
T1-9					
T-10					
T-11					
T-12					
L-1					
L-2					
L-3					
L-4					
L-5					
Rib 1	L				
	R				
Rib 2	L				
	R				
Rib 3-10 L					
	R				
Rib 11	L				
	R				
Rib 12	L				
	R				

		Location	Surface	Side	Stage
Manubrium					
Sternum Body					
Clavicle	L				
	R				
Scapula L					
	R				
Humerus	L				
	R				
Radius	L				
	R				
Ulna	L				
	R				
Os Coxae	L				
	R				
Sacrum					
Femur	L				
	R				
Tibia	L				
	R				
Fibula	L				
	R				
Patella	L				
	R				
Calcaneus	L				
	R				
Talus	L				
	R				
Tarsals	L				
	R				
Metatarsals	L				
	R				
Phalanges	L				
	R				
Carpals	L				
	R				
Metacarpals	L				
	R				
Phalanges	L				
	R				

Comments:

DENTAL INVENTORY

Maxilia

	M3	M2	M1	P2	P1	C	12	11	11	12	C	P1	P2	M1	M2	M3
presence																
Mbheight																
Dbheight																
Mlheight																
Dlheight																
Mdmax.width																
Vlmax width																
ROOT																
root length																
Mdwidth																
Vlwidth																
Hypoplasias																
caries																
calculus																
abscess																
Bucal wear Lingual																

Mandible

	M3	M2	M1	P2	P1	C	12	11	11	12	C	P1	P2	M1	M2	M3
presence																
Mbheight																
Dbheight																
Mlheight																
Dlheight																
MDmax.widh																
Vlmax width																
ROOT																
root length																
Mdwidth																
Vlwidth																
Hypoplasias																
caries																
calculus																
abscess																
Bucal wear Lingual																

NUMBER ________________

SEX ______________________ **AGE** ____________

CRANIAL MEASUREMENTS		f. magnum length		maxillo alveolar length	
max cranial legth		f. magnum breadth		maxillo alveolar breadth	
max cranial breadth		biauricular breadth		palatal length 8	
basion.bregma height		mastoid length		palatal breadth 7	
porion.bregma height		total facial height		MANDIBULAR MEASUREMFNTS	
min frontal breigth		upper facial height		bicondilar breadth	
max frontal breadthII		facial windth (bizygomatic br.)		bigonial breadth	
cranial base legth		fmt-fmt width		height of ascending ramus	
max occipital breadth		middle facial width		min breadth of ascending ramus	
frontal chord		ba-pr length		angle of ascending ramus	
parietal chord		nasal height		mandibular length from angles	
occipital chord		nasal breadth		mandibular length from condeli	
po-b-po arch		min breadth of nose bones		height of symphesis	
anterior posterior arch		orbital height		height of body	
frontal arch		orbital breadth from dacrion 16		thickness of body	
parietal arch		orbital br. from mf		distance between f. mentale	
occipital arch		biorbital breadth 8ec-ec)		max breadth of ascending ramus	
		dacrion breadth			

HUMERUS	**RIGHT**	**LEFT**
max length		
whole length		
max diam at the mid-shaft		
min diam at the mid-shaft		
least circum of the shaft		
mid shaft circum		
epicondilar breadth		
vertical diam of the head		
anterior-posterior diameter		
medial-latereral diameter		
RADIUS max length		
physiological length		
medio lateral diam		
anterio-posterior diam		
min circum. of the mid-shaft		
ULNA max length		
physiological length		
anterio-posterior diam		

ULNA	**RIGHT**	**LEFT**
medio-lateral diam		
upper medio-lateral diam		
upper anterior-posterior diam		
least circum of the shaft		
FEMUR max length		
bicondilar (oblique) length		
anterior-posterior diam of the wid-shaft		
medio-lateral of the mid-shaft		
max diam of the head		
circum of the mid-shaft		
subtrochanteric ante posterior diam		
subtrochanteric med lateral diam		
epicondilar breadth		
TIBIA max length		
facies articularis malleolaris-facies articularis tibian		

TIBIA	RIGHT	LEFT	*PELVIS*	RIGHT	LEFT
Whole Length			Height		
max proximal epiphyseal breadth			iliac breadth		
max distal epiphyseal breadth			pubis length		
anterior posterior diam of the mid-shaft			ishium length		
medial-lateral diam of the mid-shaft			max pelvis breadth		
anterior-posterior diam at nutrient E.			anterior posterior diam		
medio-lateral diam at nutrient E.			transversal diam		
circum at mid-shaft			biacetabular diam		
circum at nutrient E.			iliac height		
the least circum			***CLAVICLE*** max length		
FIBULA max length			physiological length		
max diam at the mid-shaft			anterior posterior diam at mid-shaft		
SACRUM max anterior height			superior inferior diam of the mid-shaft		
max anterior breadth			***SCAPULA*** height anatomical breadth		
anterior arch length			breadth anatomical breadth		
max tranverse diam of base			***CALCANEUS*** max length		
			middle breadth		

		GENERAL						GENERAL 2° PATHOLOGY					
		GEN	SPEC	SEV	LOC	STATE	L/W	GEN	SPEC	SEV	LOC	STATE	L/W
Frontal													
Parietal	L												
	R												
Occipital													
Temporal	L												
	R												
Z+A30ygomatic	L												
	R												
Sphenoid	L												
	R												
Maxilla	L												
	R												
Mandible	L												
	R												

JOINT PATHOLOGY

								OSTEOPHYTES		POROSITY		EBURNAT+N105I		EROSION	
								SEV	LOC	SEV	LOC	SEV	LOC	SEV	LOC
Mand condyle	L														
	R														
TMJ	L														
	R														
C-1															
C-2															
C-3-6															
C-7															
T1-9															
T-10															
T-11															
T-12															
L-1															
L-2															
L-3															
L-4															
L-5															
Rib 1	L														
	R														
Rib 2	L														
	R														
Rib 3-10	L														
	R														
Rib 11	L														
	R														
Rib 12	L														
	R														

Comments:

		FIRST PATHOLOGY						SECOND PATHOLOGY					
		GEN	SPEC	SEV	LOG	STATE	L/W	GEN	SPEC	SEV	LOC	STATE	L/W
Manubrium													
Sternum Body													
Clavicle	L												
	R												
Scapula	L												
	R												
Humerus	L												
	R												
Radius	L												
	R												
Ulna	L												
	R												
Os Coxae	L												
	R												
Sacrum													
Femur	L												
	R												
Tibia	L												
	R												
Fibula	L												
	R												
Patella	L												
	R												
Calcaneus	L												
	R												
Talus	L												
	R												
Tarsals	L												
	R												
Metatarsals	L												
	R												
Phalanges	L												
	R												
Carpals	L												
	R												
Metacarpals	L												
	R												
Phalanges	L												
	R												

Comments:

PATHOLOGY CODING --POSTCRANIAL JOINT PATHOLOGY

Burial N° ____________ Age _____ Sex __________ Recorder ________________ Date ____________

		FIRST PATHOLOGY								SECOND PATHOLOGY							
		Osteophytes		Porosity		Eburnation		Erosion		Osteophytes		Porosity		Eburnation		Erosion	
		SEV	LOC	SEV	LOC	SEV	LOC	SEV	LOC	SEV	LOC	SEV	LOC	SEV	LOC	SEV	LOC
Manubrium																	
Sternum Body																	
Clavicle	L																
	R																
Scapula	L																
	R																
Humerus	L																
	R																
Radius	L																
	R																
Ulna	L																
	R																
Os coxae	L																
	R																
Sacrum																	
Femur	L																
	R																
Tibia	L																
	R																
Fibula	L																
	R																
Patella	L																
	R																
Calcaneus	L																
	R																
Talus	L																
	R																
Tarsals	L																
	R																
Metatarsals	L																
	R																
Phalanges	L																
	R																
Carpals	L																
	R																
Metacarpals	L																
	R																
Phalanges	L																
	R																

VERTEBRAL BODY HEIGHT

			INFERIOR		BODY		
	Anterior	Posterior	LT	RT	LT	CEN	RT
C1							
C2							
C3							
C4							
C5							
C6							
C7							
T1							
T2							
T3							
T4							
T5							
T6							
T7							
T8							
T9							
T10							
T11							
T12							
L1							
L2							
L3							
L4							
L5							

APPENDIX B: Calculus Sample Processing to Extract Phytoliths

This appendix details the three-day processing methodology utilized to extract phytoliths from dental calculus recovered from the Chongos skeletal collection.

After reviewing processing methods used by Perry (2001, 2002), Buchet et al., Juan-Tresserras et al (1997), and Cummings and Magennis (1997), Ms. Chandler-Ezell and I, with consultation from Dr. Deborah Pearsall, designed a procedure with the lowest concentrations of chemicals to avoid damage to starch grains that may have been stuck in the calculus matrix. Two processing methods were tested that used varying concentrations of acid and hydrogen peroxide to try to avoid damage to starch grains. However, the concentrations did not sufficiently dissolve the calculus matrix and chemical concentrations had to be increased to yield results. Even so, with the increase in concentration levels throughout processing the concentration levels were still not as high as in the published literature (Dietz et al. 2003a, b).

On day one the dry calculus samples were rinsed into individual test tubes with distilled water. The test tubes were then placed into an ultrasonic bath and sonicated for 30 minutes to "break up the matrix." After the sample was sonicated, it was placed into a centrifuge for five minutes at 2000 rpm to concentrate the sample to the bottom of the tube, and the excess water was pipetted. The final step on day one was to add 10% diluted HCl (hydrochloric acid) to each sample tube. The tubes were then left alone for 12-24 hours to react.

On day two the tubes were first placed into a centrifuge for five minutes at 2000 rpm to again concentrate the sample at the bottom of the tube. The HCl and reaction byproducts were pipetted. The sample was rinsed with distilled water and the centrifuge process was repeated until all acid was removed from the sample. Once completed the sample was covered with paper towel to prevent contamination and allowed to dry through evaporation at room temperature. Also during day two a subset of three samples was treated with 6% Hydrogen peroxide (H_2O_2).

Finally, on day three the samples that had been treated with H_2O_2 were centrifuged and rinsed using the same methods as day two. Upon rinsing they were also allowed to dry. A small amount of the acid-only samples were mounted onto slides to check for processing effectiveness.

The subset of three samples was added to determine whether HCl alone was enough to dissolve the calculus matrix to view starch and phytoliths, or whether both HCl and H_2O_2 together were too harsh and resulted in destruction of the delicate starch cells. The calculus was still clumped and undissolved in both subsets, so it was determined that a more intensive processing was needed to extract the samples from the calculus matrix.

Based on the three day processing methodology, adjustments had to be made to complete sample extraction from the calculus matrix. All samples were reprocessed with 10% HCl for 4 days, rinsed twice, then treated with 27% H_2O_2 for 24 hours, and finally rinsed 3 times to remove all traces of the H_2O_2. This adjusted methodology worked to break down the calculus matrix, and was still lower than what was in the literature at the time.

The slides were mounted in a 100% glycerol solution, two drops of glycerol to 45 microliters of extract. Once mixed it was covered with a cover slip and sealed with fingernail polish to keep the mixture from leaking.

Chandler-Ezell and I performed full scans of the slides. All items seen on the slide were counted and described. Items were identified to the finest taxonomic class possible.

References

Allison, M., E. Gerszten, J. Munizaga, C. Santoro and D. Mendoza
1981 Tuberculosis in Pre-Columbia Andean Populations. In *Prehistoric Tuberculosis in the Americas*, J.E. Buikstra, ed. Pp: 69-81. Evanston, Il: Northwestern University Archaeological Program.

Angel, J.L.
1966 Porotic Hyperostosis, Anemias, Malarias, and Marches in the Prehistoric Eastern Mediterranean. *Science* 253(3737): 760-763.

Armelagos, G.J.
1998 Introduction: sex, gender and health status in prehistoric and contemporary populations. In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer and P. Stuart-Macadam, eds. Pp: 1-10. Cambridge, U.K.: Cambridge University Press.

Armitage P.L.
1975 The extraction and identification of opal phytoliths from the teeth of ungulates. *Journal of Archaeological Science* 2: 187-97.

Arriaza, B.T.
1995 *Beyond Death: The Chinchorro Mummies of Ancient Chile*. Washington, D.C.: Smithsonian Institution Press.

Aufderheide, A.C. and C. Rodriguez-Martin.
1998 *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge, U.K.: Cambridge University Press.

Bass, W.M.
1996 *Human Osteology: A Laboratory Manual and Field Manual*. Columbia, MO, Missouri Archaeological Society.

Benfer, Jr. R.A.
1984 Challenges and Rewards of Sedentism: The Preceramic Village of Paloma, Perú. In *Paleopathology at the Origins of Agriculture*, M.N. Cohen and G.J. Armelagos, eds. Pp: 531-558. Orlando, Fl: Academic Press.

Benfer Jr., R.A.
1990 The Preceramic Period Site of Paloma, Perú: Bioindications of Improving Adaptation to Sedentism. *Latin American Antiquity* 1: 284-318.

Benfer Jr., R.A.
1997 Where stature estimated from regression of limb bone length is inappropriate. *American Journal of Physical Anthropology Supplement* 24: 74.

Benfer Jr., R.A.
1999 Projecto de Excavaciones en Paloma: El Valle de Chilca, Perú, El Periódo Arcaico en el Perú. Hacia una definición de los orígenes. *Boletín de Arqueología PUCP* 3: 213-237.

Benfer Jr., R.A.
2001 *Within Family Adjustments in Prehistoric Coastal Peru*. Paper presented in the symposium Plastic and Enduring: 100 Years of Studies of Past Lives and Past Histories, organized by E. Pechenkina, R.A. Benfer, Jr. chair. Washington, D.C.: American Anthropological Association meeting.

Benfer, R.A.
2008 Early Villages. In *Encyclopedia of Archaeology*, D.M. Pearsall, ed. Pp: 368-380. San Diego, CA: Elsevier.

Benfer, R.A. and S. Gehlert
1980 Los Habitantes Precolombinos de La Paloma. In *El Hombre y La Cultural Andina*, R. Matos M., ed. Pp: 792-799. Lima, Perú: Editora Lasontay.

Benfer, R.A. and E.A. Pechenkina
1998 *Biographical Stories: Parental Investment and the Health of children in Prehistory*. Paper presented at the International Congress of Anthropological and Ethnological Sciences, Williamsburg, Virginia.

Benfer, R.A., G.H. Weir, and B. Ojeda E.
1987 Early Water Managment Strategies on the Coast of Perú. In *Risk Management and Arid Land Use Strategies in the Andes*, D. Browman, ed. Pp: 195-206. Boulder, CO: Westview Press.

Benfer, R.A. et al.
n.d. Buena Vista y Otros Templos Tempranos y Calendarios de Los Valles al Oeste del Perú. From *Simposio Internacional de Arqueología: Procesos y Expresiones de Poder, Identidad y Orden Tempranos en Sudamérica*, Primera parte, Boletine de Arqueología 10 (2006), Peter Kaulicke y Tom Dillahay, eds. Lima, Perú: Pontificía Universidad Católica del Perú. Manuscript in possession of the author.

Bergfield, R.A.
2007 Dietary Analysis of Archaeological Hair Samples from Perú. Unpublished thesis, Department of Anthropology, University of Missouri, Columbia, MO.

Blakey, M.L., T.E. Leslie, and J.P. Reidy
1994 Frequency and chronological distribution of dental enamel hypoplasia in enslaved African Americans: a test of the weaning hypothesis. *American Journal of Physical Anthropology* 95: 371-383.

Blau, S.
2007 Skeletal and Dental Health and Subsistence Change in the United Arab Emirates. . In *Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification*, M.N. Cohen and G.M.M. Crane-Kramer, eds. Pp: 190-206. Gainesville, Fl: University Press of Florida.

Blom, D.E., J.E. Buikstra, P.D. Tomczak, L. Keng, E. Shoreman, and D. Stevens-Tuttle.
2005 Anemia and Childhood Mortality: Latitudinal Patterning along the Coast of Pre-Columbian Perú. *American Journal of Physical Anthropology* 127: 152-169.

Bocquet-Appel, J.P. and C. Masset
1982 Farewell to Paleodemography. *Journal of Human Evolution* 11: 321-333.

Bruhns, K.O.
1994 *Ancient South America*. Cambridge, UK: Cambridge University Press.

Buikstra, J.E.
1977 Biocultural Dimensions of Archaeological Study: A Regional Perspective. In *Biocultural Adaptation in Prehistoric America*. R. Blakey, ed. Pp: 67-84. Athens, GA: University of Georgia Press.

Buikstra, J.E. and D.H. Ubelaker
1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archeological Survey Research Series No. 44. Fayetteville, AR: Arkansas Archeological Survey.

Burger, R.L.
1992 *Chavin and the Origins of Civilization*. New York, NY: Thames and Hudson.

Burger, R.L.
1989 An overview of Peruvian archaeology (1976-1986). *Annual Review of Anthropology* 18: 37-69.

Burger, R.L. and L. Salazar-Burger
1991 The second season of investigations at the Initial Period Center of Cardal, Perú. *Journal of Field Archaeology* 18(3): 275-296.

Burger, R.L., K.L. Mohr Chavez and S.J. Chavez
2000 Through the Glass Darkly: Prehispanic Obsidian Procurement and Exchange in Southern Perú and Northern Bolivia. *Journal of World Prehistory* 14: 203-362.

Burton, J.H. and T.D. Price
1990 The Ratio of Barium to Strontium as a Paleodietary Indicator of Consumption of Marine Resources. *Journal of Archaeological Sciences* 17:547-557.

Capasso, L., K.A.R. Kennedy and C.A. Wilczak
1999 *Atlas of occupational markers on human remains*. Teramo, Italy, Edigrafital.

Carmichael, P.H.
1995 Nasca Burial Patterns: Social Structure and Mortuary Ideology. In *Tombs for the Living: Andean Mortuary Practices*, T.D. Dillehay, ed. Pp: 161-188. Washington, D.C.: Dumbarton Oaks Research Library and Collection.

Chirichingno, N.
1980 *Instituto del Mar del Perú informe No. 44: Clave para identificar los peces marinos del Perú*. Lima, Perú: Servicios Editoriales Edisert EIRL.

Cohen, M.N., and G.J. Armelagos.
1984 *Paleopathology at the Origins of Agriculture*. Edited Volume. New York: Academic Press.

Cohen, M.N. and S. Bennett
1998 Skeletal evidence for sex roles and gender hierarchies in prehistory. In *Reader in Gender Archaeology*, K. Hays-Gilpin and D.S. Whitley, eds. Pp: 297-318. New York, NY: Routledge.

Cohen, M.N. and G.M.M. Crane-Kramer
2007a *Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification*. Edited Volume. Gainesville, Fl: University Press of Florida.

Cohen, M.N. and G.M.M. Crane-Kramer
2007b Editors' Summation. In *Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification*, M.N. Cohen and G.M.M. Crane-Kramer, eds. Pp: 320-344. Gainesville, Fl: University Press of Florida.

Cook, D.C. and K.D. Hunt
1998 Sex differences in trace elements: status or self-selection? In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer and P. Stuart-Macadam, eds. Pp: 64-78. Cambridge, U.K.: Cambridge University Press.

Craig, A.C. and N.P. Psuty
1968 *The Paracas papers: Studies in marine desert ecology*. Boca Raton, Fl: Florida Atlantic University, Department of Geography, Occasional Papers no. 1.

Cummings, L.S. and A. Magennis
1997 A phytolith and starch record of food and grit in Mayan human tooth tartar. In *The state-of-the-art of phytoliths in soils and plants*, A. Pinilla, J. Juan-Tresserras and M.J. Machado, eds. Pp: 211-218. Madrid, Spain: Monografias del Centro de Ciencias Medioambientales, Centro de Ciencias Medioambientales, consejo Superior de Investigacions Cientificas.

DeLeonardis, L.
1997 *Paracas Settlement in Callango, Lower Ica Valley, 1st Millennium B.C., Perú*. Unpublished dissertation, Department of Anthropology, Catholic University, Washington, DC.

DeLeonardis, L.
1991 *Settlement History of the Lower Ica Valley, Perú, Vth-Ist Centuries, B.C*. Unpublished thesis, Department of Anthropology, Catholic University, Washington, DC.

Delgado, M.
1992 Investigaciones en Villa el Salvador. En: *Pachacamac,* Lima, Perú: Museo de la Nacion, Vol. 1: 135-136.

Delgado, M.
1994 *Proyecto investigaciones arqueologicas en Villa el Salvador: Rescate arqueologicos*. Informe Final. Unpublished ms on file with author.

Dietz, M.J., K. Chandler-Ezell and R.A. Bergfield
2003a *Reconstruction of Diet along the South Central Coast of Perú*. Paper presented at the 102nd Annual Meeting of the American Anthropological Association: Chicago.

Dietz, M.J., K. Chandler-Ezell and D.M Pearsall
2003b *Dietary Reconstruction of the Chongos Culture using Phytolith and Starch Analysis*. Paper presented at the 68th Annual Meeting of the Society for American Archaeology: Milwaukee.

Ebert, V. and T.C. Patterson.
2006 Gender in South American Archaeology. In *Handbook of Gender in Archaeology*, S.M. Nelson, ed. Pp: 853-874. Walnut Creek, CA: AltaMira Press.

Edwards, D.S.
1984 *Dental Attrition and Subsistence at the Preceramic Site of Paloma, Perú*. Unpublished thesis, Department of Anthropology, University of Missouri, Columbia, MO.

Engel, F.
1957 Early Sites in the Pisco Valley of Perú: Tambo Colorado. *American Antiquity* 23(1): 34-45.

Engel, F.
1966 *Paracas: Cien Siglos de Cultura Perúana*. Lima, Perú: Editorial Juan Mejía Baca.

Engel, F.
1987 *De las Begionas al Maíz*. Centro de investigacion de zonas aridas. Lima, Perú: Center for the Investigation of Arid Zones.

Farnum, J.
1996 *Multi-Method Approaches to Diet and health Reconstruction and Estimation of Ages of Pregnancies and Weaning for Paloma, Peru Using Sr, Zn, and Non-Specific Indicators of Stress*. Unpublished thesis, Department of Anthropology, University of Missouri, Columbia, MO.

Farnum, J.
2002 *Biological Consequences of Social Inequalities in Prehistoric Perú*. Unpublished dissertation, Department of Anthropology, University of Missouri, Columbia, MO.

Forgey, K.
2006 *Investigating the Origins and Function of Nasca Trophy Heads Using Osteological and Ancient DNA Analyses*. Unpublished dissertation, Department of Anthropology, University of Illinois, Chicago.

Guillet, D., L. Furbee, J. Sandor and R.A. Benfer
1995 The Lari Soils Project in Peru - A methodology for combining cognitive and behavioural research. In *The Cultural Dimension of Development: Indigenous Knowledge Systems*, D.M. Warren, D. Brokensha, and L.J. Slikkerveerk, eds. Pp: 71-81. Warwickshire, UK: Practical Action Publishing.

Goodman, A.H. and D. Martin
2002 Reconstructing Health Profiles from Skeletal Remains. In *The Backbone of History: Health and Nutrition in the Western Hemisphere*. R.H. Steckel and J.C. Rose, eds. Pp: 11-60. Cambridge, UK: Cambridge University Press.

Goodman, A.H. and J.C. Rose
1990 Assessment of Systemic Physiological Perturbations from Dental Enamel Hypoplasias and Assoicated Historological Structures. *Yearbook of Physical Anthropology* 22: 59-110.

Goodman, A.H. and J.C. Rose
1991 Dental Enamel Hypoplasias as Indicators of Nutritional Stress. In *Advances in Dental Anthropology*, M.A. Kelley and C.S. Larsen, eds. Pp: 279-293. New York: Wiley-Liss.

Goodman, A.H., D.L. Martin, and G.J. Armelagos.
1984 Indications of Stress from Bones and Teeth. In Paleopathology at the Origins of Agriculture. G.J. Armelagos and M.N. Cohen, eds. Pp: 13-49. Orlando, Fl: Academic Press.

Guillen, S.E.
1992 *The Chinchorro Culture: Mummies and Crania in the Reconstruction of Preceramic Coastal Adaptation in the South Central Andes*. Unpublished dissertation, Department of Anthropology, University of Michigan, Ann Arbor.

Hillson, S.W.
2000 Dental pathology. In *Biological anthropology of the human skeleton*. M.A. Katzenberg and S.R. Saunders, eds. Pp: 249-286. New York: Wiley-Liss.

Hillson, S.
1996 *Dental Anthropology*. Cambridge, UK: Cambridge University Press.

Hsu, S.A.
1988 *Coastal Meteorology*. San Diego, CA: Academic Press.

Huss-Ashmore, R., A.H. Goodman, and G.J. Armelagos
1982 Nutritional inference fro paleopathology. *Archaeological Method and Theory* 5: 395-474.

Hutchinson, D.L., C.B. Denise, H.J. Daniel, and G.W. Kalmus
1997 A reevaluation of the cold water etiology of external auditory exostoses. *American Journal of Physical Anthropology* 103: 417-422.

Isbell, B.J.
1985 *To Defend Ourselves: Ecology and Ritual in an Andean Village*. Long Grove, Il: Waveland Press.

Isbell, W.H.
1997 *Mummies and Mortuary Monuments*. Austin, TX: University of Texas Press.

Iscan, M. and S. Loth
1986a Determination of Age from the Sternal Rib in White Males: A Test of the Phase Method. *Journal of Forensic Science* 31: 122-132.

Iscan, M. and S. Loth
1986b Determination of Age from the Sternal Rib in White Females: A Test of the Phase Method. *Journal of Forensic Science* 31: 990-999.

Jackes, M.K.
2000 Building the bases for paleodemographic analysis: adult age determination. In *Biological Anthropology of the Human Skeleton*, M.A. Katzenberg and S.R. Saunders, eds. Pp. 407-456. New York, NY: John Wiley and Sons.

Johnston, R.J., P.J. Taylor and M. Watts
2002 *Geographies of Global Change: Remapping the World*. New York, NY: John Wiley and Sons.

Jurmain, R. and L. Kilgore
1998 Sex-related patterns of trauma in humans and African apes. In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer, and P. Stuart-Macadam, eds. Pp: 11-26. Cambridge, U.K.: Cambridge University Press.

Katzberg, R.W., R.H. Tallents, K. Hayakawa, T.L. Miller, M.J. Goske and B.P. Wood
1985 Internal derangements of the temporomandibular joint: findings in the pediatric age group. *Radiology* 154: 125-127.

Kellner, C.
2002 *Coping with Environmental and Social Challenges in Prehistoric Perú: Bioarchaeological Analyses of Nasca Populations*. Unpublished dissertation, Department of Anthropology, University of California, Santa Barbara.

Kroeber, A.L. and W.D. Strong
1924 *The Uhle Pottery collections from Chincha*. Berkeley, CA: University of California Press.

Krogman, W.M. and M.Y. Iscan
1986 *The Human Skeleton in Forensic Medicine*, 2nd edition. Springfield, IL: Charles C. Thomas.

Kumar, A., S. Kotrashetti, and M. Umarani
2007 Mandibular fractures as a possible aetiology in temporomandibular joint disorders. *International Journal of Oral and Maxillofacial Surgery* 36(11): 1068.

Lambert, P.M.
1993 Health in Prehistoric Populations of the Santa Barbara Channel Islands. *American Antiquity* 58: 509-521.

Lampl, M. and F.E. Johnston
1996 Problems in the aging of skeletal juveniles: Perspectives from maturation assessments of living children. *American Journal of Physical Anthropology* 101(3): 345-355.

Lanning, E.P.
1960 *Chronological and Cultural Relationships of Early Pottery Styles in Ancient Perú*. Unpublished dissertation, Department of Anthropology, University of California, Berkeley.

Lanning, E.P.
1967 *Perú Before the Incas*. Englewood Cliffs, NJ: Prentice Hall.

Larsen, C.S.
1984 Health and disease in prehistoric Georgia: the transition to agriculture. In *Paleopathology at the Origins of Agriculture*. G.J. Armelagos and M.N. Cohen, eds. Pp: 367-392. Orlando, Fl: Academic Press.

Larsen, C.S.
1997 *Bioarchaeology: Interpreting Behavior from the Human Skeleton*. Cambridge, UK: Cambridge University Press.

Larsen, C.S.
2002 Bioarchaeology: The Lives and Lifestyles of Past People. *Journal of Archaeological Research* 10(2): 119-166.

Lathrap, D.W.
1973 Gifts of the Cayman: some thoughts on the subsistence basis of Chavin. In *Variation in anthropology*, D.W. Lathrap and J. Douglas, eds. Pp: 91-105. Urbana, IL: Illinois Archaeology Survey.

Loesche, W.J.
1986 Role of Streprococcus mutans in human dental decay. *Microbiology and Molecular Biology Review* 50(4): 353-380.

Loth, S. and M. Iscan
1989 Morphological Assessment of Age in the Adult: The Thoracic Region. In *Age Markers in the Human Skeleton*, M.Y. Iscan, ed. Pp: 105-136. Springfield, IL: Charles C. Thomas.

Lovejoy, C.O. and K.G. Heiple
1981 The analysis of fractures in skeletal population, with an example from the Libben site, Ottowa County, Ohio. *American Journal of Physical Anthropology* 55: 529-541.

Lovejoy, C.O., R.S. Meindl, R.P Mensforth, and T.J. Barton
1985a Multifactorial Determination of Skeletal Age at Death: A Method and Blind Tests of Its Accuracy. *American Journal of Physical Anthropology* 68: 1-14.

Lovejoy, C.O., R.S. Meindl, T.R. Pryzbeck, and R.P. Mensforth
1985b Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Age at Death. *American Journal of Physical Anthropology* 68: 15-28.

Lukacs, J.
2008 Fertility and Agriculture Accentuate Sex Differences in Dental Caries Rates. *Current Anthropology* 49(5): 901-914.

Lumbreras, L.G.
1979 *The Peoples and Cultures of Ancient Perú*. Translated by Betty J. Meggars. Washington, D.C., Smithsonian Institution Press.

Maat, G.J.R. and E.A. Van der Velde
1987 The caries-attrition competition. *International Journal of Anthropology* 2(4): 281-292.

Makowski, K.
2002 Power and Social Ranking at the End of the Formative Period: The Lower Lurin Valley Cemeteries. In *Andean Archaeology I: Variations in Sociopolitical Organization*, W.H. Isbell and H. Silverman, eds. Pp: 89-120. New York, NY: Kluwer Academic/Plenum Publishers.

Makowski, K.
2008 Andean Urbanism. In *Handbook of South American Archaeology*, H. Silverman and W.H. Isbell, eds. Pp: 633-657. New York, NY: Springer.

Massey, S.
1986 *Sociopolitical Change in the Upper Ica Valley, B.C. 400 to 400 A.D., Regional States on the South Coast of Perú*. Unpublished dissertation, Department of Anthropology, University of California, Los Angeles.

McBride, D.G., M.J. Dietz, M.T. Vennemeyer, S.A. Meadors, R.A. Benfer, and N.L. Furbee
2001 Bootstrap Methods for Sex Determination from the Os Coxae Using the ID3 Algorithm. *Journal of Forensic Science* 46(3): 427-431.

Meindl, R.S. and C.O. Lovejoy
1985 Ectocranial Suture Closure: A Revised Method for the Determination of Skeletal Age at Death Based on the Lateral-Anterior Sutures. *American Journal of Physical Anthropology* 68: 57-66.

Meindl, R.S. and K.F. Russell
1998 Recent advances in method and theory in paleodemography. *Annual Review of Anthropology* 27: 375-399.

Meindl, R.S., C.O. Lovejoy, R.M. Mensforth, and L.D. Carlos
1985 Accuracy and Direction of Error in Sexing of the Skeleton: Implications for Paleodemography. *American Journal of Physical Anthropology* 68: 29-45.

Mendonça de Souza, S.M.F, K.J. Reinhard and A. Lessa
2008 Cranial Deformation as the Cause of Death for a Child from the Chillon River Valley, Perú. *Chungará (Arica)*, 40(1): 41-53.

Mensforth, R.P. and C.O. Lovejoy
1985 Anatomical, physiological, and epidemiological correlates of the aging process: A confirmation of multifactorial age determination in the Libben skeletal population. *American Journal of Physical Anthropology* 68: 87-106.

Mensforth, R.P., C.O. Lovejoy, J.W. Lallo, and G.J. Armelagos
1978 The role of constitution factors, diet, and infectious disease in the etiology of porotic hyperostosis and periosteal reactions in prehistoric infants and children. *Medical Anthropology* 2: 1-59.

Menzel, D., J.H. Rowe and L. Dawson
1964 *The Paracas Pottery of Ica: A Study in Style and Time*. Berkeley, CA: University of California Publications in American Archaeology and Ethnology #50.

Merbs, C.
1989 Trauma. In *Reconstruction of Life from the Skeleton*, M.Y. Iscan and K.A.R. Kennedy, eds. Pp: 161-189. New York, NY: Alan Liss.

Moseley, M.E.
1975 *The Maritime Foundations of Andean Civilization.* Menlo Park, CA: Cummings.

Moseley, M.E.
1983 The good old days were better: Agrarian collapse and tectonics. *American Anthropologist* 85: 773-799.

Moseley, M.E.
1992a *The Incas and Their Ancestors*. New York, NY: Thames and Hudson.

Moseley, M.E.
1992b Maritime Foundations and Multilinear Evolution. *Andean Past* 3: 5-42.

Moseley, M.E.
2001 *The Inca and Their Ancestors: the archaeology of Perú*. Revised Edition. New York, NY: Thames and Hudson.

Murra, J.
1972 El control vertical de un maximo de pisos ecological en la economia de las sociedades andinas. In *Visita de la Provincia de Leon de Huanuco (1562)* I. Ortiz de Zuñiga, ed. Pp: 427-476. Huanuco, Perú: Universidad Hermilio Valdizan.

Murra, J.
1985 The limits and limitations to a vertical archipelago in the Andes. In *Andean Ecology and Civilization: An Interdisciplinary Perspective on Andean Ecological Complementarity*, S. Masuda, I. Shimada and C. Morris, eds. Pp: 15-20. Tokyo: University of Tokyo Press.

Okumura, M.M.M., C.H.C. Boyadjian, and S. Eggers.
2007 Auditory Exostoses as an Aquatic Activity Marker: A Comparison of Coastal and Inland Skeletal Remains From Tropical and Subtropical Regions of Brazil. *American Journal of Physical Anthropology* 132: 558-567.

Ortner, D.J.
1998 Male-female immune reactivity and its implications for interpreting evidence in human skeletal paleopathology. In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer and P. Stuart-Macadam, eds. Pp: 79-92. Cambridge, U.K.: Cambridge University Press.

Ortner, D.J.
2003 *Identification of Pathological Conditions in Human Skeletal Remains*, 2nd edition. San Diego, CA: Academic Press.

Ortner, D.J. and W.G.J. Putschar
1985 *Identification of Pathological Conditions in Human Skeletal Remains*. Washington, D.C., Smithsonian Institution Press.

Paul, A.
1991a *Paracas Art and Architecture: Object and Context in South Coastal Perú*. Edited Volume. Iowa City, IA: University of Iowa Press.

Paul, A.
1991b Paracas: An Ancient Cultural Tradition on the South Coast of Perú. In *Paracas Art and Architecture: Object and Context in South Coastal Perú*, A. Paul, ed. Pp: 1-34. Iowa City, IA: University of Iowa Press.

Paulsen, A.
1976 Environment and Empire: Climatic Factors in Prehistoric Andean Culture Change. *World Archaeology* 8: 121-132.

Paulsen, A.C.
1977 Patterns of Maritime Trade between South Coastal Ecuador and Western Mesoamerica, 1500 B.C. – A.D. 600. In *The Sea in the Pre-Columbian World*, E.P. Benson, Ed. Pp: 141-160. Washington, D.C.: Dumbarton Oaks Research Library and Collections, Trustees for Harvard University

Pearsall, D.M.
2000 *Paleoethnobotany: A Handbook of Procedures,* 2nd edition. San Diego, CA: Academic Press.

Pechenkina, E.A., J.A. Vradenburg, R.A Benfer Jr. and J.F. Farnum
2007 Skeletal Biology of the Central Perúvian Coast: Consequences of changing population density and progressive dependence on Maize agriculture. In *Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification*, M.N. Cohen and G.M.M. Crane-Kramer, eds. Pp: 92-112. Gainesville, Fl: University Press of Florida.

Pechenkina, E.A. and M. Delgado
2006 Dimensions of Health and Social Structure in the Early Intermediate Period Cemetery of Villa El Salvador, Perú. *American Journal of Physical Anthropology* 131: 218-235.

Pechenkina, E.A., and R.A. Benfer, Jr.
2002 Exostosis on Mandible and Maxilla Among Neolithic Agriculturists from Northern China: an Interplay of Environmental Factors. *Homo* 53: 112–130.

Perry, L.
2001 *Prehispanic Subsistence in the Middle Orinoco Basin: Starch Analyses Yield New Evidence*. Unpublished dissertation, Department of Anthropology, Southern Illinois University, Carbondale.

Perry, L.
2002 Starch granule size and the domestication of manioc (*Manihot esculenta*) and sweet potato (*Ipomoea batatas*). *Economic Botany* 56: 335-349.

Peters, A.H.
2000 Funerary Regalia and Institutions of Leadership in Paracas and Topará. *Chungara (Arica)* 32(2): 245-252.

Peters, A.H.
1997 *Paracas, Topará and Early Nasca: Ethnicity and Society on the South Central Andean Coast*. Unpublished dissertation, Cornell University, Ithaca, NY.

Peters, A.H.
1987-88 Chongos: Sitio Paracas en el Valle de Pisco. *Gaceta Arqueologica Andina* 16: 30-34.

Peters, A.H.
n.d. *Proyecto Arqueologico Pisco: Trabajos de campo en Chongos 1987*. Informe Final. Unpublished report on file at the Regional Museum in Ica, Perú.

Peterson, J.
2002 *Sexual Revolutions*. Walnut Creek, CA: AltaMira Press

Pezzia, A.
1969 *Guia al mapa arquelogico-pictografico del Departmamiento de Ica*. Lima, Perú: editorial ItalPerú.

Phirrmann, C.W.A. and D. Resnick
2001 Schmorl Nodes of the Thoracic and Lumbar Spine: Radiographic-Pathologic Study of Prevalence, Characterization, and Correlation with Degenerative Changes of 1,650 Spinal Levels in 100 Cadavers. *Radiology* 219: 368-374.

Phenice, T.
1969 A Newly Developed Visual Method of Sexing in the Os Pubis. *American Journal of Physical Anthropology* 30: 297-301.

Piperno, D.R.
2006 *Phytoliths: A Comprehensive Guide for Archaeologists and Paleoecologists*. Lanham, MD: AltaMira Press.

Piperno, D.R.
1988 *Phytolith analysis: an Archaeological and Geological Perspective*. San Diego, CA: Academic Press.

Piperno, D.R., and D.M. Pearsall
1998 *The Origins of Agriculture in the Lowland Neotropics*. San Diego, CA: Academic Press.

Ponzetta, M.T., G. Hauser and A. Vienna
1997 Auditory hyperostosis and the environment: an update. *International Journal of Anthroplogy* 12(2): 29-42.

Powell, M.L.
1988 *Status and Health in Prehistory*. Washington, D.C.: Smithsonian Institution Press.

Powell, M.L.
1985 The Analysis of Dental Wear and Caries for Dietary Reconstruction. In *The Analysis of Prehistoric Diets*, R.I. Gilbert and J.H. Mielke, eds. Pp: 307-38. London: Academic Press.

Protzen, J-P. and D. Harris
2005 *Explorations in the Pisco Valley: Max Uhle's reports to Phoebe Apperson Hearst August 1901 to January 1902*. No. 63 Contributions of the University of California Archaeological Research Facility. Berkeley, CA: Regents of the University of California.

Proulx, D.A.
2008 Paracas and Nasca: Regional Cultures on the South Coast of Perú. In *Handbook of South American Archaeology*, H. Silverman and W.H. Isbell, eds. Pp: 563-586. New York, NY: Springer.

Proulx, D.A.
1968 *Local differences and time differences in Nasca pottery*. Berkeley, CA: University of California Press.

Quilter, J.
1989 *Life and Death at Paloma*. Iowa City, IA: University of Iowa Press.

Reich, E., A. Lussi and E. Newbrun
1999 Caries-risk Assessment. *International Dental Journal* 49: 15-26.

Rhode, M.P.
2006 *Habitual Subsistence Practices among Prehistoric Andean Populations: Fishers and Farmers*. Unpublished dissertation, Department of Anthropology, University of Missouri, Columbia, Mo.

Rhode, M. P. and B. T. Arriaza
2006 Influence of Cranial Deformation on Facial Morphology Among Prehistoric South Central Andean Populations. *American Journal of Physical Anthropology* 130: 462-470.

Roberts, C. and K. Manchester
1995 *The Archaeology of Disease*. Ithaca, NY: Cornell University Press.

Rose, J.C., B.A. Burnett, M.B. Nassaney, and M.B. Blaeuer
1984 Paleopathology at the Origins of Agriculture in the Lower Mississippi Valley and Caddoan Cultures. In *Paleopathology at the Origins of Agriculture*, M.N. Cohen and G.J. Armelagos, eds. Pp: 393-424. Orlando, Fl: Academic Press.

Rostworowski, M.
1977 *Etnia y Sociedad costa Perúana prehispanica*. Lima, Perú: Instituto de Estudios Perúanos.

Rostworowski, M.
1981 *Recursos Naturales Renovables y Pesca: Siglos XVI y XVII*. Lima, Perú: Instituto de Estudios Perúanos.

Rostworowski, M.
1999 *History of the Inca Realm*. New York, NY: Cambridge University Press

Rowe, J.H.
1960 Cultural Unity and Diversification in Perúvian Archaeology. In *Men and Cultures: Selected Papers of the Fifth International Congress of Anthropological and Ethnological Sciences*, A.F.C. Wallace, ed. Pp: 627-631. Philadelphia, PA: University of Pennsylvania Press.

Rowe, J.H.
1962 Stages and Periods in Archaeological Interpretation. *Southwestern Journal of Anthropology* 18(1): 40-54.

Rowe, J.H.
1963 Urban settlements in ancient Perú. *Ñawpa Pacha* 1: 1-28.

Rowe, J.H.
1995 Behavior and Belief in Ancient Perúvian Mortuary Practice. In *Tombs for the Living: Andean Mortuary Practices*, T.D. Dillehay, ed. Pp: 27-41. Washington, D.C.: Dumbarton Oaks Research Library and Collection.

Rowe, J.H. and D. Menzel
1967 *Perúvian archaeology: Selected readings*. Palo Alto, CA: Peek Publications.

Sandweiss, D.H.
1992 *The Archaeology of Chincha Fishermen: Specialization and Status in Inka Perú*. Pittsburgh, PA: Bulletin of Carnegie Museum of Natural History, Number 29.

Sandweiss, D.H. and J.B. Richardson
2008 Central Andean Environments. In *Handbook of South American Archaeology*, H. Silverman and W.H. Isbell, eds. Pp: 39-104. New York, NY: Springer.

Sandweiss, D.H., J.B. Richardson, III, E.J. Reitz, H.B. Rollins, and K.A. Maasch.
1996 Geoarchaeological evidence from Perú for a 5000 years B.P. onset of El Niño. *Science* 273: 1531-1533.

Sarnat, B.G. and I. Schour
1941 Enamel Hypoplasias (Chronic Enamel Aplasia) in Relationship to Systematic Diseases: A Chronological, Morphological and Etiological Classification. *Journal of the American Dental Association* 28: 1989-2000.

Sattenspiel, L. and H. Harpending
1983 Stable populations and skeletal age. *American Antiquity* 48: 489-497.

Schmorl, G. and H. Junghanns.
1971 *The Human Spine in Health and Disease*. New York, NY: Grune and Stratton.

Schollmeyer, K.G. and C.G. Turner II
2004 Dental Caries, Prehistoric Diet, and the Pithouse-to-Pueblo Transition in Southwestern Colorado. *American Antiquity* 69(3): 569-582.

Schultz, M., C.S. Larsen, and K. Kreutz
2001 Disease in Spanish Florida: Microscopy of Prortic Hyperostosis and Inferences about Health. In *Bioarchaeology of Spanish Florida: The Impact of Colonialism*, C.S. Larsen, ed. Pp: 207-225. Gainesville, Fl: University Press of Florida.

Silverblatt, I.
1978 Andean Women in the Inca Empire. *Feminist Studies* 4(3): 37-61.

Silverman, H.
1991 The Paracas Problem: Archaeological Perspectives. In *Paracas art and architecture: Object and context in south coastal Perú*, A. Paul, ed. Pg. 349-415. Iowa City, IA: University of Iowa Press.

Silverman, H.
1993 *Cahuachi in the Ancient Nasca World*. Iowa City, IA: University of Iowa Press.

Silverman, H.
1995 Recent Archaeological Investigations on the South Coast of Perú: Critique and Prospects. *Journal of the Steward Anthropological Society* 23(1-2): 13-41.

Silverman, H.
1996 The Formative Period on the South Coast of Perú: A Critical Review. *Journal of World Prehistory* 10(2): 95-146.

Silverman, H.
1997 The First Field Season of Excavations at the Alto del Molino Site, Pisco Valley, Perú. *Journal of Field Archaeology* 24: 441-457.

Silverman, H.
2002 *Ancient Nasca Settlement and Society*. Iowa City, IA: University of Iowa Press

Soldi, A.M.
1982 *La agricultura tradicional en hoyas*. Lima, Perú: Pontificia Universidad Catolica del Perú.

Spector, J.D.
1998 Male/Female task differentiation among the Hidatsa: Toward the development of an archeological approach to the study of gender. In *Reader in Gender Archaeology*, K. Hays-Gilpin and D.S. Whitley, eds. Pp: 145-158. New York, NY: Routledge.

Standen, V.G., B.T. Arriaza and C.M. Santoro
1997 External auditory exostosis in prehistoric Chilean populations: A test of the cold water hypothesis. *American Journal of Physical Anthropology* 103(1): 119-129.

Steckel, R.H. and J.C. Rose
2002 *The Backbone of History: Health and Nutrition in the Western Hemisphere*. Edited Volume. Cambridge, UK: Cambridge University Press.

Steckel, R.H., J.C. Rose, C.S. Larsen and P.L. Walker
2002a Skeletal Health in the Western Hemisphere From 4000 B.C. to the Present. *Evolutionary Anthropology* 11: 142-155.

Steckel, R.H., P. Sciulli and J.C. Rose
2002b A Health Index from Skeletal Remains. In *The Backbone of History: Health and Nutrition in the Western Hemisphere*. R.H. Steckel and J.C. Rose, eds. Pp: 61-93. Cambridge, UK: Cambridge University Press.

Steinbock, R.T.
1976 *Paleopathological Diagnosis and Interpretation*. Springfield, IL: Charles C. Thomas.

Storey, R.
1998 The mothers and daughters of a patrilineal civilization: the health of females among the Late Classic Maya of Copan, Honduras. In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer and P. Stuart-Macadam, eds. Pp: 133-148. Cambridge, UK: Cambridge University Press.

Stothert, K.E.
1980 Villa Salvador and the Early Intermediate Period. *Journal of Field Archaeology* 7: 279-295.

Stuart-Macadam, P.
1987 Porotic Hyperostosis: New Evidence to Support the Anemia Theory. *American Journal of Physical Anthropology* 74: 521-526.

Stuart-Macadam, P.
1989 Porotic Hyperostosis: Relationship between Orbital and Vault Lesions. *American Journal of Physical Anthropology* 80: 187-193.

Stuart-Macadam, P.
1992 Porotic Hyperostosis: A New Perspective. *American Journal of Physical Anthropology* 87: 39-47.

Stuart-Macadam, P.
1998 Iron deficiency anemia: exploring the difference. In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer, and P. Stuart-Macadam, eds. Pp: 45-63. Cambridge, U.K.: Cambridge University Press.

Stuart-Macadam, P. and S. Kent
1992 *Diet, Demography, and Disease: Changing Perspectives on Anemia*. New York, NY: Aldine de Gruyter.

Stumer, L.M.
1954 Population Centers of the Rimac Valley of Peru. *American Antiquity* 20(2): 130-148.

Sutter, R.C.
2000 Prehistoric Genetic and Culture Change: A Bioarchaeological Search for the Pre-Inka Altiplano Colonies in the Coastal Valleys of Moquehua, Perú, and Azapa, Chile. *Latin American Antiquity* 11: 43-70.

Sutter, R.C.
2003 Nonmetric Subadult Skeletal Traits: I. A Blind Test of the Accuracy of Eight Previously Proposed Methods Using Prehistoric Known-Sex Mummies from Northern Chile. *Journal of Forensic Sciences* 48(5): 927-935.

Tello, J.C.
1929 *Antiquo Perú*. *Primera Epoca*. Editado por la Comision Organizadora del Segundo Congreso Sudamericano de Turismo, Lima.

Tello, J.C.
1959 *Paracas, Primera Parta.* Publicacion del Proyecto 8-b del Programa 1941-1942. New York, NY: Institute of Andean Research.

Tello, J.C. and T. Mejia
1979 *Paracas. II Parte: Cavernas y Necropolis*. Lima, Perú: Universidad Nacional Mayor de San Marcos and Institute of Andean Research de Nueva York.

Torres-Rouff, C.
2003 *Shaping Identity: Cranial Vault Modification in the Pre-Columbia Andes*. Unpublished dissertation, Department of Anthropology, University of California, Santa Barbara.

Trotter, M.
1970 Estimation of Stature from Intact Long Limb Bones. In *Personal Identification in Mass Disasters*, T.D. Stewart, ed. Pp: 71-83. Washington, D.C.: Smithsonian Institution Press.

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

Tykot, R.H. and J.E. Staller
2002 The Importance of Early Maize Agriculture in Coastal Ecuador: New Data from La Emerenciana. *Current Anthropology* 43(4): 666-677.

Tykot, R.H., R.L. Burger, and N.J. van der Merwe
2006 The Importance of Maize in Initial Period and Early Horizon Perú. In *Histories of Maize*, J. Staller, R.H. Tykot and B. Benz, eds. Pp: 187-197. Boston, MA: Elsevier.

Tykot, R.H., A. Metroka, M.J. Dietz, R.A. Bergfield, and R.A. Benfer
2008 *Chemical Analysis of Hair Segments and Short-Term Dietary Variation: Results for the Ancient Site of Chongos (Perú)*. Poster presented at the International Symposium on Archaeometry. May 12-16. Siena, Italy.

Ubelaker, D.H.
1994 The biological impact of European contact in Ecuador. In *In the Wake of Contact: Biological Responses to Conquest*, C.S. Larsen and D.H. Ubelaker, eds. Pp: 147-160. New York, NY: Wiley-Liss.

Ubelaker, D.H.
1989 *Human Skeletal Remains*. Washington, D.C.: Taraxacum.

Uhle, M.
1914 The Nazca Pottery of Ancient Perú*. Proceedings of the Davenport Academy of Sciences* 13: 1-46.

Umlauf, M.L.
1988 *Paleoethnobotanical Investigations at the Initial Period Site of Cardal, Perú*. Unpublished thesis, Department of Anthropology, University of Missouri, Columbia, MO.

Vaughn, K.
2000 *Ancient Andean Domestic Economies: A View from an Early Nasca Village*. Unpublished dissertation, Department of Anthropology, University of California, Santa Barbara

Vogel, M.A.
2003 Sacred Women in Ancient Perú. In *Ancient Queens*, S.M. Nelson, ed. Pp: 117-136. Walnut Creek, CA: AltaMira Press

Vradenburg, J.A.
2001 *The Role of Treponematoses in the Development of Prehistoric Cultures and the Bioarchaeology of Proto-urbanism on the Central Coast of Perú*. Unpublished dissertation, Department of Anthropology, University of Missouri, Columbia, MO.

Vradenburg, J.A. and R.A. Benfer
n.d. Biologia Osea de Una Poblacion del Periodo Inicial Tardio: Cardal Peru. In *Materiales del Coloquio: El Valle de Lurin en el Periodoo Formativo*, ed.by R. L. Burger and K. Makowski H. Lima, Peru: Pontificia Universidad Católica del Peru. In Press.

Walker, P.L.
1989 Cranial Injuries as Evidence of Violence in Prehistoric Southern California. *American Journal of Physical Anthropology* 80: 313-323.

Wallace, D.T.
1985 Paracas in Chincha and Pisco: A Reappraisal of the Ocucaje Sequence. In *Recent Studies in Andean Prehistory and Protohistory: Papers from the Second Annual Northeast Conference on Andean Archaeology and Ethnohistory.* D. P. Kvietok and D. H. Sandweiss, eds. Pp: 41-66. Ithaca, NY: Cornell University, Latin American Studies Program.

Wallace, D.T.
1986 The Topará Tradition: An Overview. In *Perspectives on Andean Prehistory and Protohistory: Papers from the Third Annual Northeast Conference on Andean Archaeology and Ethnohistory*. D. H. Sandweiss and D. P. Kvietok, eds. Pp: 35-48. Ithaca, NY: Cornell University, Latin American Studies Program.

Wallace, D.T.
1971 *Sitios Arqueologicos del Perú. Segunda Entrega. Valles de Chincha y de Pisco*. Arqueologicas 13. Lima, Perú: Museo Nacional de Antropologia y Arqueologia.

Wallace, D.T.
1962 Cerrillos, an Early Paracas Site in Ica, Perú. *American Antiquity* 27(3): 303-314.

Weaver, D.S.
1998 Osteoporosis in the bioarchaeology of women. In *Sex and Gender in Paleopathological Perspective*, A.L. Grauer and P. Stuart-Macadam, eds. Pp: 27-44. Cambridge, U.K.: Cambridge University Press.

Weir, G.H., R.A. Benfer and J.G. Jones
1988 Preceramic to Early Formative Subsistence on the Central Coast. In *Economic Prehistory of the Central Andes*, E.S. Wing and J.C. Wheeler, eds. Pp: 56-94. Oxford, UK: BAR International Series 427.

Weis, P.
1953 *Las trepanaciones peruanas estudiadas como técnica y sus relaciones con la cultura*. Revista del Museo Nacional, Lima 22: 17-34.

White, T.W.
1991 *Human Osteology*. San Diego, CA: Academic Press, Inc.

Wilson, D.J.
1988 *Prehispanic settlement patterns in the lower Santa valley, Perú: A regional perspective on the origins and development of complex North Coast society*. Washington, DC: Smithsonian Institution press.

Winkelstein, B.A., R.W. Nightingale, W.J. Richardson, and B.S. Myers
2000 The Cervical Facet Capsule and its role in whiplash injury: A biomechanical investigation. *Spine* 25(10): 1238-1246.

Wood, J.W., G.R. Milner, H.C. Harpending, and K.M. Weiss
1992 The Osteological Paradox: Problems of Inferring Prehistoric Health from Skeletal Samples. *Current Anthropology* 33: 343-370.

Yun, P. and Y. Kim
2005 The role of facial trauma as a possible etiologic factor in temporomandibular joint disorder. *Journal of Oral and Maxillofacial Surgery* 63(11): 1576-1583.

VITA

Michael Dietz is a Wyoming native, born in Sheridan, Wyoming. He is the son of Jim and Shirley Dietz. He lived in Sheridan until the age of 12, when he and his family moved to Douglas, Wyoming for one year. He moved with his family to Gillette, Wyoming at the age of 13. He graduated from Campbell County High School in Gillette. After graduating high school he was accepted and chose to attend Luther College in Decorah, Iowa, planning to become a biologist. He was introduced to the field of anthropology by Dr. Dale R. Henning. After that first class he declared an anthropology major, graduating from Luther College with a double major in Anthropology and Biology. While an undergraduate he worked for two summers as a field archaeologist for the US Forest Service in the Douglas Ranger District of the Medicine Bow National Forest in central Wyoming. After graduation he worked as an English teacher at Gymnazium Ostrov in Ostrov nad Ohre, Czech Republic for one school year. After returning to the US he was accepted and enrolled in the Anthropology graduate program at the University of Utah, where he earned a Master's Degree in 1997. At Utah he was exposed to bioarchaeology for the first time, peaking an interest that ultimately led to his dissertation research. He was accepted to the University of Missouri to begin his PhD studies in Anthropology. The University of Missouri offered not only holistic training in anthropology, it also offered specialized training in bioarchaeology. It was at Missouri that he was first introduced to South American archaeology and the endless research opportunities there. He went to Perú for the first time in 1998, where he first learned about the Chongos skeletal collection that would become be the focal point of his dissertation. In 2002 he began an association with an archaeological research project in the Czech Republic that continues to this day. While in Missouri he has also worked in public health and as a grant writer, and taught courses at the University of Missouri, Columbia College and Stephens College. He currently is Assistant Professor of Anthropology at College of DuPage in Glen Ellyn, Illinois.