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Labor and Social Identity in Ancient Peru: A Bioarchaeological Perspective

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LABOR AND SOCIAL IDENTITY IN ANCIENT PERU:

A BIOARCHAEOLOGICAL PERSPECTIVE

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This dissertation presents a bioarchaeological study of labor and social identity in coastal Peru during the Late Intermediate Period (900 – 1470 CE), using data from contemporaneous Middle Sicán (Sicán Precinct and El Brujo, north coast) and Ychsma (Pachacamac, central coast) mortuary contexts. I combine information about funerary treatment with skeletal evidence of trauma, degenerative joint disease, and muscle attachment site morphology (enthesial changes or EC) to test whether inferred commoners were "over-worked" relative to their elite counterparts, as often assumed based on western, Marxist notions of social class.

Much of what has been inferred about socio-economic organization in coastal Peru during the Late Intermediate Period is modeled after the *parcialidades* described in early Spanish chronicles and colonial documents. In this system, occupation, social status, and ethnicity were intimately intertwined, with common fishers and farmers serving as the "productive base" for privileged members of society, including full-time artisans and their elite patrons. Archaeological evidence of elite sponsored large-scale labor projects, including specialized craft production, in pre-Hispanic coastal Peru accords well with the *parcialidad* model, but assumptions about the social identities of laborers often go untested. Human skeletal data offer a unique opportunity to redress this situation, providing information about life experience –

including patterns of physical activity – that are not typically accessible with other kinds of archaeological data.

Bioarchaeological studies of physical activity hold great promise for testing hypotheses about social identity and life experience in ancient societies, but they are not without some limitation. People who engage in strenuous physical activity tend to have more degenerative joint disease and enthesial changes than those who do not, but the precise mechanisms behind this are not well understood. Age and body size are known to influence these skeletal markers, although some researchers have suggested certain entheses may be less sensitive to size and thus more informative about activity, than others.

In my sample, there were no discernible differences in skeletal trauma, degenerative joint disease, or ECs between elites and non-elites, or between males and females, when statistically controlling for the influence of age and/or size. These results do not support the hypotheses that non-elites were over-burdened by arduous labor tasks or that exemption from such tasks was part of the social privileges afforded to elites. Therefore, conventional perspectives that tend to conflate elite and non-elite identities with oppressor/oppressed or manager/laborer roles appear to have little relevance for characterizing the social dynamics of labor organization in Middle Sicán and Ychsma societies.

My study supports, at least in part, previous research that argues some entheses are less prone to the influence of size than others, and may therefore be more reliable indicators of activity. In this sample, strong statistical correlations between EC scores, age, and size as determined from three humeral measurements were found for fibrous entheses, but humeral size did not correlate to scores for the fibrocartilaginous type. However, current uncertainties about the precise etiology of enthesial changes makes it difficult to interpret variation in EC scores with a high degree of certainty, and thus my study also highlights some of the drawbacks associated with using EC scores to infer patterns of activity. Experimental research to better understand how the timing, duration, and severity of muscle stress and strain influence enthesial development and technological innovations to quantify enthesial size and shape will be key to resolving these issues in the future.

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CHAPTER 1

INTRODUCTION

Research Objectives & Hypotheses

In this study, I infer patterns of physical activity from human skeletal remains to explore how labor demands varied in relation to social status in two pre-Hispanic Peruvian societies. I offer new insights regarding how social identities were experienced as part of daily life, focusing on the Sicán (also known as Lambayeque) and Ychsma archaeological cultures that flourished on the northern and central coasts (respectively) during the Late Intermediate Period (900 – 1470 CE). This was a time characterized by significant socio-political reorganization and the rise of regional elites and polities of varied complexity and scale, just prior to Inka and then Spanish conquest. The power and authority of Sicán and Ychsma elites were thought to have been rooted in religious ideologies that naturalized social inequality, and contingent upon the ability to mobilize laborers on a large scale (Eeckhout 2008b; 2013; Klaus et al. 2017; Shimada 2014), ideal conditions for exploring the issue at hand. I also evaluate recent revisions to how patterns of activity are inferred from human skeletal remains, highlighting some of the strengths and weaknesses of these approaches.

Using contemporaneous (c. 1000 – 1400 CE) samples from the Sicán Precinct and Pachacamac, major ceremonial centers occupied by Middle Sicán and Ychsma societies (respectively), as well as Middle Sicán burials at the site of El Brujo some 300 km south of the Precinct (see Figure 1 for a map showing Peru and the approximate location of these archaeological sites), I question whether elites and non-elites differed significantly with respect to their engagement in manual labor. Was exemption from physically-demanding labor tasks part of the social privileges afforded to elite members of society? Were the bulk of subsistence activities, resource extraction and transportation, as well as construction activities being performed by non-elites? These assumptions are often implied in archaeological studies of labor based on contemporary, western notions of social class, but may have little relevance for understanding social dynamics in the ancient past, and have seldom been examined using human skeletal and mortuary data. I address these primary questions by focusing on patterns of skeletal trauma, degenerative joint disease (DJD) and enthesial changes [ECs] (i.e muscle attachment site morphology) in relation to information about social status inferred from mortuary contexts. These skeletal markers have long been associated with physical activity in the archaeological literature, offering a useful approach for my study (Derevenski 2000; Hawkey 1988; Hawkey and Merbs 1995; Klaus et al. 2009; Pearson and Buikstra 2006; Porčić and Stefanović 2009; Schrader 2014; Steen and Lane 1998; Villotte et al. 2010; Weiss 2007; Wesp 2014).

To assess whether conventional models of social class are relevant for understanding how social inequality was experienced as part of daily life in Middle Sicán and Ychsma societies, I test three related hypotheses: 1) Non-elites engaged in activities that placed them at greater risk of accidental injury compared to elites, so that evidence of skeletal trauma will be more prevalent in this group; 2) Degenerative joint disease (DJD)

Figure 1 - Map of Peru, yellow stars indicate approximate locations of the Sicán Precinct (top), El Brujo (center), and Pachacamac (bottom).

will be more common and more severe in non-elites, because they were more likely to engage in strenuous tasks on regular basis; and 3) the greatest physical demands were imposed upon non-elites as part of their labor obligations, resulting in more pronounced muscle attachments and thus higher combined EC scores relative to elites.

My secondary objective is to evaluate recent assertions regarding ECs, which have broader implications for how studies of activity should be approached in an archaeological context. Henderson and Cardoso (2013), Villotte et al. (2010), and Weiss (2015) have suggested that fibrocartilaginous entheses are less prone to systemic influences and thus more reliable as indicators of activity than fibrous entheses. I test this supposition by analyzing EC scores separately for the two enthesial types and comparing their statistical correlations with measures of age and size. Results of these analyses will contribute to current debates regarding the utility of ECs as markers of activity, and help to clarify future directions for this approach.

Problem Context: Labor and Social Identity

Labor division and task specialization have long been considered hallmarks of social complexity and stratification (Hayden 1995; Henrich and Boyd 2008; Kerbo 2009; Service 1971). From the very inception of the social sciences and through the works of pioneers like Émile Durkheim, Karl Marx, and Max Weber, labor has emerged as one of the main focal points for discussing political power, ideology, and social relations. How labor is organized – and the social significance attributed to different kinds of work – says something of the prevailing cultural, political, and economic values and ideals held by a society at large, what Marx referred to as a society's "superstructure."

At the same time that labor reveals something of the structuring principles of society, it is also a very personal endeavor. What we do is a huge component of who we are, not only in terms of how we are valued and perceived by others or judged in relation to social values, ideals, and "norms", but also in how we understand and express our sense of being and engage in daily life. Identities are constructed, negotiated, and made meaningful only through social interactions, and labor activities provide an important medium for these interactions (Christiansen 1999; Costin 1998b; Meskell 2001; Robb 2010).

That labor activities reveal something of the organizing principles of a society and help shape peoples' social identities is not lost to archaeology, a discipline that relies primarily on material remains – the very products of human labor – for social analysis. Heavily influenced by Karl Marx's theory of class which argues that peoples' position in the social hierarchy is inextricably linked with their relationship to the means of production, archaeological investigations of labor have traditionally tended to focus on assessing political complexity and making inferences about elite strategies for control and legitimization (Brumfiel and Earle 1987; Childe 1950; Costin 2006; Peregrine 1991; Schortman and Urban 2004; Service 1971; Vaughn 2006). According to this perspective, often labeled as political economy, elites emerged and came to power by controlling all or some aspects of the production and/or distribution of goods, particularly corporate architecture and "luxury" or "exotic" items that served as symbols of status and power. Implicit in this perspective is the Marxian notion that social status is dependent upon the abilities to amass material goods/property (i.e. "wealth") and to control – rather than participate in – the actual physical work of production (Babić 2005). Following this line of reasoning, archaeologists, particularly those who adhere to a Marxist perspective, have often taken as a given the notion of elites as consumers and non-elites as producers, thereby failing to explicitly test the interplay of labor activities and social status (Inomata 2001; 2007).

The idea that strenuous labor and marginal social status go hand in hand seems almost "natural" in the context of Western society, where serfdom, slavery, and class distinctions between "blue collar" and "white collar" workers have a long history. But the degree to which we can project these perceptions of class onto complex societies of the ancient past is questionable, especially in light of ethnographic and archaeological examples that seem contrary to modern, western assumptions (Brumfiel 1998; Costin 1998a; Costin 1998b; Inomata 2001; 2007; Lass 1998; Meskell 2002; Reents-Budet 1998). In fact, there is good reason to believe that in traditional societies where craft specialization and social stratification were present, artisans involved in the production and/or acquisition of resources perceived to be of high value by one or more social groups may have in some cases achieved a special, privileged status because of, not despite, their labor activities (Helms 1993; Inomata 2001; Netherly 1977; Ramírez 2008; Shimada and Craig 2013; Uceda and Rengifo 2006). Furthermore, while there is little doubt that those of low social status tend to have a reduced quality of life compared to their "privileged" counterparts, the specifics of what this "privilege" actually entailed in ancient contexts need to be tested rather than assumed. Projecting modern day, eurocentric ideals that connect manual labor to marginal social status onto the past misses an important opportunity to explore what it actually meant to be "elite" or "plebeian" in terms of peoples' daily lives, an essential endeavor given the increasing emphasis on lived experience within archaeology over the last twenty years (Buikstra and Scott 2011; Fisher and Loren 2003; Hodder and Hutson 2003; Joyce 2005; Knapp and van Dommelen 2008; Knudson and Stojanowski 2008; Meskell 1996; Robb 2010).

Much of what has been written about the social division of labor in pre-Hispanic coastal Peru draws upon historical reference to lineage-based (real or fictive), ethnically-distinct, and in some cases highly-specialized work collectives, referred to as *parcialidades* by the Spanish (Costin 2016; Eeckhout 2008b; Isbell 1995; Netherly 1977; Ramírez 2007; Rostworowski 1975). Each *parcialidad* was headed by a lord or *principal* responsible for mobilizing labor to sustain higher-level regional leaders and infrastructure, in exchange for access to corporately-held resources (e.g. land, water), provisions, and other goods (Netherly 1977; Ramírez 2007; Ramírez-Horton 1981; Rostworowski 1975). Access to these resources was granted according to the respective rank of each *principal*, which was largely determined by the size of the labor force they commanded and the kinds of goods and services they provided (Netherly 1977; 1990). It has been postulated that the greatest labor demands were placed upon *parcialidades* engaged in seasonal activities such as fishing and farming, as they may have also been primarily responsible for extracting raw materials, transporting goods, and building and maintaining irrigation canals or other public works on a rotating basis (Netherly 1977; 1984; Ramírez 2007; 2008; Ramírez-Horton 1981). Full-time, specialized artisan groups – particularly potters, metalsmiths, and perhaps weavers as well – may have been largely exempt from this labor tax, known during colonial times as *mita* (Netherly 1977; Ramírez 2007). These groups fulfilled their obligations by providing goods that in some cases served as important symbols of elite ideology and power, and are thus assumed to have had a certain degree of social prestige (Helms 1993; Netherly 1977; Ramírez 2007).

If historical documentation of *parcialidades* reflect socio-economic systems in place prior to European contact, it may be reasonable to expect agreement between the degree and kind of physical tasks people engaged in and their place in the social hierarchy. This is especially true in the case of the north coast, where previous bioarchaeological studies highlight social status as the single best predictor of health in terms of nutrition and exposure to developmental insults

(Farnum 2002; Shimada 2006). My research extends this discussion by investigating how – or even if – labor demands factored in to quality of life differentials already observed between elites and non-elites in Sicán society. Less is known about the nature and impact of social hierarchy in Ychsma society (Eeckhout 2013; Marsteller et al. 2017) , and recent research has raised some interesting questions about the social identities of the Pachacamac burial sample included in this study (Shimada et al. 2006a; Shimada et al. 2010; Shimada et al. 2006b; Takigami et al. 2014). My work contributes to these discussions by looking for patterns in physical activity and mortuary treatment that might be informative with regards to the samples' social composition

Research Orientation: The Bioarchaeological Approach

Bioarchaeology is a rapidly expanding branch of physical anthropology that utilizes human skeletal remains in concert with other kinds of archaeological, historical, and/or ethnographic data to test hypotheses and draw inferences about ancient societies and the human condition across space and time (Buikstra 2006b; Buikstra et al. 2011; Larsen 1997; Larsen 2018). Archaeologists have long appreciated the value of mortuary contexts for understanding hierarchy and social identity (Binford 1971; Brown 1995; Pearson 2000), and human skeletal remains provide the most direct means for exploring these issues in terms of life experience (Agarwal and Glencross 2011; Buikstra and Scott 2011; Knudson and Stojanowski 2008; Martin et al. 2013; Sofaer 2006). The human skeleton responds in observable ways to dietary practices, exposure to disease and trauma, and patterns of physical activity; precisely those aspects of experience expected to vary between different social groups. By establishing the normal range of variation in mortuary treatment and recognizing patterns in relation to time and basic components of identity revealed through skeletal analyses (such as age, sex, and geographic origins), it becomes possible to better recognize how other aspects of identity, such as social status, occupation, gender, and ethnicity may have been symbolized archaeologically (Brown 1995). When archaeological and skeletal data are combined, we can test hypotheses about the interaction of identity and experience, and such approaches continue to deepen our understanding of, for example, the division of labor, changes to peoples' quality of life over time in response to economic and/or political shifts, and the health consequences of belonging to particular status groups (Cohen and Armelagos 1984; Farnum 2002; Klaus et al. 2017a; Klaus et al. 2009; Klaus and Tam 2009; Meskell 1996; Shimada et al. 2004; Wesp 2014).

In 1977 when Jane Buikstra first outlined bioarchaeology as practiced in North America, she characterized the approach as part and parcel of processual archaeology's scientific agenda to move beyond the descriptive, typological, and often racialized research that characterized both archaeology and physical anthropology for the first half of the twentieth century (Armelagos 2003; Buikstra 1977; Buikstra 2006a). Processual archaeology was revolutionary in its attempt to explain – rather than just identify – cultural change in the archaeological record. Processualists defined culture as an adaptive strategy for dealing with specific environmental challenges, and were therefore interested in modeling relationships between culture, human organisms, and their environments that could be tested with archaeological data. Stuart Struever, an early and very influential proponent of processualism, argued this was only possible through multidisciplinary collaboration and greater integration of the natural sciences into archaeology (Brown and Struever 1973). His ground-breaking Illinois Valley Archaeology Program in Kampsville Illinois, of which Buikstra was a part, brought together a range of specialists who contributed to every phase of the project from inception to completion, perhaps for the first time in archaeology's history. The goal at Kampsville was to reconstruct the ecological, biological, and cultural landscape of prehistoric populations living in the Lower Illinois Valley just prior to and during the transition to agriculture (i.e. the "Hopewell Tradition"), upon which explanatory models of social organization and cultural change could be built (Brown and Struever 1973). Buikstra envisioned bioarchaeology as a way to further promote and standardize this integrative approach, focusing her attention specifically on human skeletal remains and their value for addressing archaeological problems in a more "holistic" way.

Buikstra argues that the experiential information encoded in human skeletal remains is essential for reconstructing the "social worlds and personae" of ancient peoples (Buikstra 2006b; Buikstra et al. 2011), and her allegiance to a social-archaeological agenda likely stems from involvement with the Kampsville project early-on in her career. These experiences helped to articulate and strengthen her argument that the physical body, as an integral component of the cultural "landscapes" past peoples inhabited, is equally shaped by social processes and adaptive strategies detectible in other kinds of archaeological materials. Buikstra not only sees bioarchaeology as a way to realize the potential of human skeletal data for understanding past social dynamics, she also advocates for their careful contextualization, recognizing that social, cultural, and ideological processes not only influence patterns of health and behavior identified in mortuary samples, but also who is, and who is not, represented within them (Knüsel 2010).

Buikstra's bioarchaeological approach attempts to synthesize method and theory from two fields of study, skeletal biology and archaeology, traditionally subsumed under rather disparate branches of anthropology. It is therefore perhaps no surprise that despite resounding support, the discipline has been slow to fully implement her agenda (Goldstein 2006; Kakaliouras 2017; Rakita 2014). For example, efforts to engage social theory in a more critical, self-reflexive way have lagged far behind those put forth in archaeology, a legacy that bioarchaeologists continue with increasing fervor to distance themselves from (Agarwal and Glencross 2011; Baker and Agarwal 2017; Becker and Juengst 2017; Kakaliouras 2017). Part of the reason for this stems from competing ideas about what bioarchaeology should be that emerged as the discipline was coming into full fruition during the late 1990's (Rakita 2014). Because these two viewpoints have provided an important impetus for more recent trends, they are worthy of further exploration.

In contrast to Buikstra's approach that advocated bioarchaeology as a way to address social questions within specific sociocultural, temporal, and spatial contexts, others saw the approach primarily as a strategy for identifying the biological consequences of major behavioral shifts in human history, such as the transition to agriculture (e.g. Cohen and Armelagos 1984) or European colonialism (e.g. Larsen and Milner 1994). Because the questions raised by this approach are fundamentally biological, there is less consideration of archaeological context beyond that required to establish basic population parameters (i.e. ecology, subsistence, political structure), with models of physiological stress and adaptation taking precedence over social theory (Agarwal and Glencross 2011; Baker and Agarwal 2017; Goldstein 2006; Goodman 1998; Kakaliouras 2017; Rakita 2014). Clark Larsen, often characterized as the "face" of this approach, emphasizes methodological rigor and sophistication – rather than engagement with social theory – as key to bioarchaeology's vitality. Larsen promotes bioarchaeology as a strategy for understanding the origins and development of the modern world and issues that continue to affect us today (e.g. inequality, migration, epidemics), and therefore aligns the approach more broadly with disciplines outside of archaeology such as history, economics, public health, and even "hard" sciences like chemistry and physics (Knüsel 2010; Larsen 1997; 2017; 2018).

Buikstra and Larsen's approaches to bioarchaeology have historically been cast in opposition to one another, and while the resulting debates over engagement with social theory and adaptationist perspectives still loom large in present discussions, this distinction is becoming less relevant as the discipline matures (Baker and Agarwal 2017; Larsen 2018; Rakita 2014). Larsen's methodological focus, reliance on biological theory, and promotion of bioarchaeology's relevance to present-day concerns, have helped pave the way for the renaissance the discipline has been experiencing since the late 1990's (Rakita 2014). For example, the extensive collection of human skeletal data amassed to explore adaptive strategies in response to large-scale change was also used to test assumed relationships between skeletal lesions and overall health, ushering in a more critical stance regarding the representativeness of bioarchaeological samples (e.g. Wood et al. 1992; Wright and Yoder 2003). This in turn spurred the development of improved methods for estimating age and sex from skeletal remains and technological advances such as stable isotope and DNA analyses that have greatly expanded bioarchaeology's interpretive power (Baker and Agarwal 2017; Larsen 2018). Theories of stress and adaptation continue to play an important role in the biocultural approach, which promotes the inclusion of political-economic perspectives to critically explore "the relationship between biological well-being and inequalities in access to and control of resources" (Goodman 1998: 148). The biocultural program, as articulated in Alan Goodman and Thomas Leatherman's seminal book *Building a New Biocultural Synthesis* (1998), argued that conventional adaptive approaches – with their emphasis on biological reactions to large-scale factors (e.g. ecology, subsistence) – tend to cast societies as homogenous, functional units and obscure important within group differences linked to ideology and power relations. A political-economic approach not only helped to better align bioarchaeological research with themes of identity and power incorporated into archaeology as part of the post-processual movement (discussed further in chapter 2), it was also seen as a way for bioarchaeology to become more sensitive and responsive to the issues facing present day indigenous peoples, descendant communities, and other marginalized groups (Armelagos 2003; Blom 2017; Goodman 1998; Kakaliouras 2017; Knüsel 2010; Martin 1998). This second point became exceedingly important in the wake of the Native American Graves Protection and Repatriation Act (NAGPRA), a law enacted in 1990 in response to mounting tensions between indigenous groups and researchers that requires explicit consent from affiliated tribes before excavating or analyzing Native American cultural items, including human remains.

There is little doubt that Buikstra's vision for bioarchaeology, with emphases on context and the application of social theory, continues to exert the strongest influence on how the discipline is practiced today, and even Larsen himself has more recently acknowledged the value of incorporating social theory into bioarchaeological studies (Baker and Agarwal 2017; Larsen 2018). Researchers are beginning to expand engagement with social theory, moving beyond a consideration of skeletal data with well-known socio-cultural significance to address "messier" concepts such as community (e.g. Becker and Juengst 2017), caregiving (e.g. Tilley 2015), or personhood (e.g. Boutin 2011), to give a few examples. As Kakaliouras (2017) succinctly puts it:

> "Bioarchaeologists have all too often employed a Tylorian comparative method to ground their interpretations in something that is already known, such as a cultural practice that leaves marks on bone, or a set of behaviors that are expressed skeletally in similar ways … here I wish to stretch a smidgen past that … even if that means being left in a place of not knowing the culturally-specific significance of a feature, adaptation, or cultural modification" (pg. 14).

This move within bioarchaeology to address more complex sociocultural phenomena has been important for challenging some of the assumptions and biases influencing archaeological work on identity, particularly in relation to ideas about the relationship between sex and gender, biological age and "adulthood," as well as ethnicity and status (Buikstra and Scott 2011; Knudson and Stojanowski 2008; Sofaer 2006). And yet, despite the potential for bioarchaeological research to explore identity in a more nuanced way, few studies have integrated skeletal and archaeological data to test conventional ideas about labor demands and social status (Milella et al. 2015; Porčić and Stefanović 2009; Robb et al. 2001; Schrader 2014). I highlight this under-utilized avenue of bioarchaeological inquiry in my research, contributing to current debates regarding the future of activity studies within the field, and offering new data. The research presented here highlights this under-utilized avenue of bioarchaeological research, contributing to current debates regarding activity studies within the field and offering new data to enhance current understandings of labor division and social stratification in Middle Sicán and Ychsma societies.

Organization of the Dissertation

This section provides a synopsis of the dissertation chapters, outlining the major themes to be addressed in each. Chapter 1 introduces the research objectives, hypotheses, and problem context for this study. Here I discuss common perceptions about social status and manual labor based on historical and modern examples, and the need to test whether such assumptions have relevance for understanding social experience and the division of labor in ancient societies. I outline the bioarchaeological approach employed to test assumed relationships between social status and manual labor using archaeological human remains and their associated mortuary contexts, and explain why these lines of evidence are particularly useful for addressing this problem.

Chapter 2 details the theoretical framework for my research. I define social status as understood here, discuss the theory of embodiment that relates status identity to biological well-being, outline the rationale for using mortuary treatment to infer social status, and present theories adopted to understand relationships between bone biology and physical activity.

Chapter 3 reviews the current literature pertinent for understanding the strengths and limitations of activity reconstructions based on patterns of skeletal trauma, enthesial changes, and degenerative joint disease. Recently proposed changes to the scoring and interpretation of ECs are explored, and then commented on further in the final chapter. The second section of this chapter summarizes previous research on social stratification, labor organization, and quality of life differences between elites and commoners in Sicán and Yschma societies just prior to Inca and subsequent European conquest. These works provide the foundation upon which my hypotheses are built and are useful for identifying gaps in our understanding of status identity and labor activities to be explored in this study.

Chapter 4 describes the research sample used, as well as the specific methods employed to infer status identities from mortuary treatment and record skeletal evidence of trauma, ECs, and DJD associated with strenuous physical activity. Also detailed in this chapter are the statistical techniques and associated data treatments used to explore the dataset and test my hypotheses.

Chapter 5 explains the results of the statistical analyses, and patterns of trauma, DJD, and ECs are considered separately. The dissertation concludes with Chapter 6, which summarizes the results, offers an interpretation of the data with respect to social status and the division of labor in pre-Hispanic coastal Peru, discusses the implications of this research for bioarchaeological studies of activity, and highlights future directions for research.

CHAPTER 2

THEORETICAL ORIENTATION

Social Status & Life Experience

Conventional understandings of social status rely upon Marx's idea that power and inequality are essentially the products of economic relationships, and there is often little distinction made between concepts such as wealth, status, and class (Babić 2005). This perspective tends to cast social stratification in a dichotomous light – the privileged elite "bourgeoisie" (i.e. the owners of the means of production) versus the lowly proletariat (i.e. the working class), but nevertheless establishes a direct connection between material objects and social relations, with obvious relevance to archaeology (McGuire 1992).

Recognizing that social life is more than just the sum of economic activities, Max Weber extended Marx's view of social stratification to consider the role of prestige, or one's ability to live up to a certain set of principles held important by society at large or by social groups (Kerbo 2009). For Weber, social classes were not just economic units, but rather collections of people sharing a common lifestyle based on similarities in material as well as social conditions (Kerbo 2009). Informed by these understandings of social stratification, I consider social status to be the cumulative index of one's access to material and social capital (i.e. wealth and prestige) that manifests as differential behaviors and life experiences. These differences are encoded not only in the objects made and used throughout the course of daily life and the spaces that people inhabit, but also in the physical body.

My research adopts the perspective that status is paramount to social identity and life experience, relying on the concept of embodiment to explain interactions between social life and biological well-being. Embodiment as defined here is the process by which social conditions and experiences are incorporated into the physical body. Embodiment is the recognition that the way we move, our postures, how we decorate and adorn ourselves, the kinds of foods we eat, the environments we are exposed to, the challenges we face, and the strategies we use to survive are the products of the societies in which we live, our cultural values, and our social relations.

Archaeological theories of embodiment draw largely from the works of Maurice Merleau-Ponty, Marcel Mauss, and Pierre Bourdieu (Crossland 2010; Csordas 1994; Joyce 2005; Meskell 1996). Merleau-Ponty's ideas reflect the phenomenological approach that attempts to break down traditional philosophical dichotomies such self-object and mind-body (Csordas 1994). According to Merleau-Ponty, the body, through experience, provides the basis of perception, and this experience or "being-in-the-world" in turn shapes the body (Csordas 1994). Because humans come to understand and engage with the world through corporeal experience, the body is "both the medium and the product of social relations" as well as the "locus of identity formation" (Joyce, 2005: 142). Mauss and Bourdieu offer the concept of *habitus,* which argues that bodily practices are not only a manifestation of personal history, they are also unconsciously patterned by socio-cultural values and expectations (Crossland 2010; Knapp and van Dommelen 2008). Bourdieu's work in particular focuses on social hierarchy, arguing that patterned behaviors (especially aesthetic tastes) emerge as a result of early indoctrination into a particular social class (Bourdieu 1984). From these ideas comes the realization that our bodies are not simply biological entities formed by genes and natural processes, they are the cumulative result of our individual experiences and histories, as well as our social and material realities (Krieger 1999; Krieger 2001).

The plasticity of the human body – our biological responsiveness to environmental stimuli– has been key to our success as a species, but also leaves us extremely vulnerable to circumstance. The most poignant example of this is the decades of clinical research showing that those with marginalized social status are disproportionately affected by disease and premature death (Chandola and Marmot 2011; CSDH 2008; Marmot et al. 1978; Marmot and Smith 1991). Furthermore, these health disparities tend to emerge even when wealth and educational factors are held constant, highlighting the role of beliefs and value systems in social stratification. Take as a an example the observation that African American and Latino communities in the United States – regardless of income and level of education – tend to experience poorer health than their white counterparts (Gravlee 2009). Genetic studies disprove the idea that these health disparities are the result of innate biological difference, and researchers have instead focused on the ways in which ideological factors, such as institutionalized racism and discrimination, can affect stress levels and in turn, immune function and overall health (Gravlee 2009; Krieger 1999). Clinical research on social health disparities situate human bodies within the appropriate context of social experience, and offer an important model for bioarchaeologists of how status identities are embodied.

Social Status & Mortuary Treatment

One of the greatest debates within archaeology is the degree to which mortuary contexts are reliable indicators of social organization and individual social status identities. At one extreme are proponents of the “New Archaeology” school, or the “processualists,” whose approach is often characterized by the works of Arthur Saxe (1970) and Lewis Binford (1971). New Archaeology emerged during the early 1960’s with the goal of moving the discipline away from cultural and chronological typologies to a more scientific approach that could test hypotheses about past human cultures and societies and offer explanations for processes responsible for cultural variation (Pearson 2000). Using cross-cultural ethnographic data to establish behavioral correlates for archaeological patterns, processualists argued that the degree of variability in mortuary contexts reflected the level of social complexity within the society, as well as the status and rank of individuals during life (Binford 1971; Saxe 1970; Tainter 1978). Brown (1995) characterized this perspective as “representationalist” because proponents tended to view mortuary contexts as a “mirror” of social processes and the status identity of the deceased. Although often accused of over-simplification, logical positivism, and indiscriminate use of ethnographic analogy (Hodder 1980; Shanks and Tilley 1987; Ucko 1969), Brown and others have noted that many processual views and cross-cultural generalizations continue to play a dominant role in archaeological studies, especially with regards to mortuary contexts (Brown 1995; Hegmon 2003; Pearson 2000).

At the other end of the spectrum are the “post-processualists,” who questioned the assumed one-to-one relationship between mortuary variability and social complexity, as well as between burial treatment and social status. Pointing to the fact that “the dead do not bury themselves,” post-processualists did not view mortuary contexts as a passive reflection of social organization or the “social personae” of individuals, they instead viewed them as dynamic spaces where ideologies of power and domination were negotiated, constructed, and even concealed or misrepresented (Arnold and Jeske 2014; Brown 1995; Pearson 2000). Rather than relying on social factors to explain mortuary variability, post-processualists emphasized ritual and symbolic aspects (Brown 1995). In its most extreme form, post-processualism questioned whether it was even possible to accurately interpret mortuary contexts, given their tremendous variability and significance only in relation to specific socio-cultural and historical contexts (Hodder 1980; Trigger 1991; Ucko 1969). However, rather than sealing the nail in the coffin of mortuary archaeology, so to speak, post-processualist critiques provided valuable insights for improving the field. They emphasized human action and experience, and championed holistic, contextual analyses (Pearson 2000). Out of this sprang greater consideration of the sentiments, actions, memory, and processes involved in creating mortuary assemblages (Tarlow 1999), and a growing awareness that valid interpretations – especially with regards to social status – are only possible when mortuary data are analyzed in concert with other lines of evidence, such as settlement patterns and indices of skeletal health (Ashmore and Geller 2005; Goldstein 2006; Trigger 1991).

By the 1970's and 1980's, the chasm between processual and post-processual archaeologies was on the wane as researchers began advocating for "middle ground" approaches (Pearson 2000), or what Hegmon (2003) referred to as "processual-plus." While recognizing that ethnographic data should be used cautiously, that mortuary contexts may reflect idealized rather than realistic versions of the social order, and that mortuary data are just one of many lines of evidence needed to make sound inferences, there is still general consensus that mortuary assemblages are patterned in socially-meaningful ways, so that distinctions in power and prestige are discernible (Arnold and Jeske 2014; Brown 1995; Carr 1995). For example, there is wide ethnographic and archaeological support for Saxe and Binford's assertion that the allocation of resources expended on funerary activities will be directly related to the number of individuals with social obligations to the deceased (Brown 1995). Brown (1995) argues that because every society has a finite amount of resources that can be expended, it is possible to establish the "normal" range of variation in mortuary treatment and thus identify unusual cases suggestive of special social significance. Elite burials can be identified archaeologically using estimates of the amount of time and resources dedicated to the treatment of the corpse, the architecture of the internment facility, and the material contribution to the funerary ritual (Tainter 1978). It is assumed that because elites occupy a larger number of social roles than the average citizen, their deaths will inspire greater community involvement (i.e. more energy expended on funerary treatment), and symbolic representation in the mortuary context will be more diverse (Howell and Kintigh 1996).

Bioarchaeology provides an important platform for integrating processual and post-processual perspectives, and the field has contributed to, and benefited from, both approaches. New Archaeology's call to be more "scientific" and the post-processual emphasis on experience resulted in greater appreciation for human skeletal remains as an important source of social information (Sofaer 2006). By highlighting the body's role in social practice, post-processualism has also helped generate a more socially-relevant bioarchaeology, serving as a catalyst for enhanced dialogue between the field and the social sciences more broadly conceived (Knudson and Stojanowski 2008). Today's bioarchaeologists are trying harder than ever not only to apply social theories to human skeletal datasets, but also to actively engage in developing and testing them. Bioarchaeological approaches have been particularly fruitful with regards to ancient social identities, and my study of status and labor in pre-Hispanic coastal Peru is part of a larger push to situate interpretations of the past within the appropriate context of daily life and experience.

Bone Biology and Physical Activity

My research is guided by the basic premise that labor organization – and by extension, patterns of physical activity – are socially and culturally meaningful, particularly with regards to the embodiment of status identity. Status divisions organize relations of power to determine one's rights, responsibilities, and expected behaviors, and therefore one's social position is often expressed most clearly in terms of the activities they engage in (Porčić and Stefanović, 2009). Social status, patterns of physical activity, and human skeletal data are linked together here by the underlying principle of biological plasticity. Just like any other living tissue, bone is malleable, and responsive to both the internal and external environment. This plasticity is precisely what enables bioarchaeologists to draw meaningful inferences about life experience from human skeletal remains (Sofaer 2006).

Bioarchaeological studies of physical activity can take several forms, all with their own set of strengths and limitations. Each technique relies on the concept of bone functional adaptation, which states that bone will remodel in the direction of mechanical loading, and will increase or decrease to reflect mechanical requirements (Kennedy 1989; Ruff et al. 2006). Detailed descriptions of the skeletal traits used in my analysis (fractures, Schmorl's nodes, degenerative joint disease [DJD], and enthesial changes [EC]) are provided in the Literature Review and Methods sections.

The skeletal trauma considered in this study – Schmorl's nodes and fractures –are common sources of pain and debility in living populations, and clinical studies can therefore offer important interpretive models for bioarchaeological data. Careful assessment of skeletal trauma offers an opportunity to address aspects of life experience that are typically not accessible through other lines of evidence, although identifying the precise causal mechanism – accidental injury, violence, cultural modification, or funerary processing – can be difficult. While the relationship between biomechanical stress and skeletal injury is rather straight-forward, interpreting patterns of DJD and ECs requires more caution (Cardoso and Henderson 2010; Jurmain and Kilgore 1999; Kennedy 1989; Weiss 2007; Weiss and Jurmain 2007). Cadaveric studies and research in occupational and sports medicine have supported the idea that strenuous physical activity can induce these osseous changes (Bramhall et al. 1994; Brown et al. 2008; Chen and Bohrer 1990; Fahey et al. 1998; Parfitt 2004; Partridge and Duthie 1968; Rapillard et al. 2006; Schlecht 2012a; Swartz et al. 2005; Villotte et al. 2010; Weiss 2015). However, in addition to being influenced by physical activity, age, sex, body size, dietary factors, hormones, and genetics can also play important roles (Jurmain et al. 2012; Weiss 2007; Weiss and Jurmain 2007; Wilczak 1998).

Out of necessity, inferences about activity using evidence of DJD and ECs are rather general. It is not possible to determine the specific occupation(s) individuals engaged in during their lives, as a wide range of activities can use the same joints and muscles in similar ways (Jurmain and Kilgore 1999; Kennedy 1989; Robb 1998). At best, one may be able to use these traits to distinguish those who performed high intensity tasks from everyone else, with finer distinctions being more difficult to discern (Jurmain et al. 2012; Molnar 2006; Weiss 2007; 2015). Furthermore, there is some evidence that muscle loading intensity in adulthood beyond a threshold established during skeletal growth and development (particularly in adolescence) is more important to the development of ECs than are loading frequency and duration, so that "low-intensity" activities (i.e. do not reach the peak loading capacity of the muscles) or those within the limits of one's "adaptive range" established during adolescence – even when performed habitually – may not lead to ECs at all (Acosta et al. 2017; Chapman 1972; Churchill and Morris 1998; Henderson 2013; Schlecht 2012a; Toyne 2002).

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CHAPTER 3

LITERATURE REVIEW

Biological Indicators of Physical Activity

Bone is made of inorganic (hydroxyapatite) and organic (collagen) components that provide both strength and flexibility to support the body and facilitate movement. Bone undergoes constant cycles of proliferation, resorption (destruction of bony tissue) and maintenance throughout the lifespan – often simultaneously –to adapt to physical stresses, access calcium and phosphate reserves, and also as a normal part of growth and development (White and Folkens 2000). Bone proliferation is achieved by osteoblast cells, which produce a collagen-rich matrix that calcifies as hydroxyapatite crystals are incorporated. Once encased in the calcified matrix, these cells serve to maintain bone tissue and are referred to as osteocytes (White and Folkens 2000). Resorption occurs as osteoclast cells dissolve collagen and remove the mineral matrix. Normal patterns of bone deposition, resorption, and maintenance can be disrupted by nutritional inadequacies, as part of the inflammatory response to infectious agents and trauma, and as a result of mechanical loading (Larsen 1997). This can result in bony overgrowth and/or resorptive lesions at specific sites throughout the skeleton that are often permanent and therefore visible in bioarchaeological assemblages.

Bioarchaeologists have long recognized the need to consider the effects of age, body size, and perhaps sex when using patterns of DJD and EC to understand activity patterns, and have accounted for these factors using a variety of statistical procedures (Cheverko and Hubbe 2017;

Henderson and Nikita 2016; Nikita 2014). DJD and ECs are almost always more common and more severe in older and larger individuals than in younger and smaller ones, with size usually referring to body mass for DJD and to long bone measurements for ECs. While DJD tends to be more common in females compared to males, the opposite is true for ECs. Sex-based differences appear – at least for EC – to largely be a function of size (i.e. males tend to be larger than females), but clinical studies of DJD suggest hormonal factors are also at play (Jurmain et al. 2012; Weiss 2015). Specific genes that affect DJD severity have been identified, although thus far none have been implicated in determining whether the condition develops or not in the first place (Spector and MacGregor 2004). Hormones and dietary factors have been shown to play a role in the development of DJD, but these influences have remained largely unexplored in bioarchaeological contexts and with respect to EC (Jurmain et al. 2012). In order to produce interpretations of these skeletal traits that are meaningful with regards to patterns of activity, it is essential that bioarchaeologists account for as many confounding variables as possible, which in most studies has been age, body size, and/or sex. Different strategies for dealing with these issues will be discussed further in the methods section (chapter 4).

Skeletal trauma

Skeletal fractures occur when tensile, compressive, twisting, bending, and/or shearing forces exceed the bone's natural strength, causing displacements (when two surfaces are no longer in anatomical alignment) or the appearance of fracture line (Davidson et al. 2011). When fracture lines occur, they originate at the point of impact and radiate out in a concentric pattern, usually intersecting preexisting lines of weakness (e.g. cranial sutures; Davidson et al. 2011). Bending stresses often lead to transverse fracture lines, while shearing causes horizontal fracture lines and torsion produces lines that are spiral-patterned (Aufderheide and Rodríguez-Martín 1998). Tension may result in joint dislocations or avulsions (the tearing away of small, irregular bone fragments), while compressive forces can lead to crushing or impactation (Aufderheide and Rodríguez-Martin 1998). Fractures can be the result of a single traumatic event, repeated stress under static or dynamic loading, or abnormal weakening of the bone due to pathological processes, and are often accompanied by degenerative changes in the corresponding joints (Aufderheide and Rodríguez-Martin 1998).

In the long bones, fractures can be recognized by the presence of a bony callus that forms as part of the healing process, shortening and/or mis-alignment of the shaft, or the formation of a "pseudo-joint" (Aufderheide and Rodríguez-Martin 1998). Figure 1 provides a comparative perspective of a normal and fractured clavicle to illustrate these changes. A pseudo-joint forms when fracture causes non-union between two portions of long bone or between two joint surfaces. As a result, the two ends of the bone become rounded with sclerosis of the medullary cavity (Aufderheide and Rodríguez-Martin 1998). Vertebral fractures are largely the result of compressive forces, and are recognized by crushing or impactation of one or more vertebral bodies, oftentimes with subsequent fusion to adjacent vertebral bodies (Figure 2). Cranial fractures can be recognized by the presence of beveled or smooth punctures, indentations, and circular depressions that may extend inward into the cranial space (Aufderheide and Rodríguez-Martin 1998).

Schmorl's nodes are lytic-like lesions in the superior and/or inferior surface of vertebral bodies (Figure 3), and have been associated with acute trauma to the spine in the clinical literature (Faccia and Williams 2008; Fahey et al. 1998; Peng et al. 2003). These lesions are commonly found in the elderly and juvenile gymnasts and are thought to occur when there is a rupture in the intervertebral discs between two adjacent vertebral bodies. In some cases Schmorl's nodes can be rather painful and in others they are asymptomatic (Peng et al 2003).

Degenerative joint disease (DJD)

The best support for a relationship between DJD and physical activity comes from experimental and clinical research in occupational or sports medicine, particularly studies that focus on specific patterns of involvement for professional athletes and farmers (Brown et al. 2008; Sulsky et al. 2012; Weiss and Jurmain 2007). However, clinical data has also suggested that this relationship is more clear for some regions of the body than others, with degenerative changes in the spine being considered least reflective of differential activity patterns, given its unique susceptibility to the stress and strains of the bipedal gait common to all humans (Weiss and Jurmain 2007). While there is lack of clinical support for a relationship between osteophytosis (the development of bony spurs at the margins of vertebral bodies) and patterns of physical activity (Rogers and Waldron 1995; Weiss and Jurmain 2007), Brown et al. (2008) did find statistically significant, positive associations between load-bearing, cartilage destruction, and DJD scores in the facet joints of cadaveric spines. Their work does offer some support for including DJD of the facet joints in bioarchaeological studies of activity.

Clinical research has also been helpful for outlining "best practices" in the scoring and interpretation of DJD. Skeletal changes associated with DJD include osteophytes (bony protrusions at the margins of joint surfaces), porosity, and eburnation (polished, opaque appearance on the articular surface). Although standard bioarchaeological protocol for documenting DJD outlined in Buikstra and Ubelaker (1994) calls for the evaluation of all three of these characteristics, there is little clinical support to suggest that osteophytes and porosity in

Figure 2 - Normal right clavicle (left); fractured right clavicle (right*)*

Figure 3 - Thoracic compression fracture (left), Schmorl's node (right)

Figure 4 - Eburnation of the distal femur

isolation are sufficient evidence of DJD (Rogers and Waldron 1995; Rothschild 1997; Weiss and Jurmain 2007). Several researchers specializing in DJD advocate a conservative approach that identifies the condition only when two ormore skeletal signatures are present, with eburnation being the sole definitive indicator (Rogers and Waldron 1995; Rothschild 1997).

Enthesial changes (ECs)

Entheses are junction points of hard and soft tissues where muscles insert into bone, either directly via tendons or indirectly via the periosteum, a layer of vascular connective tissue that surrounds long bones (Benjamin et al. 2002). Their primary functions include anchoring tendons to resist static and dynamic loading, and balancing tensile loads to dissipate stress outward into the bone and/or tendon (Benjamin et al. 2002). Entheses can be grouped into one of two categories, based on general morphological characteristics. Fibrous entheses tend to be located along large sections of long bone shafts, and the soft tissue components attach directly into the bone via collagen “Sharpey’s” fibers, which are physically anchored to the bone matrix (Shaw and Benjamin 2007). Fibrocartilaginous entheses, in contrast, tend to be located in smaller regions of rather thin cortical bone devoid of periosteum at the ends of long bones, with muscles attaching via tendons (Shaw and Benjamin 2007). Fibrocartilaginous entheses are composed of four histological “zones,” including: 1) the tendon or ligament; 2) a layer of uncalcified fibrocartilage; 3) calcified fibrocartilage; and 4) subchondral bone (Benjamin et al. 2002). The surface of zone 3, the calcified fibrocartilage, is the portion of the entheses that is visible in dry bone (Villotte et al. 2010). While the distinction between entheses types as presented here has important implications for the scoring and interpretation of ECs (see below for further discussion), it is important to remember that they are not absolute and different portions of the same entheses can have different characteristics in relation to tensile loading (Cardoso and Henderson 2010; Shaw and Benjamin 2007). For example, collagen fibers at the peripheral margins of fibrocartilaginous entheses often merge with the periosteum, leaving only the inner-most portion avascular (Villotte et al. 2010).

The idea that enthesial changes (ECs) at fibrous attachment sites are indicative of intensive muscle use and therefore reflect (at least to some extent) differential activity patterns is based on the premise that forceful muscle contractions increase blood flow to the periosteum, which in turn initiates the proliferation of bone cells and thus, surface irregularities (e.g. bony ridges, porosity, lipping at enthesial margins; Schlecht 2012a; 2012b; Shaw and Benjamin 2007). Because fibrocartilaginous entheses are largely devoid of periosteum – except at the peripheral margins as explained above – and the associated cortical bone may be incapable of supporting deeply penetrating Sharpey's fibers, an alternative explanation for their response to mechanical loading is required (Shaw and Benjamin 2007; Villotte and Knüsel 2012). Shaw and Benjamin (2007) suggest that the fibers crossing the uncalcified and calcified zones of a fibrocartilaginous entheses may be equivalent to the Sharpey's fibers found in fibrous insertions. In this case, bony changes similar to those found with degenerative joint disease (i.e. pitting and other surface irregularities) may occur as soft tissue structures wear down, placing more stress and strain on the bone (Shaw and Benjamin 2007). However, unlike DJD which is thought to reflect habitual and/or repetitive episodes of biomechanical stress and strain, there is some research to suggest that ECs are more likely the result of sporadic incidences of high intensity loading beyond one's adaptive capabilities (Acosta et al. 2017; Henderson 2013; Schlecht 2012a; 2012b). Entheses are, after all, designed specifically to deal with the stress and strains of mechanical loading, and given bones' plastic and adaptive nature, it should perhaps be expected that a significant morphological response would only occur in the presence of “atypical” and intermittent loading regimes (Schlecht 2012b).

Some support for the idea that increased bone remodeling occurs at muscle attachment sites in response to biomechanical stress was found by Schlecht (2012a) in his study of insertion sites using a sample of radii from human cadavers, where elevated rates of bone remodeling were observed histologically. Previous histological studies testing the relationship between enthesial morphology and mechanical loading have largely been conducted using animal models, with conflicting results and limited relevance to humans. Schlecht’s (2012a) pioneering research lends credence to activity studies using EC, and future work that considers histological assessment of bone remodeling and enthesial morphology in tandem will help to further clarify the role of mechanical stress and strain in EC etiology (Schlecht 2012a).

Bioarchaeological and experimental research on ECs have yielded mixed results, with several studies failing to discern meaningful patterns despite known or inferred activity differences (Cardoso and Henderson 2010; Churchill and Morris 1998; Toyne 2002; Zumwalt 2006). Likely problems with scoring techniques and a lack of consistency in statistical procedures have complicated this issue further, making it hard to compare different studies in a meaningful way (Cheverko and Hubbe 2017; Henderson and Nikita 2016). The most widely used scoring method for EC provided by Hawkey (1988) and Hawkey and Merbs (1995) do not take into account significant differences in the anatomy, “normal” range of variation, and responses to biomechanical stress found between different kinds of muscle insertions (Jurmain et al. 2012; Villotte et al. 2010; Weiss 2015). Importantly, Villotte et al. (2010) and Henderson et al. (2016) presented a new method that does address these concerns and has in some cases yielded greater correspondence between manual labor and severity of EC scores for skeletal samples where age, sex, size, and occupation are known (Michopoulou et al. 2015; Niinimäki 2011; Villotte et al. 2010; Weiss 2015). Dubbed the "Coimbra Method," this approach developed out of a series of workshops between 2009 and 2013 at the University of Coimbra's Research Center for Anthropology and Health in Portugal with the goal of tackling some of the most pressing concerns with regards to the utility of ECs as skeletal markers of activity (Santos et al. 2011). These workshops and the resulting publications represent a huge paradigm shift in the way ECs are analyzed and interpreted, with three dominant themes emerging: 1) all ECs – regardless of the insertion type – demonstrate positive correlations with age; 2) some insertion types perform better with regards to activity reconstruction than others; and 3) more research is needed to fully understand the etiology of ECs and better evaluate their utility in bioarchaeological studies of activity (Goode et al. 2018; Henderson and Cardoso 2013; Jurmain et al. 2012; Niinimäki 2011). Methodological considerations resulting from these discussions will be addressed more thoroughly in chapter 4.

Clinical evidence of correspondence between musculoskeletal over-use injuries and osseous changes at fibrous insertion sites is rare, and it may be exceedingly difficult to differentiate between normal variation in skeletal robusticity at these sites, and that related to biomechanical stress (Villotte 2006; Cardoso and Henderson, 2010; Villotte et al., 2010). Given this information, Villotte (2006), Cardoso and Henderson (2010), and Villotte et al (2010) argue against the inclusion of fibrous attachment sites in bioarchaeological reconstructions of activity patterns. It is quite possible that previous studies of ECs have obtained conflicting results because what was being measured was actually normal variation, rather than pathological conditions associated with increased biomechanical stress (Villotte et al. 2010). In fact, while Cardoso and Henderson (2010) were not able to distinguish between occupational groups in a well-documented skeletal collection (i.e. known age, sex, and occupation) using Hawkey and Merbs' (1995) methods, when only fibrocartilaginous insertions were considered in the same samples, Villotte and colleagues (2010) found significantly more ECs among workers involved in forceful tasks (i.e. where muscles were loaded to near-peak capacity).

Villotte et al.'s (2010) study is important because it demonstrates that – contrary to recent criticisms of activity studies in bioarchaeology – careful, clinically-informed evaluations of ECs can provide accurate information about differential exposure to mechanical stress in past populations. By providing a way to enhance archaeological models of socio-economic organization with information about life experience, bioarchaeological activity studies can contribute greatly to our understanding of the past. The Coimbra method presents a step in the right direction towards enhancing the utility of ECs as markers of physical activity, but there are some important caveats that warrant further attention. The method has only recently been made available for widespread use, and its applicability to muscle sites and skeletal samples outside of those used to initially create and test it remains to be seen. Furthermore, Villotte et al. (2010) made no attempt to control for body size even though numerous studies have found this variable to exert strong and statistically significant influence on EC scores (Michopoulou et al. 2015; Weiss 2007; 2015). Examining statistical associations between EC scores, size, and age for the different enthesial types will allow me to shed some light on these issues and assess the merit of Villotte's claims.

Middle Sicán and Ychsma Social Organization & Burial Practices

The emergence of the Sicán and Ychsma archaeological cultures corresponds to the transition from the Middle Horizon (550 – 900 CE) to the Late Intermediate Period (900-1476 CE), a time characterized by significant sociopolitical re-organization following the decline of the expansive Wari (south and central coasts, highlands) and Moche (north coast) polities in Peru (Covey 2008). Despite changes in sociopolitical organization, Late Intermediate Period sites on the central and northern coasts demonstrate clear evidence of settlement hierarchy (i.e. distinctions between civic/ceremonial structures, and elite vs. common-class residences), urban centers, extensive road and irrigation networks, and occupational specialization (Covey 2008; Shimada 1994). These features demonstrate well the large-scale monopolization of land and labor, offering valuable clues about Sicán and Ychsma socio-economic organization.

The Middle Sicán archaeological culture (900 – 1100 CE) is known for a distinct ceramic style including burnished blackware vessels, copper-arsenic and gold alloy objects, a distinct religious ideology centered on the Sicán Diety and his human equivalent the Sicán Lord, monumental religious architecture, elite shaft tombs containing an unprecedented amount of material wealth, and the development of extensive trade networks with Ecuador, Colombia, and Amazonia (Shimada 1994; Shimada 2000). The emergence of Sicán culture corresponds to the decline of the Moche polity, which at its height covered roughly one third of the entire Peruvian coast (Shimada 1994). The Late Moche capital at Pampa Grande was abruptly abandoned following a severe flood spurred by El Niño events sometime around 700 CE (Shimada 1994), and this marked a period of population movements and transition intensified by Wari expansion from the highlands into coastal areas (Segura and Shimada 2010). Wari expansion resulted in a synthesis of local and foreign elements in the north coast, and this melding of traditions in Middle Sicán iconography and material culture is perhaps responsible for its rapid spread throughout the north coast and further south (Segura and Shimada 2014; Shimada and Craig 2013).

The Sicán Precinct is a complex of six monumental mounds (Huacas Loro, Las Ventanas, La Merced, Lercanlech [also known as Rodillona], El Corte, and Soltillo) surrounding a large plaza (Shimada 2010). Each of the six ceremonial structures and associated cemeteries at the Sicán Precinct are thought to have represented an elite lineage that although united by shared religious ideology, were perhaps distinct with regards to their economic endeavors, as well as their social and political identities (Shimada 2014). Lacking evidence of intensive domestic occupation, the resident population of the Sicán Precinct appears to have been composed of a rather small number of elites, although excavations in the Great Plaza at the center of the site reveal an intensive and diverse set of activities took place here, including the construction and maintenance of buildings and large-scale food preparation, perhaps for funerary events and/or the provisioning of laborers (Matsumoto 2014; Shimada et al. 2015).

The activities documented at the Sicán Precinct were fueled by and dependent upon residential and production sites (e.g. ore mining and smelting complexes, ceramic and metal workshops) in the surrounding area, and archeometric analysis has linked vessels excavated from Huaca Loro to the Huaca Sialupe ceramic and metal workshop located some 23 kilometers to the southwest (Shimada et al. 2015). Shimada (in press) describes the network of interaction between the Precinct and its hinterland as a “dispersed city.”

Although Middle Sicán burial practices, iconography, and material culture have been found beyond the north coast, there is no evidence to suggest that elites engaged in militaristic conquest or exerted much direct control over the local populations with which they interacted (Segura and Shimada 2014; Shimada 2014). The Precinct lacks defensive structures, no Middle Sicán "enclaves" have been discovered, militaristic iconography is rare, and while the practice of human sacrifice is well-documented, little evidence of skeletal trauma has been found in the human remains excavated thus far (Farnum 2002; Klaus 2008; Klaus et al. 2017; Shimada 2014). Rather it appears that Sicán influence was tied to religious ideology surrounding the Sicán Deity/Lord and motivated by economic interests to establish and maintain trade networks and access to human labor for the acquisition, production, and exchange of resources – including exotic or "sumptuary" goods (Shimada 2014; in press).

The Sicán Deity, a ubiquitous symbol in Middle Sicán art, is a supernatural being with avian-like characteristics including almond-shaped and upturned or "winged" eyes with dilated pupils, claws, wings, a tail, and feathers with a human-like face and/or body shape (Shimada and Samillán 2014). This figure is often found in association with images linked to life-giving water and fertility such as *spondylus princeps* – whose ritual significance is widespread throughout the Andes – and fauna present on the north coast during the rainy season (e.g frogs, iguanas, bees, and parrots; Shimada and Samillán 2014). The human embodiment of this being, known as the "Sicán Lord," shares the same basic physical characteristics, although supernatural elements like wings, feathers, and a tail are replaced by anthropomorphic traits and personal adornments including elaborate headdresses and clothing (Shimada and Samillán 2014). It is believed that this "Sicán Lord" symbolized the elite leaders of Middle Sicán society, who upon death would assume the identity of the Sicán Deity (Matsumoto 2014; Shimada and Samillán 2014). It is unclear whether this all-powerful being was a symbol of Naylamp, the legendary progenitor of the Lambayeque dynasty who, based on ethnohistorical accounts, arrived in the region from coastal Ecuador, or a unique blending of the supreme masculine god common in Wari and Tiwanaku cosmology with north coast fisherfolk traditions (Shimada and Samillán 2014). In either case, symbolic associations between the Sicán Deity and Lord and Middle Sicán elites were likely important for naturalizing their authoritative role and privileged status (Shimada 2000; Shimada 2010; Shimada and Samillán 2014). Furthermore, the blending of familiar religious/ritual elements and variation in the themes associated with images of the Sican Deity and Lord (i.e. rainfall, aquatic and terrestrial flora and fauna) would have had broad appeal to the general populace composed primarily of fishing and agricultural groups, perhaps contributing to the spread of Middle Sicán influence.

Based on mitochondrial DNA, patterns of inherited dental traits, and extensive excavations of production and mortuary contexts, Shimada and his colleagues have identified at least two ethnic groups within Middle Sicán society (Cervantes et al. 2011; Klaus et al. 2017; Shimada 1994; Shimada et al. 2004; Shinoda 2014). Inferred elites were more closely related to one another than they were to the local populations living in settlements surrounding the Precinct, perhaps reflecting a distinct "Sicán" ethnic identity with possible origins in Ecuador (Corruccini and Shimada 2002; Shimada 2010; Shimada et al. 2004; Shinoda 2014). In contrast, patterns of inherited dental traits, burial practices, and material culture found for those interred in surrounding residential sectors and workshops or as sacrificial offerings associated with elite tombs aligned more closely with the earlier Moche culture, perhaps denoting the enduring presence of a "Mochica" ethnic identity (Cervantes et al. 2011; Klaus 2003; 2008; Klaus 2014; Klaus et al. 2017; Shimada 2010; Shimada et al. 2004). The persistence of an ethnic "Mochica substratum" (Klaus 2014) within Middle Sicán society as inferred from mortuary and production contexts (discussed further below) provides further support for the idea that local populations sharing religious and economic ties with elites likely enjoyed a significant degree of autonomy in their daily operations (Shimada 2015; Shimada and Craig 2013; Shimada and Wagner 2007). Shimada and his colleagues have argued that Middle Sicán elite strategies for control were focused primarily on aligning themselves with pre-existing religious and economic structures to develop relationships that could be seen as mutually beneficial (Klaus and Shimada 2016; Segura and Shimada 2014; Shimada 2014). This perhaps helps to explain the perceived willingness on the part of non-elites to participate in Middle Sicán society, despite what appears to have been pervasive social inequalities (Klaus et al. 2017; Shimada et al. 2004).

Burials excavated at the Sicán Precinct and surrounding areas provide the most striking evidence for the hierarchical organization of Middle Sicán society, and emphasize the role of religious ideology, and perhaps ethnicity, in legitimizing and maintaining the power structure. Observed mortuary patterns suggest the presence of at least four different social classes including high level elites, low level elites, commoners, and sub-commoners, with differential access to metals being a primary mechanism of distinction (Klaus et al. 2017; Shimada 2014; Shimada 2015; Shimada et al. 2000). Contrasts between inferred elites (regardless of ranking) and non-elites correspond to the suggested Sicán and Muchic ethnic distinctions outlined above, giving support to the idea that social status and ethnic identity were intertwined in Middle Sicán society (Klaus et al. 2017; Shimada 2014; Shimada et al. 2000).

At the very bottom of the social scale (i.e. commoners and sub-commoners), individuals were interred in flexed or extended positions in simple pits below the floors of humble domestic structures and workshops, or served as dedicatory and/or sacrificial offerings in Precinct plazas and elite tombs (Shimada, 2000). Ceramic associations, body positioning and orientation, as well as the kinds of grave goods (if any) associated with these people reflect Moche traditions.

For example, at the Middle Sicán production sites of Huaca Sialupe and Batán Grande, as well as at the Precinct and other Sicán-affiliated locales, inferred commoners were often buried in extended position with the head facing south in simple pits, wrapped in plain cotton cloth, and accompanied by ceramic vessels, llama offerings, with copper objects sometimes placed in the mouth and/or hands (Farnum 2002; Klaus 2003; Klaus 2014; Klaus et al. 2017; Shimada et al. 2004). An example of this type of burial is provided in Figure 5. Ceramic vessel associations rarely exceeded ten offerings and were largely reflective of Moche traditions, although some goods depicting the Sicán Deity or Lord on characteristic burnished, blackware (or imitations thereof) have also been found (ibid). Interestingly, vessels bearing images of the Sicán Deity in inferred commoner burials near the Precinct largely derive from workshop contexts and are found with individuals in a seated or flexed position more reminiscent of the pattern documented for Sicán elites than of Moche practices, perhaps denoting close social ties with elite groups and/or status emulation (Klaus et al. 2017). Inferred dedicatory or sacrificial burials ("sub-commoners") are those that lack any evidence of grave goods, demonstrate "atypical" body positioning (e.g. supine position), and/or osteological evidence of violent death (e.g. decapitation or strangulation; Eeckhout and Owens 2008). An example of this type of burial is provided in Figure 6. Individuals interred in commoner or sub-commoner type burials were also disproportionately burdened by dietary and developmental insults (Farnum, 2002; Shimada et al., 2004), supporting inferred relationships between mortuary treatment and position within the social hierarchy.

High- level elites were generally interred in seated positions at major Precinct temples in deep shaft tombs, and their burial regalia were rich with imagery of the Sicán Lord, the earthly alter ego of the Sicán Deity (Shimada, 2000). These individuals were frequently associated or adorned with masks depicting a standardized image of the Sicán Lord's face made of gold, silver, and/or copper alloys (depending on rank) and decorated with other highly-valued or exotic items (Matsumoto 2014; Shimada et al. 2000; Shimada and Samillán 2014). These masks are interpreted as a symbolic expression of elite leaders' transformation from the Sicán Lord to the Sicán Deity upon death, and were perhaps part of the mechanisms used by elites to establish and legitimize their power (Matsumoto 2014; Shimada and Samillán 2014).

High elite shaft tombs contained large quantities (as much as 1.2 tons) of high karat gold, silver, and copper alloy objects, as well as many imported items such as cinnabar pigment, emeralds, amber beads, feathers, and *Spondylus princeps* and *Conus fergusoni* shells (Shimada et al., 2000). Other high elite items included painted cloth, semi-precious stones, double and single spouted bottles, and human retainers (Shimada et al., 2000; Shimada, 2010). Low-level elite burials share many features with the previous category, although ochre pigment was used rather than cinnabar, and neither high karat gold alloy objects nor emeralds were present (Shimada, 2010). An example of a Middle Sicán elite burial is provided in Figure 7.

Middle Sicán burials and material culture have also been found at Huaca Cao Viejo, a major Moche civic-ceremonial mound at the El Brujo Archaeological Complex in the Chicama valley about 230 km south of the Sicán "heartland". The Huaca Cao Viejo mound sits atop a bluff overlooking the Pacific Ocean at the right margin of the Chicama river and is composed of at least four superimposed structures built over a span of about 500 years (Mujica et al. 2007). Painted with polychrome reliefs and murals, the most well-known depicting warriors parading naked captives, Huaca Cao Viejo was a major focal point for Moche ritual and administrative activities in the region, including the burial of high-ranking elites, until its eventual abandonment and re-purposing as a burial ground by local populations some time around 650 CE (Franco et al.

2007; Mujica et al. 2007). The period between Moche abandonment and the appearance of Middle Sicán-style burials and material culture around 950 CE has been dubbed the "Transitional" phase, characterized by a ceramic style blending Moche and foreign (Wari?) elements (Mujica et al. 2007).

Sicán-affiliated internments at Cao Viejo are highly concentrated and superimposed on the northeast slope of the mound, and while many of them have been disturbed by extensive looting, 100 intact and partially-intact burials dating to the late Middle Sicán and Late Sicán periods (ca. 1000 – 1100 CE) have been excavated thus far (Franco et al. 2007; Segura and Shimada 2014). Individuals were bundled in plain cotton cloth, typically in a seated flexed position or with their legs crossed, and sometimes with the addition of supporting cane or wooden frames and "false heads" (Franco et al. 2007), a practice also seen in Ychsma burials (discussed further below). The sample is thought to be composed primarily of local commoners, although several burials demonstrate similarities with elite internments at the Precinct including the presence of retainers, copper arsenic funerary masks, shiny blackware bottles with images of the Sicán Deity, finely woven textiles with Sicán-style iconography, and *spondylus princeps* shells (Franco et al. 2007). Segura and Shimada (2014) infer that these individuals were local, low-ranking elites that had adopted Middle Sicán ideology.

Most of the Sicán-affiliated burials at Cao Viejo include a single individual interred in a simple pit and accompanied by camelid remains (particularly the head and/or legs), woven clothing, blankets, and bags, Moche-style ceramics and locally-made copies of Sicán blackware bottles, copper sheets, textile tools, and pieces of chalk (Franco et al. 2007). Interestingly, there does not seem to have been any spatial differentiation between inferred elite and commoner burials at Cao Viejo, with individuals of different status designations, adults, and children being interred in close proximity to one another (Franco et al. 2007; Mujica et al. 2007).

The Ychsma archaeological culture is characterized by distinct ceramic, architectural, and burial styles distributed throughout the Lurín and Rimac valleys of Peru's central coast, particularly during the Late Intermediate Period (900 – 1470 CE), which as mentioned previously marks the period between the end of Wari influence ("Middle Horizon") and the rise of the Inca state ("Late Horizon;" Marsteller 2015; Uhle and Shimada 1991). Ychsma architecture includes ramped pyramids (discussed further below) and monumental platforms with adjacent patios (Eeckhout 2004a). Ychsma-style ceramics were produced using relatively simple technology, a limited range of colors (cream, black, white and red pastes), with simple stamped, incised, or appliqued decorations (Vallejo 2004). Although examples of Ychsma iconography are rare, common images found on ceramics vessels and figures, textiles, and wooden implements include geometric designs and stylized images of fish, mammals (e.g. camelid, dog or fox, monkeys, felines), snakes, plants such as maize, and anthropomorphic characters, often with prominent and hooked noses (Marsteller 2015; Vallejo 2004). There is no evidence that Ychsma communities utilized molds in ceramic production until the Inca intrusion into the central coast, and vessels demonstrate a high degree of variability with regards to morphological characteristics (i.e. specific dimensions of shape and size) and production strategies (i.e. the type of clay used, cleaning and firing techniques), likely reflecting the artistic preferences of the makers (Vallejo 2004).

In Spanish historical documents, Ychsma society is described as an ethnic lordship (*señorío*) consisting of *parcialidades* grouped into several chiefdoms (*curacazgos*) in the Lurín and Rimac Valleys, who were aligned to a common religious leader in residence at Pachacamac, the "creator god" in Quechua (an indigenous language in Peru) and progenitor of the world, humans, and agriculture associated with the night and earthquakes (Marsteller 2015; Shimada 1991). Pachacamac was the site of a legendary oracle believed to have been made some time during the Middle Horizon, perhaps ca. 800 – 900 CE, and a major focus of religious/ritual activities (Shimada 1991). The oracle is a seven-foot tall carved wooden staff depicting two human figures back-to-back and adorned with images of maize and possibly yucca, as well as animal and arc designs. Shimada (1991) and Eeckhout (2008a) have argued these bear resemblance to "moon animal" and "sky serpent" motifs common on the north coast during the Middle Horizon. The idol was found with remnants of a door covered by cloth bearing aquatic motifs (e.g. *spondylus* and *strombus* shell, marine creatures) outside of the "Painted Temple," which is located in the center of Pachacamac's main religious/ritual and burial sector (the "Sacred Precinct;" Eeckhout 2013; Shimada 1991). Several competing interpretations of the idol have been developed based on historically-documented folklore, including the idea that it symbolized the god Pachacamac (and perhaps also his brother, Vichama, the god of the day) and his supernatural power, or that it reflected mythical and natural explanations for the origins of the cosmos (Shimada 1991). Regardless of the specific meaning behind the oracle, it has a largely "agrarian" theme (Shimada 1991).

During the Late Intermediate Period following the intrusion of Wari and Sicán religious and stylistic influences on the central coast, monumental architecture proliferated at the site of Pachacamac and surrounding areas, offering clues about the organization of Ychsma society. Most of these structures share a common set of features (ex. rectangular platform mounds each with a short, central access ramp, and a front patio surrounded by a wall with access from the outside) and are known as "Pyramids-with-Ramps", or PCRs (Eeckhout 1999; Eeckhout 2004a; Eeckhout 2004b; Eeckhout 2008b; Eeckhout 2013). Eeckhout's extensive excavation of the largest PCR in Pachacamac (PCR III) indicated the platform had restricted access and, although food remains were less numerous than in the plaza, the high proportion of charred camelid and deer remains suggests pyramid occupants had preferential access to high quality foods (Eeckhout 2004a; Eeckhout 2004b; Eeckhout 2008b; Eeckhout 2013). The enclosures surrounding the platform contained benches, niches, and possible windows, but yielded little traces of activity save for the deposition of elaborate burials, perhaps of high status individuals (Eeckhout 2004b). In contrast, the plaza was the site of extensive occupation and activity, yielding numerous hearths, food remains, and tools associated with weaving and cooking (Eeckhout 1999).

The occupation of PCR III lasted for about 30 to 40 years, and it was abandoned shortly after the deposition of an inferred elite burial (Eeckhout 1999). Based on this information, Eeckhout (1999) interprets PCRs as the homes of elite individuals who held periodic ceremonies for their subjects in the plazas. The abandonment of one PCR and subsequent construction and occupation of another is seen to reflect the transfer of power from one lord to their successor (Eeckhout 2004b). This interpretation of Ychsma contexts accords well with the *parcialidad* model outlined previously and discussed in more detail below. To summarize, Eeckhout and others have argued that Ychsma chiefdoms were organized into different land-owning kin groups (i.e. *parcialidades*) sharing labor, resource, and ritual obligations (Díaz and Vallejo 2005; Díaz 2004; Eeckhout 1999; Eeckhout 2004a; Eeckhout 2004b; Eeckhout 2008b). Tribute (i.e. agricultural products, herd animals, raw materials) was sent from the *parcialidades* in the provinces to Pachacamac, where it was exchanged and stored by elites to maintain their wealth and fuel public ritual events (Eeckhout 1999).

While archaeological data seem largely consistent with the characterization of Ychsma society as a confederation of ranked chiefdoms comparable to the *parcialidades* described in historical documents, associated burial assemblages have yet to reflect the standard "hallmarks" commonly used to identify and distinguish between different status groups (Díaz and Vallejo 2005; Díaz 2015; Marsteller 2015; Owens and Eeckhout 2015; Shimada et al. 2010). For example, although early historical accounts identify silversmithing as an important craft on the central coast, archaeological evidence of this practice remain elusive, likely due in part to extensive looting and destruction of sites in this region (Díaz and Vallejo 2005; Díaz 2015; Owens and Eeckhout 2015). Therefore, access to metals, a useful indicator of social status in Sicán society, has limited applicability in Ychsma contexts. Current knowledge regarding Ychsma mortuary practices suggests symbols of status were likely expressed through different (often less durable) means such as textiles, wood implements, dedicatory offerings, or even the extent of mortuary care and maintenance (Díaz and Vallejo 2005; Eeckhout and Owens 2008; Owens and Eeckhout 2015; Shimada et al. 2007b; Shimada et al. 2010).

Ychsma funerary practices have been characterized based on cemetery assemblages from the sites of Armatambo and Rinconada Alta in the Rimac valley, as well as Pachacamac in the Lurin valley (Díaz and Vallejo 2005; Owens and Eeckhout 2015; Shimada et al. 2010; Takigami et al. 2014). Individuals were positioned in a seated, flexed position, bundled in layers of woven cotton and/or braided reeds with the addition of padding and/or filling made of plant materials to provide shape and support, particularly around the head (Díaz and Vallejo 2005). These bundles were often grouped into simple pits and accompanied by food offerings, ceramics, and craft tools, either arranged around the exterior of the bundle or tucked inside the various layers (Díaz and Vallejo 2005; Takigami et al. 2014). While most of the bundle wrappings were relatively simple and plain, textile layers closer to the body tended to be more colorful and elaborately designed (Díaz and Vallejo 2005). Women were often dressed in tunics while men wore *unkus*

Figure 5 – Example of a non-elite burial at the Sicán Precinct; drawing by Izumi Shimada and César Samillán

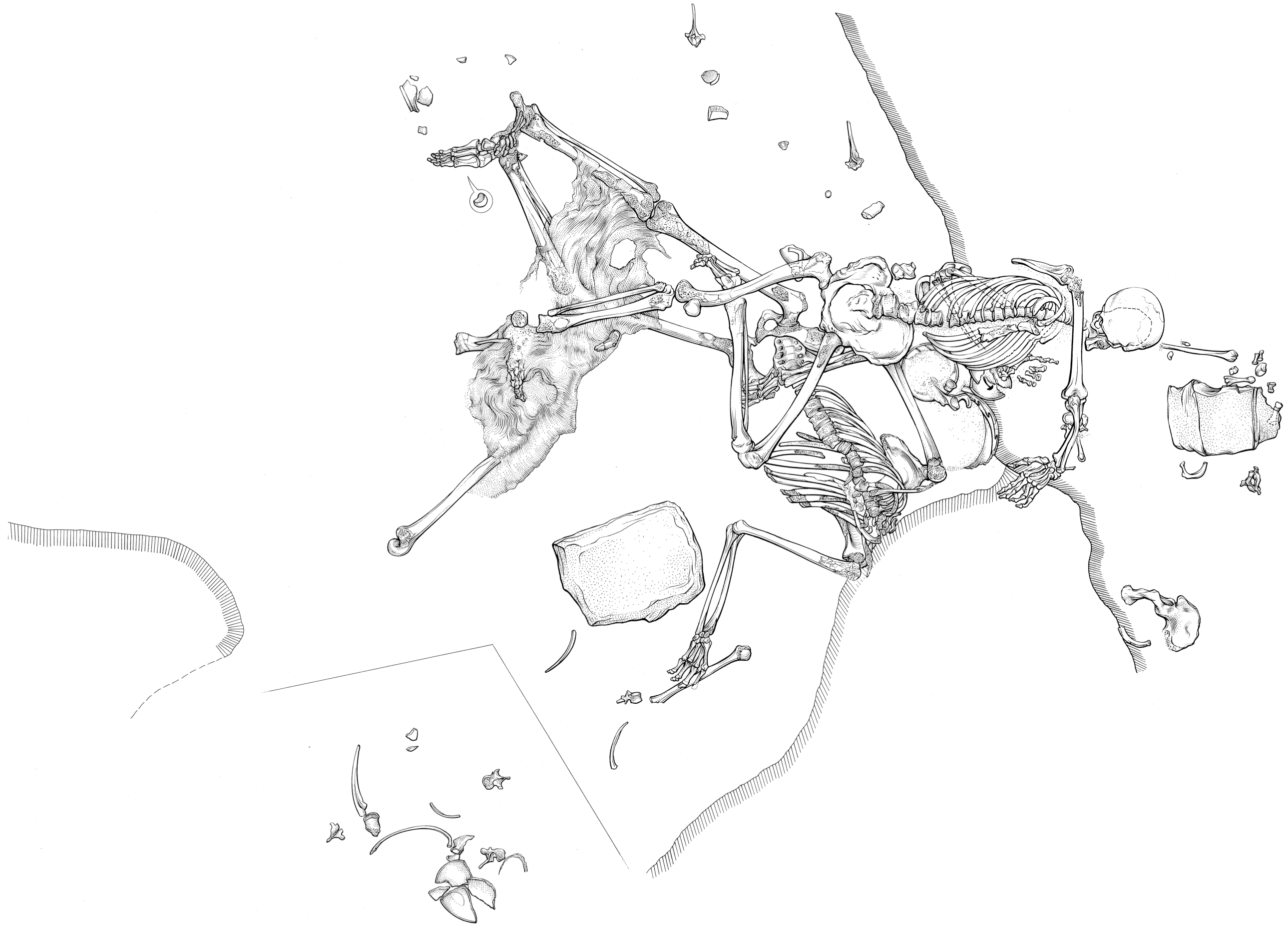

Figure 6 - Example of a possible sacrificial burial at the Sicán Precinct; drawing by Izumi Shimada and César Samillán

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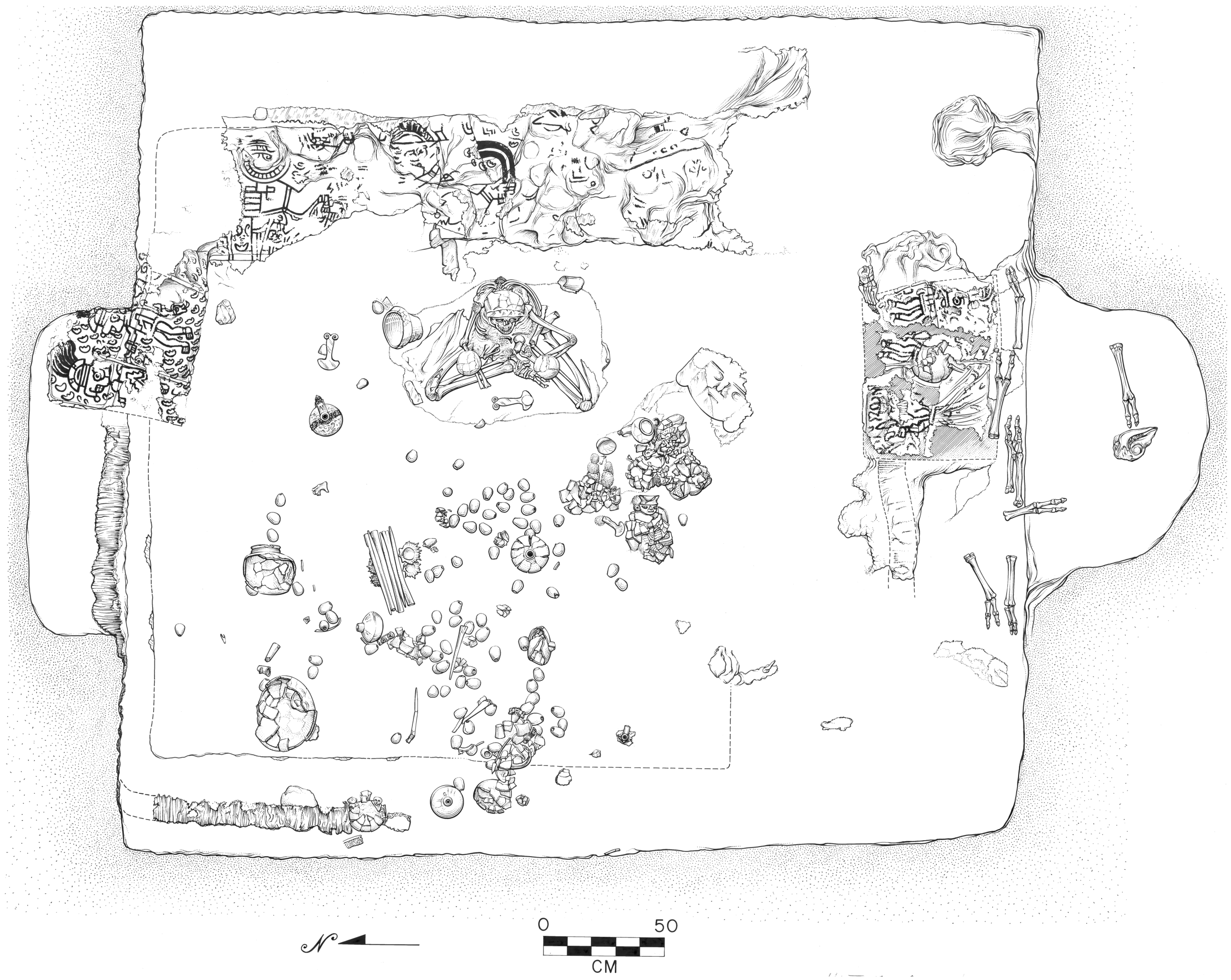

Figure 7 – Example of an elite burial at the Sicán Precinct; drawing by Izumi Shimada and César Samillán

(ponchos) and loincloths. Bodies and clothing were sometimes stained with a red pigment, perhaps cinnabar, and adorned with simple shell or metal necklaces (Díaz and Vallejo 2005).

Díaz and Vallejo (2005) have recognized two main types of Ychsma funerary bundles including a "simple" type that took on the shape of the wrapped body, and those that were reinforced laterally with supportive cane or wooden frames, sometimes with the addition of decorated "false heads" (Shimada et al. 2007b; Shimada et al. 2010; Takigami et al. 2014). Presumably, the frames and false heads served to give the bundle the appearance of an upright, seated person and to provide structural support when being moved or transported (Shimada et al. 2010). While Díaz and Vallejo (2005) have suggested funerary bundles with supportive frames may have been reserved for people of high rank or elite status, the possibility that these features are a marker of age or the result of temporal change cannot be eliminated (Owens and Eeckhout 2015). For example, in comparing the Ychsma burial assemblages at Armatambo and Rinconata Alta, Marsteller (2015) found more cane-reinforced bundles and higher frequencies of ceramic vessels and other grave goods in the former. However, because grave goods (including "prestige" items such as metal objects and *spondylus* shells) become more numerous and funerary bundles become more elaborate over time at both sites, caution is required when using these characteristics as a basis for status inferences (Díaz and Vallejo 2005; Marsteller 2015).

Previous studies of the Ychsma funerary bundles included in my sample offer important models for how estimates of the time, effort, and energy expended to prepare and maintain funerary bundles – "tomb biographies", so to speak – may be helpful for identifying individuals with special social significance (Shimada et al. 2010; Takigami et al. 2014). For example, Takigami et al. (2014) found that the most elaborate of the 34 funerary bundles recovered

(Bundle B; described in more detail in Chapter 6) from an adobe brick and stone-lined pit, also maintained a central position within the tomb despite evidence that bundles were added, removed, and rearranged on at least three occasions over the roughly five hundred years it was in use. This, combined with the tomb's location just outside the Painted Temple in Pachacamac's Sacred Precinct and its intrusion upon burials associated with an earlier, non-Ychsma occupation, suggest competition for space was high in this area (Shimada et al. 2010). Shimada et al (2010) and Takigami et al (2014) use this in addition to the elaborate design of Bundle B to argue the individual was afforded a significant amount of social prestige, at least in death.

Labor Organization in Middle Sicán and Ychsma Societies

Models of pre-Hispanic labor organization on Peru's north and central coasts rely heavily on the *parcialidad* system described in early Spanish chronicles and colonial records. *Parcialidades* were territorially-bounded, lineage-based socio-economic groups headed by a lord or *principal* and ordered into a nested hierarchy under a central political and/or religious authority (Netherly 1977). These *parcialidades* provided the labor and/or goods necessary to sustain infrastructure and elite ideologies in exchange for access to corporately-held resources, particularly land and water (Netherly 1984). *Principales* were responsible for coordinating and supervising labor activities within their respective territories and serving as intermediaries between their subjects and higher-level leaders (Netherly 1977). They also filled an important role in religious life, and subjects' allegiance to their *principal* was contingent upon his ability to sustain communal well-being, not only during life but also in death as a venerated ancestor (Netherly 1977; Ramírez-Horton 1981).

According to Netherly (1984), the territory of each *parcialidad* was defined by irrigation canals, and placement within the network (i.e. whether located along primary, secondary, or tertiary canals) as well as access to other corporately-held resources, corresponded to the rank or status of the group. *Parcialidades* were hierarchically ordered according to the size of their labor force, as well as the kinds of goods and services they provided (Netherly 1977; Ramírez-Horton 1981). While most *parcialidades* were composed of farmers, other specialized groups identified in historical records included fisherfolk, potters, leather-workers, brick-layers, salt-makers, metalsmiths, chicha-makers (a fermented corn drink), carpenters, shoemakers, and traders (Netherly 1977; Rostworowski 1975). Rostworowski (1975) and Netherly (1977) have argued that *parcialidades* on the central and northern coasts were extremely specialized – so much so that they relied heavily upon exchange to fulfill basic needs. They conclude that the bulk of tasks completed to fulfill labor obligations to the regional polity, such as extracting and transporting resources to administrative centers, provisioning non-producing elites, or building and maintaining agricultural and administrative infrastructure, fell to those engaged in seasonal occupations such as farming and fishing (Netherly 1977; 1984; Rostworowski 1975). Artisan groups, and in some cases fishers, were thought to have worked on a more full-time basis, exchanging their goods in lieu of their labor to fulfill tax obligations and meet basic subsistence requirements. This interpretation is based on legal records of fishermen, artisans (e.g. potters, leather-workers, metalsmiths), and traders or merchants asking for exemption from Spanish-imposed labor tax (*mita*) on the grounds that they did not own land or know how to farm.

The argument for full-time specialization is particularly strong for those involved in the production of regalia for elite consumers, such as potters, metalsmiths, and weavers, as well as the merchants or traders that acquired the necessary materials (Netherly 1977; Ramírez 2007;

2008; Ramírez-Horton 1981). These individuals appear to have not only been exempt from "menial" labor, but likely enjoyed some social privilege as a result of their close association with the top rungs of the social hierarchy (Netherly 1977; Ramírez 2007). Although Spanish records are somewhat ambiguous with regards to the social status of artisans and other specialists, the Inka practice of co-opting and re-settling skilled potters and metal smiths from occupied coastal areas suggests they were highly-valued members of their local communities (Netherly 1977; Ramírez 2007).

Parcialidad membership, at least during historical times, appears to have been not only a marker of occupational identity and a source of social prestige for some, but also of ethnic identity. *Parcialidades* were often described as distinct with regards to their style of dress, how and where they practiced religion, and even the dialects they spoke (Netherly 1977; Ramírez-Horton 1981; Rostworowski 1975). For example, ethnic differences between fisherfolk and the larger agrarian population are suggested by historical reference to '*la lengua pescadora,*' a distinct dialect thought to have been shared by fishing communities all along the Peruvian coast (Netherly 1977).

Ramírez (2007; 2008) has been more critical in her reading of historical documents, arguing that *parcialidades* may not have been as specialized or as territorially-bounded as conventionally assumed. She notes that historical records provide some indications that families often moved around to take advantage of both terrestrial and marine resources as weather and circumstance dictated, dividing their time between farming and/or fishing, craft production, and labor tax obligations. Marsteller (2015) and Marsteller et. al's (2017) bioarchaeological study of dietary practices at the Ychsma sites of Armatambo and Rinconata Alta (Rímac valley, Peruvian central coast), assumed to be fishing and farming *parcialidades* (respectively) based on their locations, also bring the extent of specialization into question. Using stable isotope analyses of human remains excavated from the sites, Marsteller and colleagues' findings were largely consistent with the notion of specialized *parcialidades* in that the Armatambo individuals consumed more marine or higher-quality marine foods than those at Rincondad Alta, who in turn relied more heavily on terrestrial products (Marsteller 2015; Marsteller et al. 2017). Nevertheless, they notes some deviations from this general pattern to suggest a more complex situation was at play than offered by the above mentioned model (Marsteller 2015; Marsteller et al. 2017). Several "outliers" were identified, with some individuals at Armatambo consuming more terrestrial foods relative to the average for the site, and some at Rinconata Alta consuming more marine resources than expected (Marsteller 2015; Marsteller et al. 2017). Based on their data, Marsteller and colleagues conclude that there was either more internal specialization within each *parcialidad* than traditionally assumed, or alternatively that there was a greater degree of fluidity between groups (Marsteller 2015; Marsteller et al. 2017).

Previous studies on Peru's north and central coasts suggest *parcialidades* or comparable socio-economic systems dominated from at least the Middle Horizon (Cornejo 2000; Eeckhout 1999; 2008b; 2013; Klaus et al. 2017; Rengifo and Castillo 2015; Shimada 1994; 2001; Uceda and Rengifo 2006). Eeckhout's (1999; 2004b; 2008b; 2013) interpretation of the Ychsma "Pyramids-with-Ramps" using this model was discussed in the previous section. Unfortunately, little in the way of direct evidence regarding labor organization, such as workshops and other production contexts, is available for Ychsma society. This is not the case for Middle Sicán, and here I outline current models of labor derived from experimental studies and production site excavations in areas surrounding the Sicán Precinct.

Shimada and colleagues have described a "modular" approach for Middle Sicán construction, ceramic production, and metallurgy (Shimada and Craig 2013; Shimada and Wagner 2007). The modular approach is described as:

> "Relatively small-scale production units sharing basic technology and achieving equivalent or similar outputs with a great deal of technical, artistic, and perhaps even political autonomy" (Shimada and Craig 2013:25,27).

All Precinct monuments were built using a chamber-fill technique that required a large-scale, unified construction effort (Cavallaro and Shimada 1988; Shimada 2000). Variations in the brick type, size, shape, and markings, as well as their distribution in Precinct structures suggest distinct groups were responsible for their production, transport, and ultimate use (Cavallaro and Shimada 1988). Almost all bricks were marked with a distinct design (e.g. lines, dots, hand and foot prints), and even bricks marked with the same or similar designs varied in terms of the materials used to make them, size, and shape (Bezúr 2003; Cavallaro and Shimada 1988). Furthermore, instead of entire segments of structures being built with similar bricks, they were distributed throughout the structures in a seemingly random pattern (Cavallaro and Shimada 1988). Cavallaro and Shimada (1988) and Shimada (2000) use these data to postulate that bricks were commissioned from various sources by groups or individuals who would then contribute them to elite administrators at the Precinct for construction projects, perhaps as a way to gain privileged access to the structures upon completion, or to assert social prestige.

Strategies used to construct monumental architecture provide strong evidence that labor was managed by the Middle Sicán elite lineages and involved significant task specialization, and Cleland and Shimada's (1998) identification of three distinct spheres of craft production provide a useful perspective on how tasks were divided among different social groups. According to Cleland and Shimada's (1998) research, sumptuary items (ex. fine ceramic and gold-alloy objects decorated with rare and/or imported materials and imagery of the Sicán Lord and Deity) appear to have been produced under the direct supervision of highly-specialized artisans and their apprentices in workshops directly associated with elite compounds. In contrast, more widely distributed crafts (i.e. copper alloy objects and mold-made ceramics) were produced in nucleated – but relatively autonomous – workshops, with laborers participating in all phases of production and sharing resources with relatively little over-sight by higher authorities (Cavallaro and Shimada 1988; Goldstein and Shimada 2007; Shimada 2000; Shimada and Craig 2013). Finally, production of paddle-and-anvil or *palateada* utilitarian ceramics appears to have been organized at the household level and performed in domestic workshops on a seasonal or part-time basis (Cleland and Shimada, 1998).

Excavations at Huaca Sialupe, a ceramic and metalworking complex just 22 km. from the Sicán Precinct associated with residential and burial contexts, offers the most striking evidence that labor was specialized and likely divided along status and/or ethnic lines (Goldstein and Shimada 2010; 2007; Klaus 2003; Klaus et al. 2017; Shimada and Craig 2013). The workshop produced both "high-status" and more broadly distributed goods, including mold-made ceramics (elite blackware bottles and utilitarian redware bowls), as well as thin copper-arsenic and gold alloy sheets, tools, and ornaments. Similar to the adobe bricks used to make Precinct structures, ceramic molds found in workshop rooms had "makers marks" (Shimada and Wagner 2007). Different markings were found on molds of nearly identical form and paste, and molds with the same or similar marking were in some cases clustered by room (Shimada and Wagner 2007). Based on this evidence, Shimada and Wagner (2007) suggest at least two distinct groups of artisans were working in close proximity to produce the same kinds of goods. Goldstein and Shimada's (2007) analysis of fuel remains from kilns and furnaces indicate that ceramic and metal-working were conducted at the workshop in a complimentary fashion, with charcoal produced during ceramic firing being re-utilized for smelting purposes. Technological and stylistic details recall earlier Moche traditions and were highly variable, although the resulting goods were uniform with respect to product type and the raw materials used (Shimada and Wagner 2007). This suggests artisans at Huaca Sialupe maintained a significant degree of autonomy, and perhaps a distinct social identity (Shimada 2014; Shimada and Craig 2013; Shimada and Wagner 2007).

Refuse from domestic hearths at Huaca Sialupe and proximity to residential and burial grounds suggest the workshop was in use year-round (Goldstein and Shimada 2010). Food remains included terrestrial products (e.g. agricultural crops, llama, dog) supplemented by marine resources (e.g. fish and mollusk), and remnants of a canal system indicate those living in the area engaged in both farming and crafting activities (Goldstein and Shimada 2010). The burial ground included a combination of 15 adults and children of both sexes, and largely reflect local, Moche burial traditions (discussed in detail in the previous section of this chapter).

The technological skills required to produce classic Middle Sicán burnished blackware vessels and many of the metal objects found in elite tombs suggest the presence of highly-skilled artisans (Bezúr 2003; Shimada 2015). Middle Sicán metallurgy was rather labor-intensive, and the sustained high temperatures and drafts required for smelting – all achieved without the use of bellows – would have required substantial manpower (Shimada and Craig 2013). Based on excavations at the Cerro Blanco mine and associated smelting sites used during Middle Sicán times, ore was largely extracted by hand from deposits at or near the surface using simple stone tools (Shimada and Craig 2013). Although physically-taxing, mining and initial processing of mineral deposits would have required minimal skills and is thought to have been accomplished by common laborers or apprentices (Bezúr 2003; Shimada and Craig 2013). Producing the characteristic Middle Sicán thin, uniform metal sheets and working them into intricate ornaments such as the elaborate headdresses and masks found in elite tombs at the Precinct, on the other hand, surely involved a great deal of specialized skill (Shimada and Griffin 2005). There is some evidence to support the idea that highly-skilled artisans involved in the production of elite goods may have been afforded some social prestige, either because they were drawn from the elite class or as a result of their technological and/or artistic abilities. For example, while most individuals buried in association with Middle Sicán production sites are interred in a manner consistent with inferred commoner status and a Mochica ethnic identity, a few burials at the Huaca Sialupe and Batán Grande workshops possess features found among inferred Middle Sicán elites, both within the Precinct and at sites outside the "core", including El Brujo (Franco et al. 2007; Klaus 2003; Klaus et al. 2017; Segura and Shimada 2014).

Given the aesthetic mastery and scale of Middle Sicán craft production, full-time artisans would be expected, and therefore the burden of raw material extraction, transport, and food production may not have been shared evenly. While evidence of llama husbandry (Cavallaro and Shimada 1988) suggest Sicán people were perhaps exempt from physically-demanding transportation tasks, non-elite fishers and farmers whose participation in craft production may have been intermittent were potentially incorporated under the elite lineages and perhaps largely responsible for construction activities and resource extraction, in addition to subsistence activities.

Klaus et al. (2009) and Klaus and Chang (2011) found increased prevalence of degenerative joint disease in burial samples from the north coast during the colonial era (ca. 1532 – 1600 CE) thought to reflect intensified labor demands under Spanish rule, but we still know very little about how the social division of labor outlined above contributed, if at all, to previously identified health inequalities between status groups during the Middle Sicán era. We know even less about the division of labor and degree of social hierarchy present in Ychsma society, and this study provides insights that will help to address these issues.

CHAPTER 4

METHODS AND MATERIALS

My primary research question is whether non-elite members of Middle Sicán and Ychsma society were over-burdened with manual labor tasks relative to elites, as often assumed based on Marxist notions of social class. To address this issue, I focus on human skeletal remains and mortuary characteristics, testing the hypotheses that skeletal trauma, DJD, and ECs will be more frequent and more severe in non-elites. An important first step for these analyses is the ability to identify status groups based on mortuary treatment, and I begin this chapter with a discussion of the parameters considered to accomplish this. I then discuss each of my hypotheses and the statistical procedures used to test them, and describe the research sample.

Methods for Determining Status

Sufficient archaeological data have been collected to outline the normal range of variation present in Sicán - and Ychsma - affiliated burials so that status-related differences in treatment are discernible. Mortuary information for sampled individuals was gathered from site reports, detailed burial drawings, artifact assemblages, and works published by various members of the Sicán, El Brujo, and Pachacamac Archaeological Projects. Social status designations were made only after osteological analyses were complete to avoid any potential biases that might influence data collection. Shimada's (2010) characterization of Sicán social classes is modified to accommodate the range of variation found within Ychsma burials, and a summary of the criteria used to infer social status is presented in Table 1 and described in more detail in the following sections.

Burial type, feature, and location

Characteristics considered in this section include burial type (i.e. whether multiple or single internment), feature (e.g. built tomb and earthen pit), and location (near monuments, in public plazas, nucleated workshops, or domestic contexts). Elite burials should reflect the greatest energy expenditure in terms of labor and materials, yielding characteristics with a relatively limited range of distribution (Tainter 1978). For Middle Sicán and Ychsma contexts, single or multiple internments (3 or more individuals) in large tombs associated with major monuments that include dedicatory or sacrificial individuals (criteria for identifying these cases is discussed below) fit these requirements and are therefore considered reliable indicators of high social status.

In contrast, non-elite burials should reflect the least amount of energy expenditure and present characteristics that are more widely distributed in Middle Sicán and Ychsma contexts. In terms of burial type, feature, and location, this includes single pit internments located in areas peripheral to major monuments where access was less exclusive (ex. public plazas, nucleated workshops, and domestic contexts), although they could also be present as "dedicatory offerings" or "sacrificial individuals" in elite tombs and/or the columns and walls of major monuments. Dedicatory and sacrificial individuals can be identified based on archaeological evidence of being bound, buried alive, strangled, or deposited in supine position, lack of personal grave associations, and/or osteological evidence of stabbing or decapitation (Klaus and Shimada 2016).

Grave goods

Grave goods with limited range in Middle Sicán and Ychsma contexts that have been associated with elites throughout pre-Hispanic coastal Peru include religious iconography, various types of metal including high karat gold and silver, *tumbaga* (low karat gold-silver-copper alloy), and copper (Díaz and Vallejo 2005; Díaz 2015; Franco et al. 2007; Shimada 2010; Shimada et al. 2010). Other high-status objects include imported materials such as cinnabar pigment, amber, emeralds, feathers, *Spondylus princeps* and *Conus fergusoni* shells, and elaborately decorated textiles (ibid). Copper objects, floral and faunal remains, and craft tools have the widest distribution in Middle Sicán and Ychsma mortuary contexts, and are thus expected in both elite and non-elite burials.

Intentional post-mortem alterations

Sustained contact between the living and the dead and the veneration of ancestors (real or mythical) are well-documented on the north and central coasts during the Late Intermediate Period, and ethnohistorical data point to the close association between those in leadership positions within the *parcialidad* system (discussed in detail in chapter 3) and the supernatural world (Eeckhout 2013; Eeckhout and Owens 2008; Klaus and Shimada 2016; Lopez-Hurtado 2015; Matsumoto 2014; Shimada et al. 2007b; Shimada et al. 2015). Leaders were believed to have literally transformed into powerful ancestors who would periodically be visited, fed, and cared for by the living in exchange for their protection of communal well-being (Netherly 1977). In Middle Sicán and Ychsma contexts, evidence of tomb re-visiting as well as intentional comingling and disarticulation of human remains has been found in burials considered high status based on type, feature, location, and grave good assemblage, supporting an association between these characteristics. The death of an average citizen would likely not be associated with the same kind of social upheaval that can occur with the death of key political and/or religious figures (Metcalf and Huntington 1991), and therefore evidence of grave re-visiting and post mortem alterations is not expected in non-elite mortuary contexts.

Methods for Determining Activity Patterns

To test the assumed relationship between low social status and manually-intensive activities and better understand how life experience varied for different status groups in Middle Sicán and Ychsma societies, several osseous changes were considered including post-cranial skeletal trauma (fractures and Schmorl's nodes), DJD in the shoulder, elbow, wrist, knee, and ankle, and ECs for fibrous and fibrocartilaginous insertions on the humerus, radius and ulna. Information about the specific muscle attachment sites considered in my EC analysis is presented in Table 2. These skeletal markers have been selected because they: 1) are associated with strenuous activities in the clinical and anthropological literature; 2) are commonly observed in archaeological populations; and; 3) can be scored according to clearly defined standards that are either widely used in bioarchaeology (fractures, Schmorl's nodes, and DJD) or in need of further testing (ECs).

Activity assessments include all adult individuals whose skeletons are complete enough to: 1) determine sex using pelvic morphology and/or cranial features (i.e. extent of cranial robusticity) as outlined by standard bioarchaeological methods (Buikstra and Ubelaker 1994); 2) determine age according to standards developed for the cranium (i.e. extent of suture closure), and/or pelvis (the auricular surface and/or pubic symphysis; Buikstra and Ubelaker 1994);

Table 1 - Mortuary characteristics used to infer social status

Mortuary Characteristics		Elite	Non-elite
Burial type, structure, and location	Single or multiple internments in tombs closely associated with major monuments	X	
	Multiple internments in tombs associated with public plazas	X	X
	Sacrificial or dedicatory internment in tombs associated with monuments and/or public plazas		X
	Single pit internments in plazas, nucleated workshops, or domestic contexts		X
Grave goods	Religious iconography	X	
	High karat gold/silver	X	
	Tumbaga (low karat gold-silver-copper alloy)	X	
	Copper alloy	X	X
	Elaborately decorated textiles	X	
	Imported items	X	
	Craft tools	X	X
	Floral/faunal remains	X	X
Intentional Post mortem alterations		X	

3) evaluate several major joints for degenerative changes; 4) create size variables using measurements of the humerus (maximum length, vertical head diameter, and epicondylar breadth); and 5) evaluate both fibrous and fibrocartilaginous attachment sites of the upper limbs (humerus, radius, ulna). Prior to reaching full skeletal maturity, normal variations in muscle attachment morphology encompass characteristics also associated with physical strain (ex. rough surface texture, pitting), and therefore individuals with incomplete fusion of the upper and/or lower extremities were excluded from my sample.

A sexual division of labor is common in both traditional and contemporary societies, and it may therefore be warranted to investigate whether statistical associations between sex (male/female) and participation in strenuous labor activities are present in my sample. While not the focus of this research, a sexual division of labor may influence my ability to discern meaningful differences between status groups, and statistical testing of association between sex and skeletal markers of activity are included in the Results chapter.

Hypothesis 1 - skeletal trauma

Based on the assumption that status groups in Middle Sicán and Ychsma societies differed with regards to engagement in manual labor tasks, I predict that there will be a significant association between inferred social status and evidence of skeletal trauma, with post-cranial fractures and Schmorl's nodes being more prevalent among non-elites in my sample. I also explore whether any differences in fracture prevalence are discernible between males and females. Evidence of cranial fractures and other skeletal trauma often attributed to violent acts such as decapitation or stabbing is not considered here, as it has been discussed elsewhere for the

Middle Sicán sample (Farnum 2002; Klaus and Shimada 2016) and was not observed in the Ychsma group.

Fractures and Schmorl's nodes were scored as either present or absent and the specific bone, side, and location affected were recorded, according to standard bioarchaeological protocol outlined in Buikstra and Ubelaker (1994). Statistical testing of the association between two dichotomous categorical variables, in this case status (elite/non-elite) or sex (male/female) and skeletal trauma (present/absent), is best achieved with the Chi-square procedure, which I performed using the Crosstabs function in SPSS 21. In circumstances where counts were low (i.e. less than five individuals in any category), results for Fisher's exact test were considered in place of Pearson's Chi-square test, as is the standard procedure (Howell 2007). The p-value was set at 0.05; the standard threshold used to reject the null hypothesis of no association between two categorical variables in social science research (Howell 2007). P-values extrapolated using Chi-square and Fisher's exact tests below 0.05 would indicate a statistically significant association between sex or status and skeletal trauma, supporting my hypothesis.

The chi-square statistic determines whether two variables are associated, but does not offer any information about the strength of relationships – which is known as the effect size. Effect size for associations between two dichotomous variables are determined using the phi statistic. Phi values that are 0.5 or greater denote a "strong" effect, while phi values between 0.3 and 0.5 are considered "medium" or "typical" effects, and those below 0.3 reflect a "small" effect (Morgan et al. 2007). Phi values were determined for each chi-square test employed, and are reported in the Results chapter along with statistically significant chi-square tests.

Prevalence rates of skeletal trauma were low in my sample as a whole (discussed further under the "Research Sample" heading), and therefore data for the individual bones affected were

Table 2 - Entheses evaluated by bone and type

Bone	Fibrous entheses		Fibrocartilaginous entheses	
	muscle	location	muscle	location
Humerus	Deltoideus	Deltoid tuberosity		
	Pectoralis major	Lateral lip intertubercular groove		
	Teres major	Medial lip; intertubercular groove		
	Latissimus dorsi	Floor of the intertubercular groove		
Radius	Pronator teres	Medial portion of lateral radial shaft	Biceps brachii	Radial tuberosity
			Brachioradialis	Styloid process
Ulna			Triceps brachii	Olecranon process
			Brachialis	Coronoid process

combined under three broad categories for statistical testing. The upper limb category includes data for the clavicle, humerus, and radius. The torso category includes the ribs and vertebrae, and the tibia is the only lower limb bone for which trauma was observed.

Hypothesis 2 – DJD

If non-elites engaged in physically-demanding tasks on a more regular basis than elites, it is predicted that degenerative joint disease (DJD) will be more prevalent and more severe in this group. I test this hypothesis by searching for statistically significant associations between social status and the presence of DJD in the shoulder, wrist, knee, hip, and ankle joints, as well as the facet joints of the cervical, thoracic, and lumbar spines. Osteophytosis, the development of osteophytes at the margins of vertebral bodies, was omitted from consideration due to its tenuous relationship with physical activity (Jurmain et al. 2013; Weiss and Jurmain 2007).

While Buikstra and Ubelaker's (1994) standards provide ordinal scoring criteria to measure DJD severity, this was based on the premise that all bony traits associated with DJD are equally indicative of the condition, which we now know not to be the case. I therefore also scored DJD as a dichotomous variable (present/absent), which is the most widely adopted approach in bioarchaeological studies (Cheverko and Hubbe 2017; Henderson and Nikita 2016). Because eburnation is the only definitive indicator of DJD but can be difficult to identify in archaeological bone, I opted for a conservative approach that scores DJD as present only when two or more skeletal signatures (i.e. lipping at the margins and porosity on the surface of joint articulations) and/or eburnation were present, as recommended by Cheverko and Hubbe (2017); Rogers and Waldron (1995); Rothschild (1997).

The same statistical procedures used for Hypothesis 1, Pearson's Chi-square, Fisher's exact, and the phi tests were also employed to test for associations between sex or status and DJD, as well as to determine the strength of relationship for statistically significant results. However, because DJD is an age-related process, comparing prevalence rates between status groups and the sexes without first partitioning the samples into age categories can lead to spurious results. Therefore, I partitioned the samples into two age groups: 1) under 30 years; and 2) 30 years and older, following the recommendations of Cheverko and Hubbe (2017). This accords well with clinical studies that find the effects of age on DJD expression increase significantly following the third decade of life (Cheverko and Hubbe 2017; Felson et al. 2000; Weiss and Jurmain 2007), and will ensure that adequate sample sizes are maintained even after partitioning individuals by age.

<u>Hypothesis 3 - ECs</u>

If the labor activities performed by non-elites were more physically-demanding than those performed by elites, aggregate enthesial (EC) scores should also be significantly higher in the former group, even after accounting for variations related to age and size. This hypothesis is tested using a non-parametric version of ANCOVA, the preferred procedure for determining whether two or more groups – in this case inferred elites and non-elites – differ significantly in a response variable (i.e. aggregated EC scores) while accounting for additional contributing factors ("covariates"; i.e. age and size; Howell 2007). For EC analyses, I did not include sex as a covariate, as previous studies suggest sex-associated influences are largely related to size (Vilotte et al 2010; Weiss 2015), which is considered. Instead, the sample was divided into male and female groups so that ANCOVA could be employed to test for significant differences in aggregate EC scores between the sexes as a separate analysis.

Table 2 shows the muscle sites evaluated in this study by bone and enthesial type, and EC scores for every individual included in this sample are provided in Appendices C – F. ECs were not recorded for the lower limbs because body weight – a measure difficult to estimate and account for with archaeological human remains – is a particularly strong influence on these sites, and previous bioarchaeological studies have had little success in discerning differences in activity patterns using EC data from the lower limbs (Churchill and Morris 1998; Weiss, 2004).

ECs were scored using a four-category ordinal scale where a score of zero indicates no expression, and score of one indicates faint expression, a score of two indicates moderate expression, and a score of three indicates strong expression. Criteria for each category were adapted from the methods outlined by Hawkey (1988), Hawkey and Merbs (1995) for fibrous entheses and Villotte (2006) and Villotte et al. (2010) for fibrocartilaginous entheses. The Coimbra method was not yet finalized or published at the time of data collection, but does not vary significantly from the Villotte (2006) and Villotte et al. (2010) schemes used here. My scoring criteria is as follows: a) 0 = no expression; slightly rounded cortical surface (fibrous), smooth, well-defined imprint with regular margins (fibrocartilaginous), and an absence of surface irregularities (ridges, crests, body outgrowths); b) 1 = faint expression; irregular cortical surface (slight indentations; fibrous), irregular margins (fibrocartilaginous); c) 2= moderate expression; uneven cortical surface with a distinct ridge (fibrous), irregular margins accompanied by surface irregularities (pitting, bony outgrowths) covering less than half of the insertion surface (fibrocartilaginous); and d) 3= strong expression; distinct ridges and crests separated by a slight indentation (fibrous), clearly delineated and irregular margins accompanied by surface pitting or bony outgrowths covering more than half of the insertion surface (fibrocartilaginous). Figure 8 demonstrates “strong” ECs (score of 3) at the fibrous attachment for the deltoideus muscle on the humerus and the fibrocartilaginous attachment for the biceps brachii on the radius, respectively. Note the distinct ridges present for the fibrous insertion, and the irregularity and pitting at the surface of the fibrocartilaginous insertion.

There are two general data treatment approaches used to handle ordinal response data such as EC scores. One approach collapses the ordinal information into a binary category, while the other assigns numerical values to the ordinal scores and treats them as a continuous variable (Agresti 2010). The latter approach will be used for this research, and EC scores will be aggregated by summing ordinal scores for the left and right side, so that each individual is represented by a single value that reflects their overall level of biomechanical stress and strain. This is guided by the premise that the labor activities of status groups differed primarily in terms of physical requirements, and also acknowledges that associations between EC scores and specific activities are extremely tenuous. Treating ordinal EC scores as a continuous variable ensures no data are lost by collapsing categories into a dichotomy and also provides more statistical power (Stiger et al. 1998). The continuous approach is generally preferred when one can reasonably assume a latent continuous variable underlying the ordinal categories (Agresti 2010). This assumption is acceptable in circumstances where: 1) the range of possible responses actually lies on a continuum from one ordinal category to the next; and 2) the ordinal variable could be measured on a continuous scale if sufficient measurement instruments were available (Stiger et al. 1998). ECs conform well to these assumptions. Muscle attachment sites are difficult to measure because they are three-dimensional, and in some cases, it is not possible to pinpoint their borders precisely. Nevertheless, numerical scoring of ECs is not arbitrary in that

Figure 8 - "Strong" fibrous EC on the humerus (left) and “strong” fibrocartilaginous EC on the radius (right)

larger numbers reflect increasing size and complexity, and actual observations – if measured precisely – would vary along a continuum from one category to the next.

For statistical tests involving ECs, age will be scored for each individual using the average of their estimated age range. For example, if based on skeletal aging techniques, an individual is classified between the ages of 35-50 years, their average age would be (35 + 50)/2 = 42.5 years. The size variable was calculated by summing the z-scores of humeral measurements including maximum length, vertical head diameter, and epicondylar breadth, as recommended by Weiss (2003; 2007). Z-scores denote how many standard deviations away from the sample mean a particular observation is, with positive values denoting cases above the mean, negative values denoting cases below the mean, and 0 denoting cases that are at the mean (Howell 2007). In this study, the combined z-scores provide a comparative index of humeral size for each individual included in my sample, and this is crucial for testing the hypothesis that elites and non-elites will vary with regards to aggregate EC score beyond what can be explained by differences in size.

Although the lower limbs (particularly the pelvis and femur) may yield better estimates of overall body size due to their weight-bearing responsibilities, humeral dimensions were chosen here because previous studies have shown them to correlate strongly with upper limb EC scores, and they are the most commonly used proxies for size in EC analyses (Michopoulou et al. 2015; Niinimäki 2011; Weiss 2007; 2015). Additionally, focusing on humeral measurements allowed me to increase sample size and include individuals whose lower limbs were either fragmentary or incomplete.

Cheverko and Hubbe (2017) have recently highlighted ANCOVA's potential value for bioarchaeological studies of age-related skeletal traits like the ones studied here because it provides a way to address the age bias without having to partition the sample into smaller age-specific groups. In datasets like mine, where there are: 1) small sample sizes; 2) non-normally distributed data; 3) unbalanced groups and; 4) unequal variance between groups, non-parametricalternatives outperform standard ANCOVA and are preferred (Rheinheimer and Penfield 2001). Quade's (1966) ranked ANCOVA works particularly well when parametric assumptions are violated, especially if there is a positive relationship between group size and variance (i.e. the largest group should also be the most variable with respect to the covariates; Howell 2007; Rheinheimer and Penfield 2001). As Table 31 in Chapter 5 shows, my sample meets these conditions because the largest group (non-elites) also has the greatest variance with respect to size and aggregate EC scores.

Quade's (1966) ranked ANCOVA follows the same procedures of combining linear regression and ANOVA as parametric ANCOVA, except the ranked variables are used in place of the raw data. For this analysis, average age and size are first ranked and then regressed against ranked aggregate EC scores, ignoring the grouping variable (status). The unstandardized residuals were saved as a new variable, REC. A REC score was calculated for each individual, representing the amount of their aggregate EC score not explained by age and size. This new variable provides a measure of aggregate EC score adjusted for confounding influences. Finally, a one-way ANOVA test was performed using the unstandardized REC residuals as the dependent variable, and the grouping variable (status or sex) as the factor. The resulting F-test determines whether there is a significant difference in aggregate EC scores between inferred elites and commoners, or between males and females, beyond what has been accounted for by variations in age and size. The threshold for rejecting the null hypothesis of no significant difference between groups was set at $p = 0.05$. Effect size measures the strength of the relationship between the variables, and is determined from the Eta test statistic. Standard thresholds used in social science research to determine whether the effect is “small” (eta = 0.14), “medium” (eta = 0.36), or large (eta = 0.51) were employed. (Howell 2007).

<u>Hypothesis 4 - ECs</u>

The final research question to be addressed in this analysis is whether fibrocartilaginous entheses are less prone to systemic influences such as age and size and thus better markers of activity than the fibrous type. Based on previous research done by Villotte (2006), Villotte et al. (2010) and Weiss (2015), I hypothesize that statistical correlations between EC scores, age, and size will be positive and stronger for fibrous entheses than for fibrocartilaginous entheses. This hypothesis is tested using the Spearman’s rho statistic, which is a non-parametric version of the Pearson’s correlation recommended when the data are not normally-distributed, which is the case with my dataset. Because previous studies have found statistically significant and positive correlations between EC scores, size, and age, I employed a one-tailed Spearman’s rho test, as recommended for directional hypotheses (Howell 2007). The value of Spearman’s rho is equivalent to the correlation coefficient (r), which provides an indication of effect size, or the strength of the relationship between the variables. I employed Cohen’s (1988) thresholds to evaluate the effect size, as is standard for the social sciences. A correlation coefficient at or below 0.10 is considered a “small” effect; values from 0.30 to 0.4 are considered “medium” or “typical;” and those 0.5 and over are considered “large” or “larger than typical” (Morgan et al. 2007).

Table 3 - Sample sizes by site, status, and sex

Site			Sex		Total
			Female	Male	
El Brujo	Status	Non-elite	9	13	22
		Elite	1	1	2
	Total		10	14	24
Pachacamac	Status	Non-elite	4	7	11
		Elite	2	3	5
	Total		6	10	16
Sicán Precinct	Status	Non-elite	2	5	7
		Elite	17	3	20
	Total		19	8	27

Table 4 - Descriptive statistics for age by site, status, and sex

Site	Status	Sex	N	Min	Max	Mean	Std. Deviation
El Brujo	Non-elite	Female	9	21.00	55.00	34.3333	10.33501
		Male	13	20.50	50.00	32.3846	8.58330
	Elite	Female	1	35.00	35.00	35.0000	.
		Male	1	30.00	30.00	30.0000	.
Pachacamac	Non-elite	Female	4	19.50	47.00	30.1250	13.28768
		Male	7	27.50	44.50	35.7857	7.56008
	Elite	Female	2	40.00	57.00	48.5000	12.02082
		Male	3	27.00	47.00	35.5000	10.33199
Sicán Precinct	Non-elite	Female	2	17.50	23.50	20.5000	4.24264
		Male	5	22.00	45.00	34.9000	11.72817
	Elite	Female	17	18.50	40.00	23.7353	5.39999
		Male	3	25.00	42.50	32.5000	9.01388

Research Sample

Relationships between social status and physical activity are investigated using burial samples from three pre-Hispanic Peruvian archaeological sites including: 1) the Sicán Precinct in Pomac (La Leche Valley, north coast), Middle Sicán's religious capital; 2) El Brujo in Magdalena de Cao overlooking the mouth of the Chicama River (Chicama Valley, north coast), a religious/ceremonial center established by the local Moche polity and later reutilized as a major burial ground; and 3) the cemetery in front of the Painted Temple at Pachacamac, the major religious and pilgrimage center in pre-Hispanic Peru (Lurín Valley, central coast). Included burials date from the Terminal Middle Horizon to the Late Intermediate Period (c. 900-1400 CE; Shimada et al., 2004, Shimada et al., 2006), and are associated with the Sicán and Provincial Sicán (Sicán Precinct and El Brujo), or Ychsma (Pachacamac) archaeological cultures. The sample includes 67 males and females ranging in age from 19-55+ years. Complete inventories of the individuals comprising the non-elite and elite groups considered here are provided in Appendices A and B and the composition of the sample with regards to site, status, sex, and average age are presented in Tables 3 and 4.

This sample was selected to obtain a sufficient number of elites and non-elites of both sexes, and to reflect the age range at which full integration into the labor system would be most likely (i.e. young adulthood to late adulthood). Although the sample can be considered representative in that individuals from the different status groups, sexes, and ages are included, females under the age of 30 years make up seventy percent of the entire elite group from the Sicán Precinct. This may reflect preferential burial for elite females in the West Tomb of Huaca Loro, where the bulk of my elite sample comes from. Their young age is a bit more difficult to explain, and it is unclear whether this reflects sex-based differences in life expectancy for Middle Sicán elites, selective burial practices at the Precinct, or some other factor.

CHAPTER 5

RESULTS

Social Status

Status inferences for the Sicán sample were drawn from previous research (Farnum 2002; Franco and Gálvez 2014; Franco et al. 2007; Klaus 2003; Shimada et al. 2007a; Shimada et al. 2004) and the primary criteria used were discussed Chapter 4 (refer to Table 1). This portion of the sample includes individuals from the Huaca Loro, Las Ventanas and Lercanlech [also known as Rodillona] Precinct monumental mounds, a sacrificial individual bound to a wooden pole atop the North Platform of Huaca Loro, as well as people from the Huaca Sialupe workshop and associated burial ground. All but the platform sacrifice, two inferred sacrificial burials incorporated into columns at Huaca Lercanlech, and four individuals buried in and around the Huaca Sialupe workshop are inferred elites, with the majority of Sicán "commoners" coming from Cao Viejo at El Brujo. While all of the Cao Viejo individuals in this sample were thought to have been buried alone in simple pits without precious metals or imported items, looting and the superimposed and concentrated burial context may have in some cases led to misidentification using criteria such as grave goods and burial type.

The inclusion of the potential sacrificial burials in the non-elite category also deserves further consideration. Possible sacrificial burials did not contain any of the characteristics associated with inferred elites, but I cannot rule out the possibility that these burials lacked "elite" characteristics due to the circumstances surrounding their death, and not because of their position in the social hierarchy. Nevertheless, available archaeological and osteological data do seem to support the inclusion of potential sacrificial victims in the non-elite group. First of all, there is no evidence to suggest that Middle Sicán elites engaged in the kind of militaristic endeavors that would involve the capture and sacrifice of foreign warriors and/or dignitaries, as has been documented on the north coast during earlier Moche times (Toyne et al. 2014; Sutter and Verano 2007). Additionally, Farnum (2002) argued that in terms of skeletal health, many of the inferred sacrifices at the Sicán Precinct were more similar to non-elites derived from less questionable contexts than they were to elites.

The Ychsma individuals come exclusively from a stone and adobe- walled tomb (Tomb 1-2) in Cemetery 1 right outside the Painted Temple in Pachacamac's Sacred Precinct and just a few meters north of the area known during Inka times as Pilgrim's Plaza (Shimada et al. 2010). Social status was inferred using a combination of previous work (Shimada et al. 2007b; Shimada et al. 2006a; Shimada et al. 2010; Takigami et al. 2014) and my own review of bundle inventories. As mentioned already, the general absence of metals in Ychsma burials (both in and outside of Pachacamac) necessitates a slightly different strategy than that used to infer social status in Middle Sicán contexts, and I outline my approach below.

Based on archaeological excavations in the Pilgrims Plaza, Shimada et al. (2006a); Shimada et al. (2010) argued that during Ychsma occupation, the site was an area of intensive, seasonal ritual activities for common farmers and fisherfolk from littoral and inland regions of the central coast. Food remains found at the site (maíz, beans, potato, yucca, squash, llama, cuy [guinea pig], deer, fish, and seal) were abundant, although signs of processing and consumption were rare. Many of the excavated contexts included large numbers of fly pupae casings, suggesting the food remains served as ritual offerings rather than food for the living (Shimada et al. 2010). In addition to food offerings, there were also weaving and metalworking tools, as well as evidence suggesting funerary bundles were prepared and/or repaired on site. This included sunken enclosures with decaying cloth, bundle filling (unspun cotton), and other plant materials, the small bones of human fingers and toes, as well as weaving tools, scraps of copper sheets, and shells containing cinnabar (Shimada et al. 2007b; Shimada et al. 2010).

Most of the Ychsma funerary bundles considered here consisted of a single, flexed individual (i.e. knees drawn up to the chest) wrapped in several layers of plain cloth and accompanied by food items (e.g. corncobs, cuy, and fish remains), as well as tools for weaving and fishing such as needles, spindles, nets, and floats. This is consistent with Shimada et al. (2006a) and Shimada et al.'s (2010) characterization of the nearby Pilgrim's Plaza as a ritual gathering area for humble fishers and farmers, and similar burial patterns have been documented at the Ychsma sites of Armatambo and Rinconata Alta (Díaz and Vallejo 2005). While bundles of this type make up the majority of the sample, "atypical" patterning with respect to grave goods and funerary processing techniques are apparent in some, perhaps reflecting high rank or status. In fact, there seems to be an association between evidence of intentional commingling, disarticulation, and the presence of grave goods recognized as prestige items throughout pre-Hispanic coastal Peru. Certainly the proximity of Tomb 1-2 to the Painted Temple, a site imbued with great sacred significance, would have made it a highly desirable resting place, an assertion supported by the density of burials and remnants of ritual activities in the area (Shimada et al. 2006a; Shimada et al. 2010; Takigami et al. 2014). In fact, Owens and Eeckhout (2015) noted a direct association between cemetery crowding, tomb disturbance, and proximity to Pachacamac's Sacred Precinct based on their excavations in a portion of Cemetery 1 just outside the walls of this sector.

Tomb 1-2 was close to the surface and easily accessible during the time it was in use, pupae casing were found in and around bundles, and evidence that bundles had been removed, rearranged, and added over time suggests periodic visits by the living (Shimada et al. 2006a; Shimada et al. 2010; Takigami et al. 2014). For example, when comparing placement within the tomb and radiocarbon dates for the bundles, expectations that the oldest bundles would be placed in the innermost portions of the tomb were not met (Takigami et al. 2014). Rather, the patterns suggest that on at least three occasions, existing bundles were re-arranged to accommodate new additions (Takigami et al. 2014). Additional evidence suggesting tomb re-visiting include basins found just below the cemetery surface and in association with the bundles that may have been receptacles for ritual offerings (Shimada et al. 2006a). It should be noted, however, that genetic and isotopic studies indicate individuals in Tomb 1-2 originated from perhaps three distinct regions of central Peru, including both coastal and highland areas (Takigami et al. 2014). It is therefore unlikely they reflect a single group of venerated ancestors.

All but one of the Tomb 1-2 individuals with “prestige” items not widely distributed in Ychsma mortuary contexts, including finely woven and brightly colored textiles, exotic feathers, *Spondylus* shell, and cinnabar, were bundled with remains from other individuals and/or were missing their heads. Neither Díaz (2015) nor Marsteller (2015) noted any evidence of intentional comingling or disarticulation in hundreds of Ychsma funerary bundles from Armatambo and Rinconata Alta, so this is perhaps exceptional. Aside from missing crania, these individuals are remarkably complete, with even the small bones of the hands and feet and some hair, skin, and cartilage still present. In contrast, the duplicate skeletal elements were isolated bones completely devoid of any tissues, typically placed in the innermost bundle layer in direct association with the body. This suggests co-mingling and disarticulation were intentional, and likely occurred during the bundling of relatively "fresh" corpses. Although small sample size limits my ability to draw any conclusions about the expression of status identity in Ychsma funerary contexts more broadly, I do believe that the combination of intentional comingling, disarticulation, and grave good "wealth" observed in some individuals has significance with regards to their social identities, especially given that these practices seem "atypical" compared to patterns described in other Ychsma contexts (e.g. Díaz and Vallejo 2005; Díaz 2015; Marsteller 2015; Owens and Eeckhout 2015) It would not be surprising to find elite individuals in Tomb 1-2, given its close proximity to the Painted Temple, evidence that it was likely re-visited and re-arranged on several occasions, and the density of ritual activity in the area. Based on the criteria outlined above, I identified five "elites" within the Tomb 1 – 2 sample, and they are discussed in more detail below.

Four of the five inferred elites in the Ychsma sample (Bundles H, N, Q, and W) demonstrate evidence of comingling, elaborate funerary processing, and/or disarticulation of the head prior to or after bundling without any associated vertebral cutmarks that would suggest decapitation. In contrast, there was no evidence of intentional comingling and only one case of cranial disarticulation in those inferred as commoners, based on their bundle assemblages. A duplicate right scapula was present in Bundle H, which contained a male aged 21 – 34 years with metal fragments, maíz, reed tubes, a ball of yarn, textile tools (needles and whorls), and shell beads that the excavator identified as *Spondylus.* Bundle N, another male aged 27 – 34 years, was headless and wrapped with an elaborately colored and decorated textile (Figure 9), as well as fishing tools (nets and floats), botanical remains, fish remains, and wooden tablets. Bundle W, a

Figure 9 - Decorated textile associated with inferred elite Ychsma Bundle N

Figure 10 – Inferred elite Ychsma Bundle B; photo by Izumi Shimada. Original source: Takigami et al. 2014. Assessing the chronology and rewrapping of funerary bundles at the prehispanic religious center of Pachacamac, Peru. Latin American Antiquity 25(3): 322-343

female aged 50 – 61 years was also missing her head, an extra sacrum was placed in correct anatomical position on her pelvis, and her pelvic cavity had apparently been filled with unspun cotton. Her grave associations included decorated textiles (camelid and cotton) and metal sheets as well as weaving tools in addition to corncobs and faunal remains. With Bundle Q, a headless female aged 35 - 44 years, there was evidence that one of her decorated bundle wrappings had been cut, possibly to remove her head after initial bundling (Takigami et al. 2014). The cutting of textiles has rarely been documented in pre-Hispanic Andean contexts (Takigami et al. 2014), and may therefore denote special or "unusual" social circumstances. Although Bundle Q lacked a head, her bundle was fastened with a false head, and additional grave goods included metal sheets (perhaps silver), ceramic fragments, and textile tools.

Bundle B (Figure 10), the largest of the group and the most elaborate Ychsma bundle described to date, was the only inferred elite without evidence of intentional comingling or disarticulation. This bundle included a man aged 40 – 49 years, a wooden cinnabar-painted false head, a headdress decorated with feathers likely from an Amazonian macaw, and elaborate textiles (Takigami et al. 2014). He was also dressed in a tunic made of camelid fiber, and strips of cloth were stitched onto the outer layer of his bundle.

Patterns of Physical Activity

Hypothesis 1 - skeletal trauma

There were low frequencies of skeletal trauma in my sample as a whole, and data for the bones of the upper limbs, torso, and lower limbs are reported by status and sex in Tables 5 - 10. Bones for which no evidence of skeletal trauma was present in my sample are excluded from these tables. Figures 10, 11, and 12 offer a visual comparison of skeletal trauma frequencies by body region for the three archaeological sites considered, males and females, and elites and non-elites, respectively. The torso was the most common site of skeletal trauma for all groups considered. Torso trauma included Schmorl's nodes, vertebral compression fractures and rib fractures – lesions that are generally attributed to accidental injury rather than interpersonal violence. Skeletal injuries in the Middle Sicán sample attributed to violence, largely associated with human sacrifice, have been discussed at length elsewhere (Farnum 2002; Klaus and Shimada 2016) and are not considered here.

My data do not support the hypothesis that skeletal trauma was more common in non-elites, and no statistically significant associations were found between inferred status and trauma of the upper limbs, torso, or lower limbs (Tables 11, 12, and 13). No discernible differences in skeletal trauma were found between the sexes, either (Tables 14, 15, and 16). Failure to detect any statistically significant differences between the sexes and status groups is likely due to the low frequencies of skeletal trauma in my sample as a whole.

Hypothesis 2 – DJD

DJD was not prevalent in my sample. Tables 17 through 22 display frequencies of DJD in the joints of the upper limbs, spine, and lower limbs by age group and status, as well as by age group and sex. When DJD was present, it was most common in the spine, particularly in the cervical region (Tables 18 and 21). Graphic comparisons of DJD frequencies by site, sex, and status for each body segment and age group are presented in Figures 14 through 19.

I hypothesized that DJD would be more prevalent in the upper limbs, spine, and lower

Table 5 - Frequencies of upper limb trauma by bone and status

			Clavicle			Humerus			Radius		
			Absent	Present	Total	Absent	Present	Total	Absent	Present	Total
Status	Non-elite	Count	38	2	40	39	1	40	39	1	40
		% within Status	95.0%	5.0%	100.0%	97.5%	2.5%	100.0%	97.5%	2.5%	100.0%
	Elite	Count	26	1	27	26	1	27	26	1	27
		% within Status	96.3%	3.7%	100.0%	96.3%	3.7%	100.0%	96.3%	3.7%	100.0%
Total		Count	64	3	67	65	2	67	65	2	67
		% within Status	95.5%	4.5%	100.0%	97.0%	3.0%	100.0%	97%	3.0%	100.0%

Table 6 - Frequencies of torso trauma by bone and status

		Cervical			Thoracic			Lumbar			Rib		
		Absent	Present	Total	Absent	Present	Total	Absent	Present	Total	Absent	Present	Total
Non-elite	Count	38	2	40	33	7	40	38	2	40	36	4	40
	% within Status	95.0%	5.0%	100.0%	82.5%	17.5%	100.0%	95.0%	5.0%	100.0%	90.0%	10.0%	100.0%
Elite	Count	27	0	27	25	2	27	27	0	27	26	1	27
	% within Status	100.0 %	0.0%	100.0%	92.6%	7.4%	100.0%	100.0%	0.0%	100.0%	96.3%	3.7%	100.0%
Total	Count	65	2	67	58	9	67	65	2	67	62	5	67
	% within Status	97.0%	3.0%	100.0%	86.6%	13.4%	100.0%	97.0%	3.0%	100.0%	92.5%	7.5%	100.0%

Table 7 - Frequencies of lower limb (tibia) trauma by status

			Tibia		
			Absent	Present	Total
Status	Non-elite	Count	39	1	40
		% within Status	97.5%	2.5%	100.0%
	Elite	Count	27	0	27
		% within Status	100.0%	0.0%	100.0%
Total		Count	66	1	67
		% within Status	98.5%	1.5%	100.0%

Table 8 - Frequencies of upper limb trauma by bone and sex

			Clavicle			Humerus			Radius		
			Absent	Present	Total	Absent	Present	Total	Absent	Present	Total
Sex	Female	Count	34	1	35	33	2	35	34	1	35
		% within Sex	97.1%	2.9%	100.0%	94.3%	5.7%	100.0%	97.1%	2.9%	100.0%
	Male	Count	30	2	32	32	0	32	31	1	32
		% within Sex	93.8%	6.3%	100.0%	100.0%	0.0%	100.0%	96.9%	3.1%	100.0%
Total		Count	64	3	67	65	2	67	65	2	67
		% within Sex	95.5%	4.5%	100.0%	97.0%	3.0%	100.0%	97.0%	3.0%	100.0%

Table 9 - Frequencies of torso trauma by bone and sex

		Rib			Cervical			Thoracic			Lumbar		
		Absent	Present	Total	Absent	Present	Total	Absent	Present	Total	Absent	Present	Total
Female	Count	35	0	35	34	1	35	31	4	35	31	4	35
	% within Sex	100.0%	0.0%	100.0%	97.1%	2.9%	100.0%	88.6%	11.4%	100.0%	88.6%	11.4%	100.0%
Male	Count	27	5	32	31	1	32	27	5	32	29	3	32
	% within Sex	84.4%	15.6%	100.0%	96.9%	3.1%	100.0%	84.4%	15.6%	100.0%	90.6%	9.4%	100.0%
Total	Count	62	5	67	65	2	67	58	9	67	60	7	67
	% within Sex	92.5%	7.5%	100.0%	97.0%	3.0%	100.0%	86.6%	13.4%	100.0%	89.6%	10.4%	100.0%

Table 10 - Frequencies of lower limb (tibia) trauma by sex

			Tibia		
			Absent	Present	Total
Sex	Female	Count	34	1	35
		% within Sex	97.1%	2.9%	100.0%
	Male	Count	32	0	32
		% within Sex	100.0%	0.0%	100.0%
Total		Count	66	1	67
		% within Sex	98.5%	1.5%	100.0%

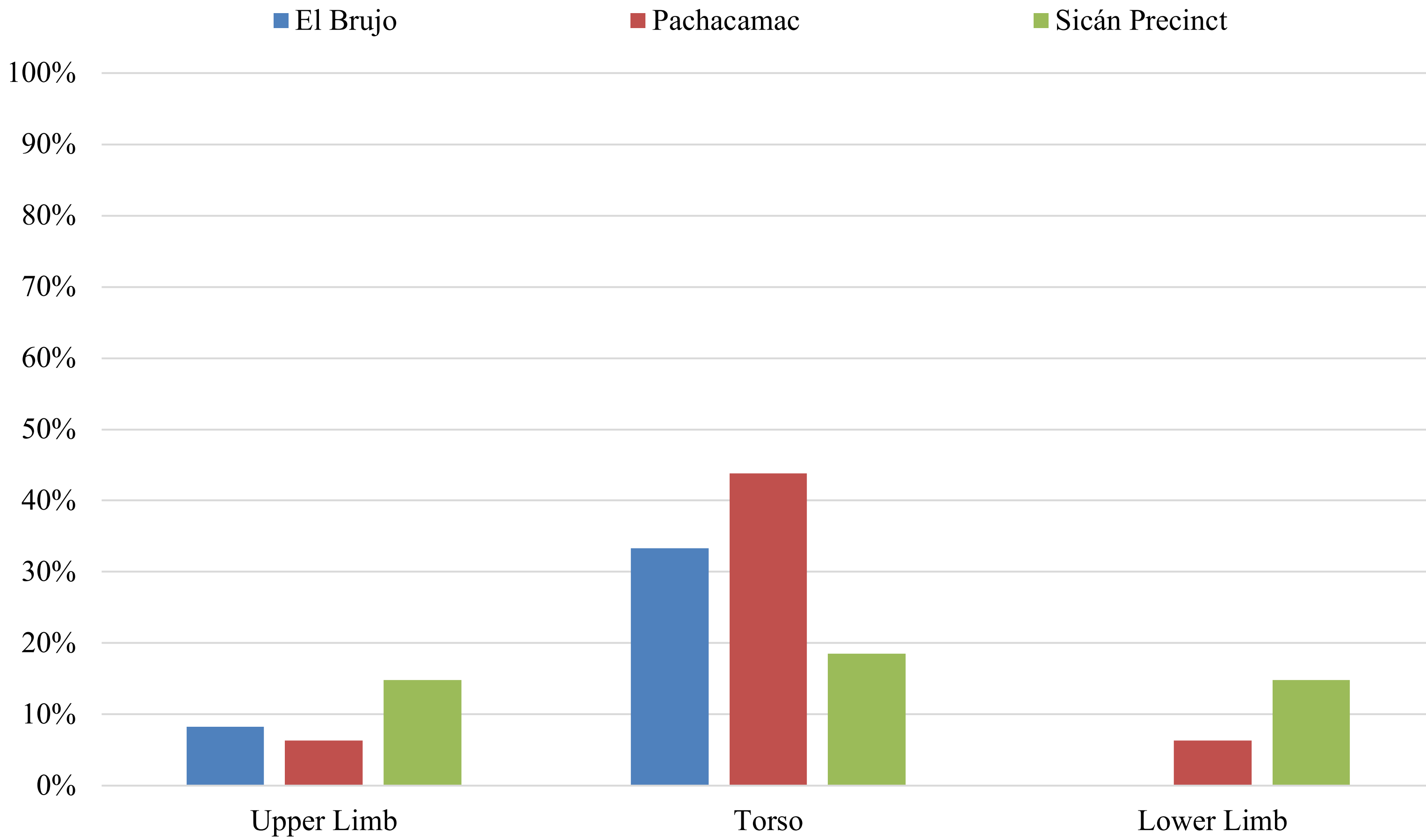

Figure 11 - Graphic comparison of skeletal trauma frequencies by site

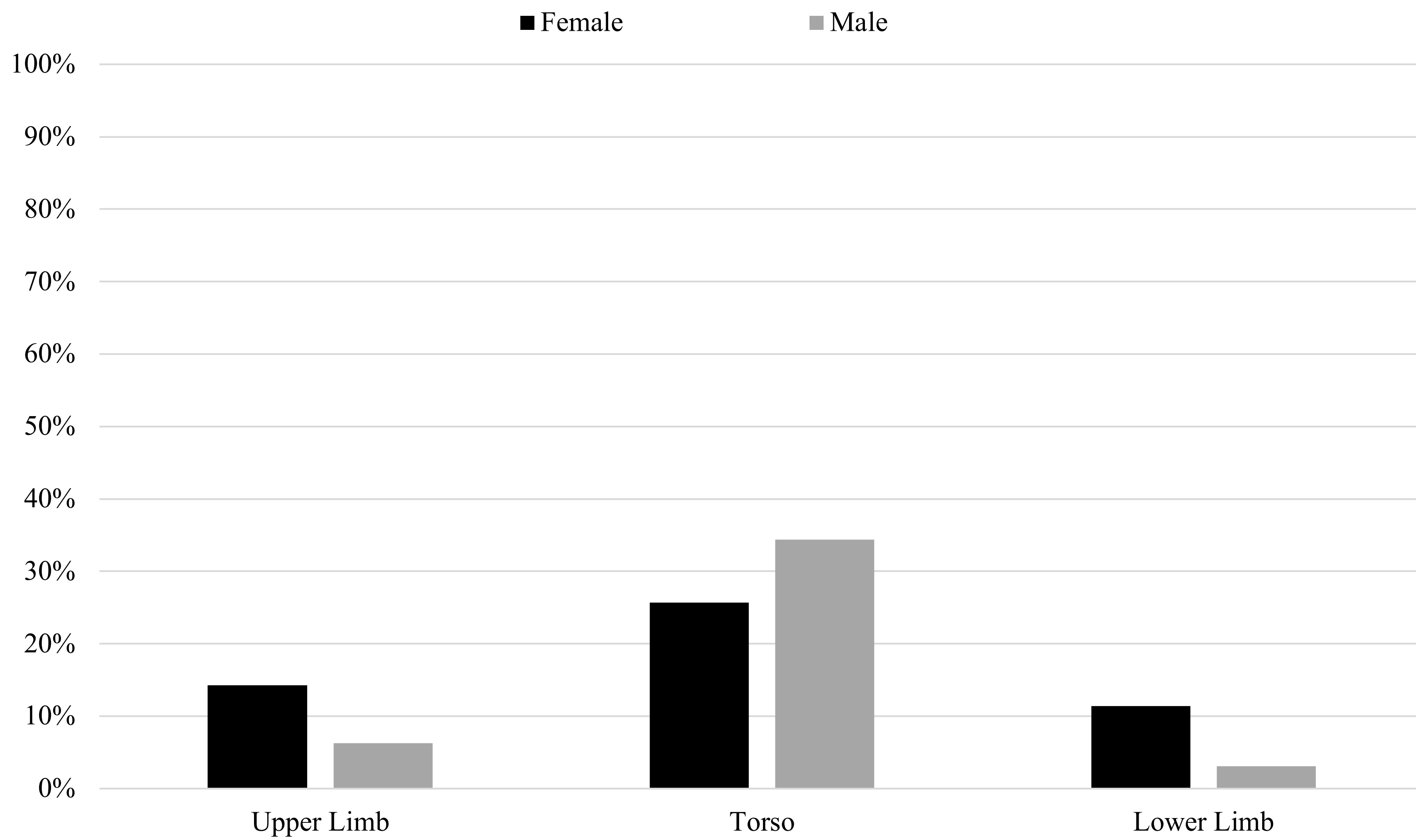

Figure 12 – Graphic comparison of skeletal trauma frequencies by sex

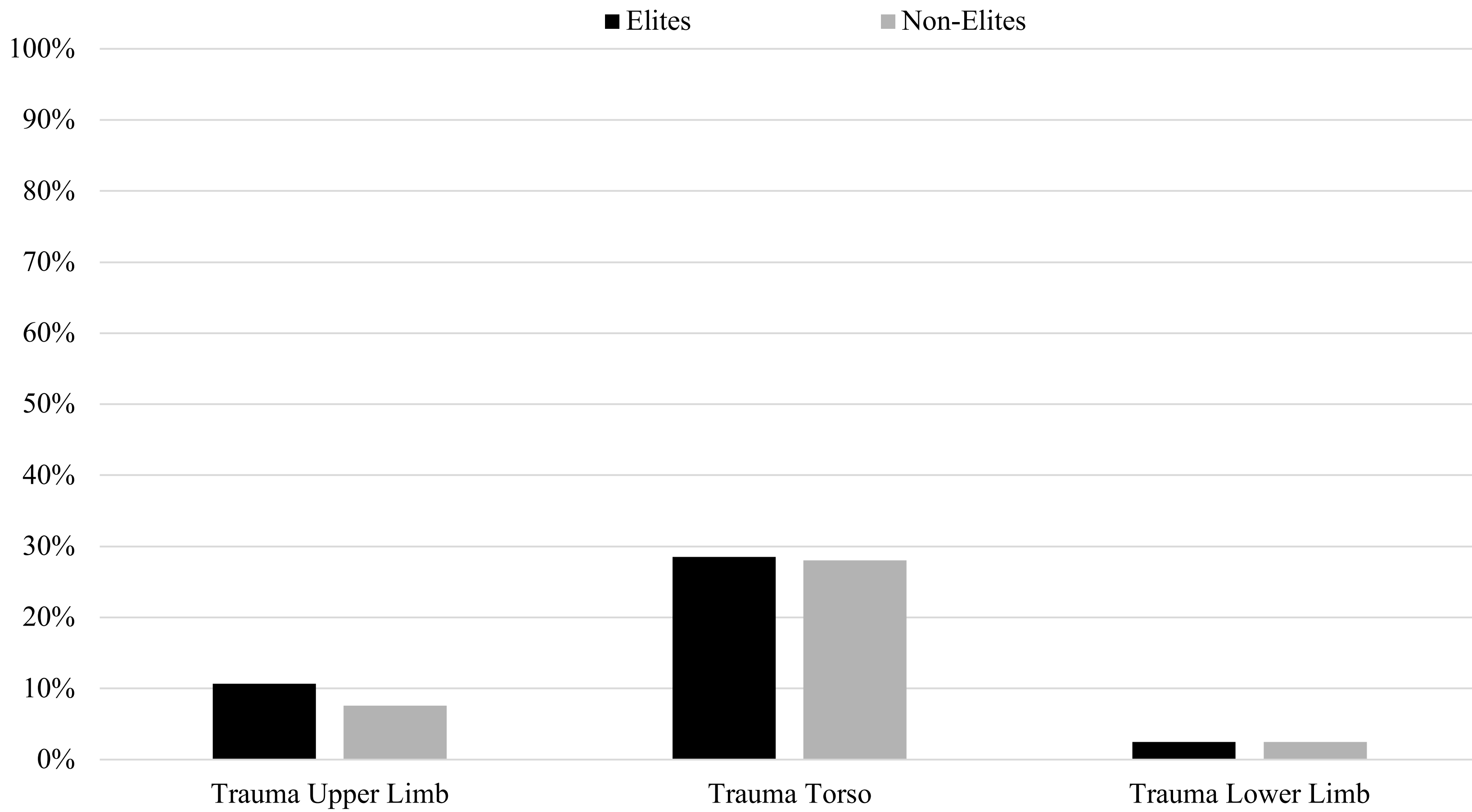

Figure 13 – Graphic comparison of skeletal trauma frequencies by status

Table 11 - Test of association between status and upper limb trauma

	N	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Fisher's Exact Test	67	1.000	.594

Table 12 - Test of association between status and torso trauma

	N	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Fisher's Exact Test	67	.599	.383

Table 13 - Test of association between status and lower limb (tibia) trauma

	N	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Fisher's Exact Test	67	.149	.081

Table 14 - Test of association between sex and upper limb trauma

	N	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Fisher's Exact Test	67	.431	.253

Table 15 - Test of association between sex and torso trauma

	N	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Fisher's Exact Test	67	.594	.306

Table 16 - Test of association between sex and lower limb (tibia) trauma

	N	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Fisher's Exact Test	67	1.000	.522

Table 17 - Frequencies of upper limb DJD by joint, status, and age group

Age Group				Shoulder			Wrist		
				Absent	Present	Total	Absent	Present	Total
< 30 years	Status	Non-elite	Count	15	0	15	15	0	15
			% within Status	100.0%	0.0%	100.0%	100.0%	0.0%	100.0%
		Elite	Count	13	1	14	14	0	14
			% within Status	92.9%	7.1%	100.0%	100.0%	0.0%	100.0%
	Total		Count	28	1	29	29	0	29
			% within Status	96.6%	3.4%	100.0%	100.0%	0.0%	100.0%
30+ years	Status	Non-elite	Count	22	3	25	23	2	25
			% within Status	88.0%	12.0%	100.0%	92.0%	8.0%	100.0%
		Elite	Count	10	3	13	13	0	13
			% within Status	76.9%	23.1%	100.0%	100.0%	0.0%	100.0%
	Total		Count	32	6	38	36	2	38
			% within Status	84.2%	15.8%	100.0%	94.7%	5.3%	100.0%

Table 18 - Frequencies of spinal DJD by vertebral segment, status, and age group

Age Group				Cervical DJD			Thoracic DJD			Lumbar DJD		
				Absent	Present	Total	Absent	Present	Total	Absent	Present	Total
< 30 years	Status	Non-elite	Count	12	3	15	12	3	15	13	2	15
			% within Status	80.0%	20.0%	100.0%	80.0%	20.0%	100.0%	86.2%	13.3%	100.0%
		Elite	Count	10	4	14	12	2	14	14	0	14
			% within Status	71.4%	28.6%	100.0%	85.7%	14.3%	100.0%	100.0%	0.0%	100.0%
	Total		Count	22	7	29	24	5	29	27	2	29
			% within Status	75.9%	24.1%	100.0%	82.8%	17.2%	100.0%	93.1%	6.9%	100.0%
30+ years	Status	Non-elite	Count	20	5	25	17	8	25	19	6	25
			% within Status	80.0%	20.0%	100.0%	68.0%	32/0%	100.0%	76.0%	24.0%	100.0%
		Elite	Count	11	2	13	11	2	13	13	0	13
			% within Status	84.6%	15.4%	100.0%	84.6%	15.4%	100.0%	100.0%	0.0%	100.0%
	Total		Count	31	7	38	28	10	38	32	6	38
			% within Status	81.6%	18.4%	100.0%	73.7%	26.3%	100.0%	84.2%	15.8%	100.0%

Table 19 - Frequencies of lower limb (knee) DJD by status and age group

Age Group				Knee DJD		
				Absent	Present	Total
< 30 years	Status	Non-elite	Count	14	1	15
			% within Status	93.3%	6.7%	100.0%
		elite	Count	14	0	14
			% within Status	100.0%	0.0%	100.0%
	Total		Count	28	1	29
			% within Status	96.6%	3.4%	100.0%
30+ years	Status	Non-elite	Count	22	3	25
			% within Status	88.0%	12.0%	100.0%
		elite	Count	12	1	13
			% within Status	92.3%	7.7%	100.0%
	Total		Count	34	4	38
			% within Status	89.5%	10.5%	100.0%

Table 20 - Frequencies of upper limb DJD by joint, sex, and age group

Age Group				Shoulder DJD			Wrist DJD		
				Absent	Present	Total	Absent	Present	Total
< 30 years	Sex	Female	Count	19	1	20	20	0	20
			% within Sex	95.0%	5.0%	100.0%	100.0%	0.0%	100.0%
		Male	Count	9	0	9	9	0	9
			% within Sex	100.0%	0.0%	100.0%	100.0%	0.0%	100.0%
	Total		Count	28	1	29	29	0	29
			% within Sex	96.6%	3.4%	100.0%	100.0%	0.0%	100.0%
30+ years	Sex	Female	Count	14	1	15	14	1	15
			% within Sex	93.3%	6.7%	100.0%	93.3%	6.7%	100.0%
		Male	Count	18	5	23	22	1	23
			% within Sex	78.3%	21.7%	100.0%	95.7%	4.3%	100.0%
	Total		Count	32	6	38	36	2	38
			% within Sex	84.2%	15.8%	100.0%	94.7%	5.3%	100.0%

Table 21 - Frequencies of spinal DJD by vertebral segment, sex, and age group

Age Group				Cervical DJD			Thoracic DJD			Lumbar DJD		
				Absent	Present	Total	Absent	Present	Total	Absent	Present	Total
< 30 years	Sex	Female	Count	15	5	20	18	2	20	20	0	20
			% within Sex	75.0%	25.0%	100.0%	90.0%	10.0%	100.0%	100.0%	0.0%	100.0%
		Male	Count	7	2	9	6	3	9	7	2	9
			% within Sex	77.8%	22.2%	100.0%	66.7%	33.3%	100.0%	77.8%	22.2%	100.0%
	Total		Count	22	7	29	24	5	29	27	2	29
			% within Sex	75.9%	24.1%	100.0%	82.8%	17.2%	100.0%	93.1%	6.9%	100.0%
30+ years	Sex	Female	Count	13	2	15	11	4	15	14	1	15
			% within Sex	86.7%	13.3%	100.0%	73.3%	26.7%	100.0%	93.3%	6.7%	100.0%
		Male	Count	18	5	23	17	6	23	18	5	23
			% within Sex	78.3%	21.7%	100.0%	73.9%	26.1%	100.0%	78.3%	21.7%	100.0%
	Total		Count	31	7	38	28	10	38	32	6	38
			% within Sex	81.6%	18.4%	100.0%	73.37	26.3%	100.0%	84.2%	15.8%	100.0%

Table 22 - Frequencies of lower limb (knee) DJD by sex and age group

Age Group				Knee		
				Absent	Present	Total
< 30 years	Sex	Female	Count	20	0	20
			% within Sex	100.0%	0.0%	100.0%
		Male	Count	8	1	9
			% within Sex	88.9%	11.1%	100.0%
	Total		Count	28	1	29
			% within Sex	96.6%	3.4%	100.0%
30+ years	Sex	Female	Count	13	2	15
			% within Sex	86.7%	13.3%	100.0%
		Male	Count	21	2	23
			% within Sex	91.3%	8.7%	100.0%
	Total		Count	34	4	38
			% within Sex	89.5%	10.5%	100.0%

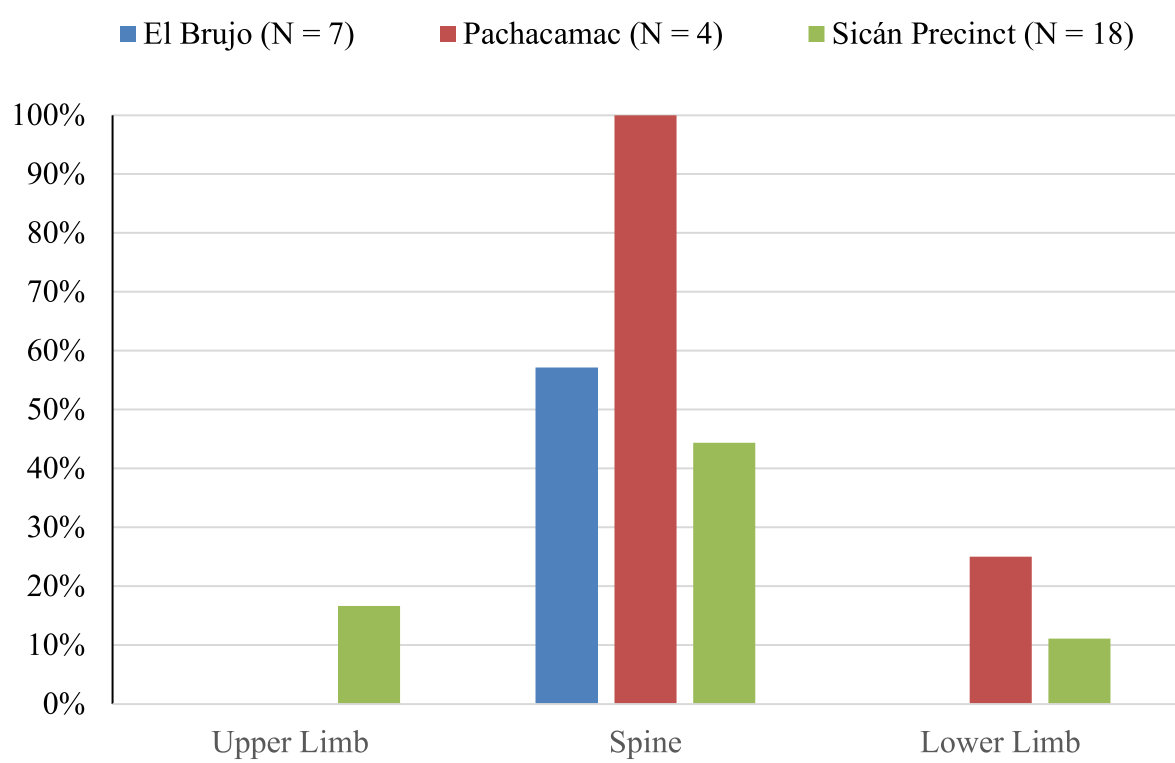

Figure 14 - Graphic comparison of DJD by site for < 30 years age group

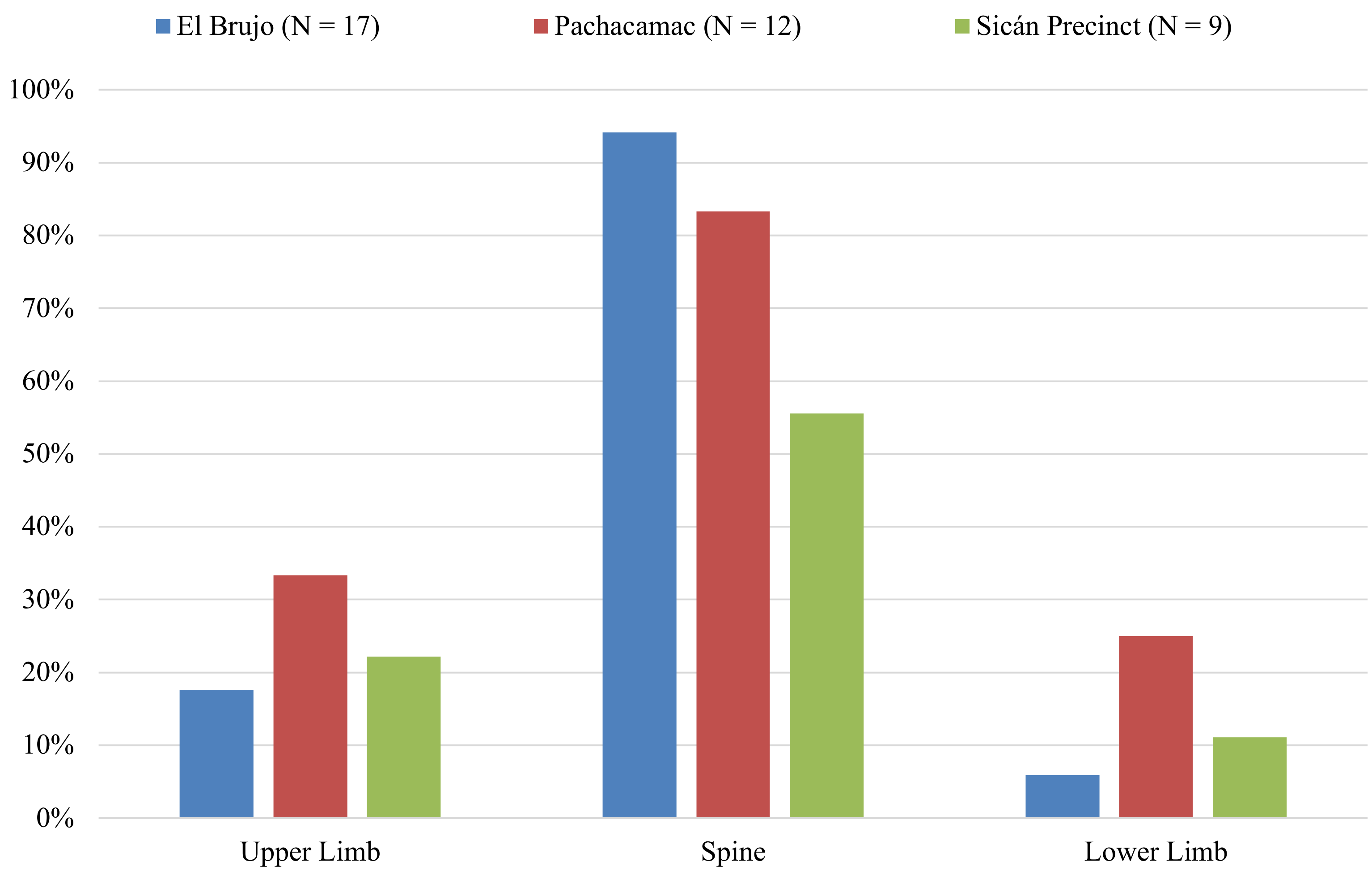

Figure 15 – Graphic comparison of DJD by site for 30+ years age group

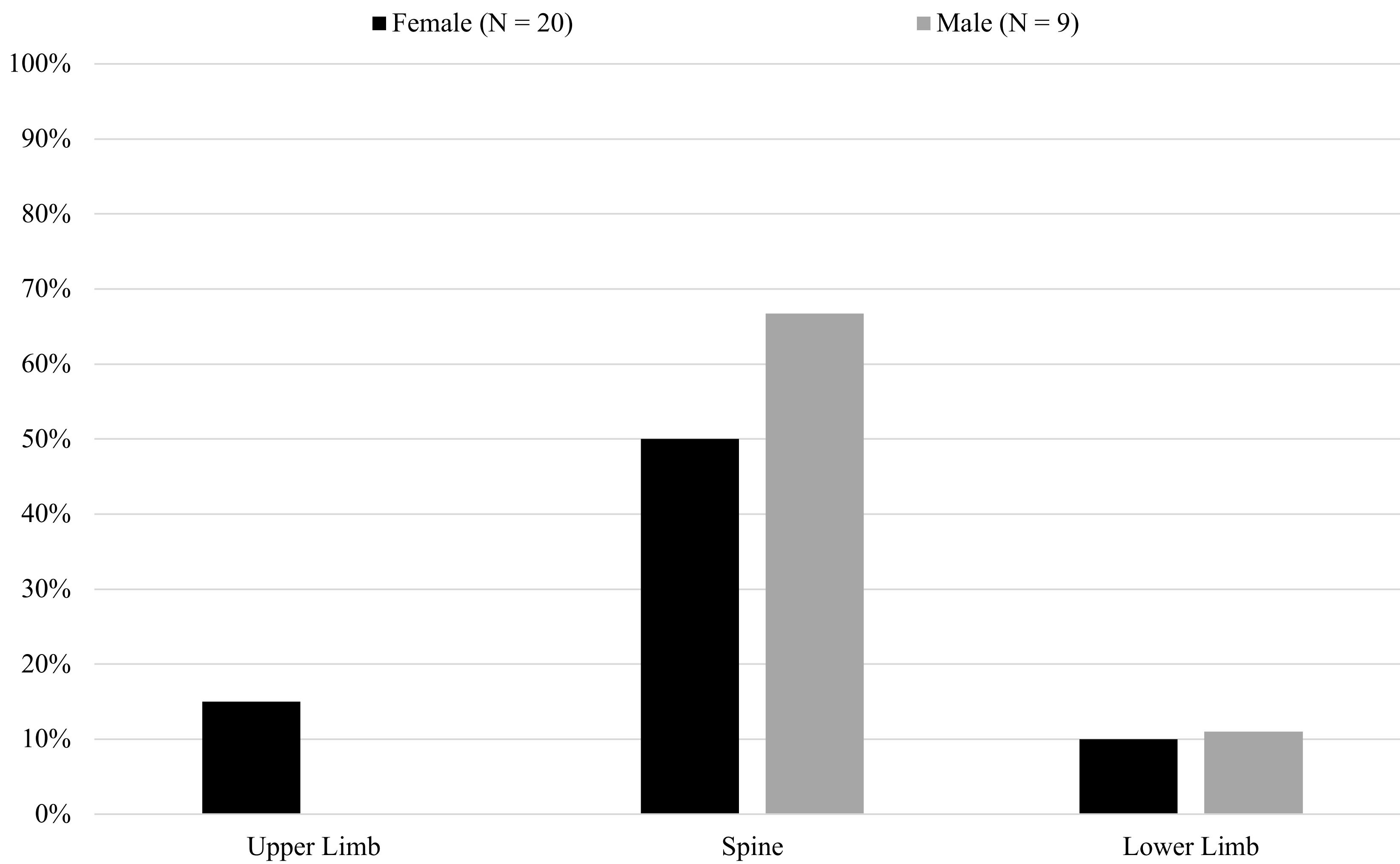

Figure 16 – Graphic comparison of DJD by sex for < 30 years age group

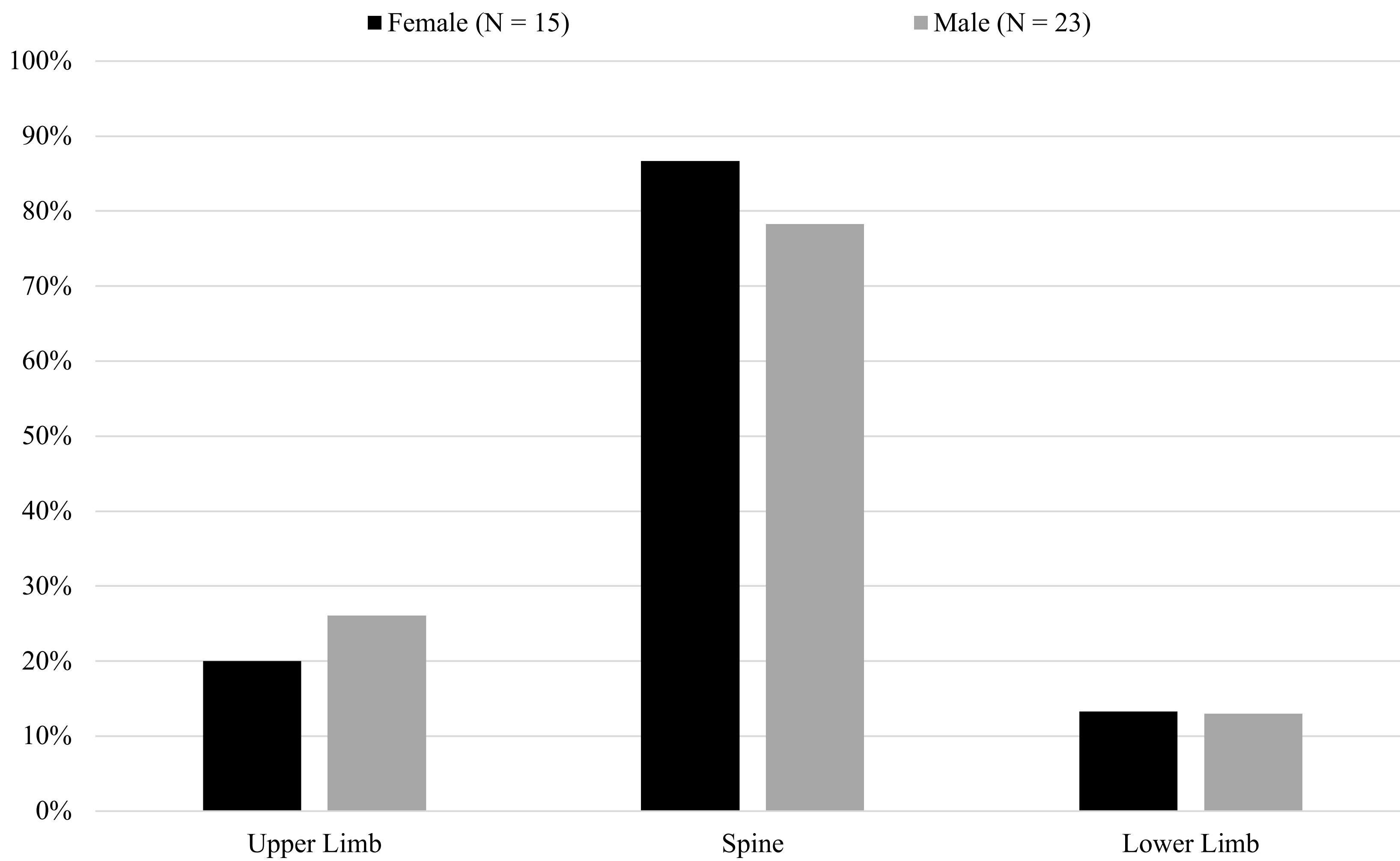

Figure 17 – Graphic comparison of DJD by sex for 30+ years age group

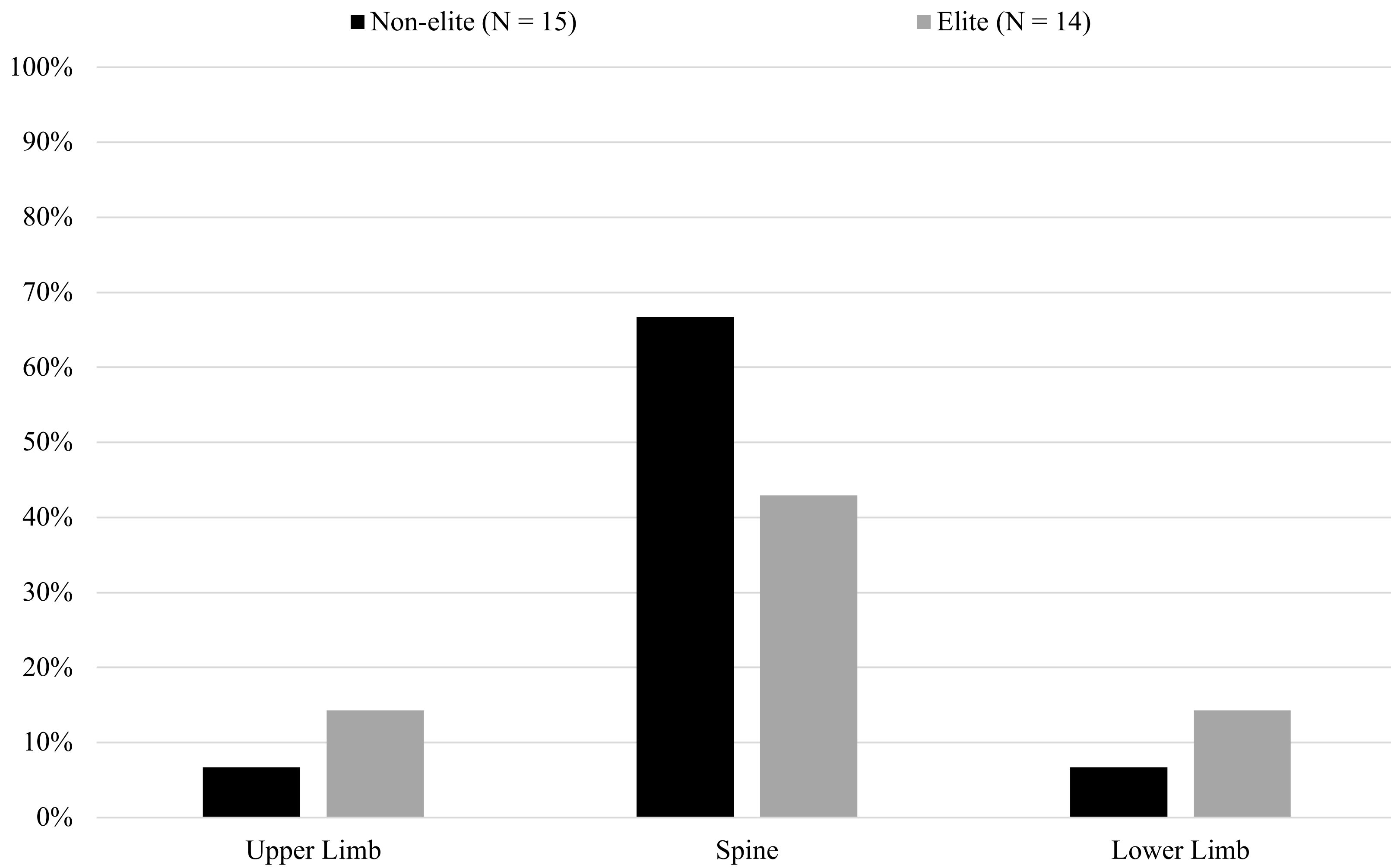

Figure 18 – Graphic comparison of DJD by status for < 30 years age group

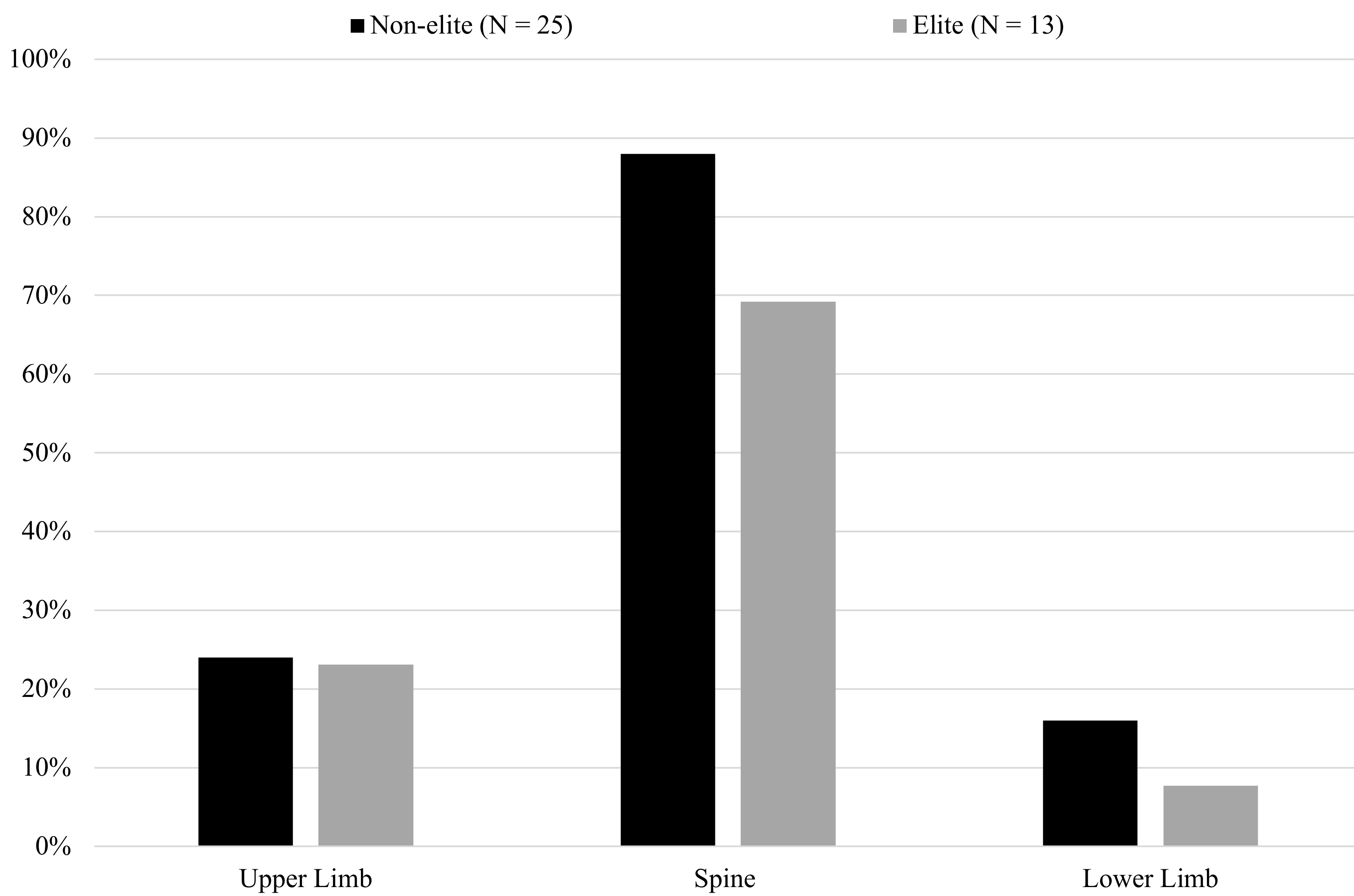

Figure 19 – Graphic comparison of DJD by status for 30+ years age group

Table 23 - Test of association between upper limb DJD and status by age group

Age Range			Exact Sig. (2-sided)	Exact Sig. (1-sided)
< 30 years	Fisher's Exact Test		.598	.473
	N of Valid Cases	29		
30+ years	Fisher's Exact Test		1.000	.640
	N of Valid Cases	38		

Table 24 - Test of association between spinal DJD and status by age group

Age Range			Exact Sig. (2-sided)	Exact Sig. (1-sided)
< 30 years	Fisher's Exact Test		.272	.180
	N of Valid Cases	29		
30+ years	Fisher's Exact Test		.203	.164
	N of Valid Cases	38		

Table 25 - Test of association between lower limb DJD and status by age group

Age Range			Exact Sig. (2-sided)	Exact Sig. (1-sided)
< 30 years	Fisher’s Exact Test		.598	.473
	N of Valid Cases	29		
30+ years	Fisher's Exact Test		.643	.433
	N of Valid Cases	38		

Table 26 - Tests of association between upper limb DJD and sex by age group

Age Group			Exact Sig. (2-sided)	Exact Sig. (1-sided)
< 30 years	Fisher's Exact Test		.532	.312
	N of Valid Cases	29		
30+ years	Fisher's Exact Test		1.000	.490
	N of Valid Cases	38		

Table 27 - Tests of association between spinal DJD and sex by age group

Age Group			Exact Sig. (2-sided)	Exact Sig. (1-sided)
< 30 years	Fisher's Exact Test		.454	.336
	N of Valid Cases	29		
30+ years	Fisher's Exact Test		.681	.419
	N of Valid Cases	38		

Table 28 - Tests of association between lower limb DJD and sex by age group

Age Group			Exact Sig. (2-sided)	Exact Sig. (1-sided)
< 30 years	Fisher's Exact Test		.310	.310
	N of Valid Cases	29		
30+ years	Fisher's Exact Test		1.000	.520
	N of Valid Cases	38		

that they bore the brunt of the most strenuous tasks associated with subsistence, infrastructure, and craft production. Tests of association between inferred status and DJD and sex and DJD were conducted separately for the two age groups. No statistically significant associations were found between status and DJD or sex and DJD for any of the body segments considered in either age group (Tables 23 through 28), and therefore the data do not support my hypothesis. This is likely due in part to low frequencies of DJD for the sample as a whole, something that Farnum (2002) also recognized in her analysis of skeletal remains from the Sicán Precinct and El Brujo. She did note more vertebral osteophytosis at El Brujo (primarily inferred commoners) compared to the Precinct (primarily inferred elites), a skeletal marker that I excluded from this analysis because its association to physical activity is spurious.

Hypothesis 3 – ECs

I predicted that status groups would differ significantly in aggregate EC scores, even after statistically controlling for variations in size and age between groups. Aggregate EC scores, which are the sum total of all EC scores for each individual, will better clarify whether inferred commoners experienced greater biomechanical stress overall, as hypothesized. The minimum and maximum values, as well as the means and standard deviations for aggregate fibrous and fibrocartilaginous EC scores by site, sex, and status are reported in Tables 29 through 31. Mean aggregate fibrous and fibrocartilaginous EC scores for fibrous and fibrocartilaginous were both higher among commoners compared to elites of both sexes. Mean aggregate scores for males and females within each status group, however, were very similar. Interestingly, a search of the data revealed that inferred commoners from Cao Viejo had the highest scores in both fibrous and fibrocartilaginous insertion types for males as well as females. This is consistent with my hypothesis that commoners were over-burdened by mechanical stress and strain relative to their elite counterparts, but requires further testing that accounts for variations in age and size, which are known influences on EC scores.

The first step for statistically testing my hypothesis that status differences will account for variation in aggregate EC scores beyond what is accounted for by humeral size and average age involved ranking these variables and performing a regression analysis. Residuals from the regression analysis were saved to create new variables, RECFib and RECCart. RECFib is the amount of aggregate fibrous EC scores not explained by average age and humeral size and RECCart denotes the same for the aggregate fibrocartilaginous scores. These variables were then subjected to One-way ANOVA, with RECFib or RECCart being the dependent variable, and status being the independent variable. P-values did not achieve statistical significance for aggregate fibrous as well as fibrocartilaginous ECs (Table 32), and thus the hypothesis that inferred status groups would vary with respect to aggregate EC scores was also not supported.

<u>Hypothesis 4 - ECs</u>

A final objective in this study was to test recent assertions put forth about how ECs should be scored and interpreted to yield information about physical activity. Henderson and Cardoso (2013); Villotte et al. (2010); and Weiss (2015) contend that fibrocartilaginous insertions are more reliable indicators of activity because, among other things, they are less sensitive to the influences of age and size. Based on their previous work, I predicted that correlations between aggregate fibrous EC scores (variable AgFibEC), average age, and humeral size would be positive, statistically significant, and stronger than those found for aggregate fibrocartilaginous ECs (variable AgCartEC).

Table 29 – Descriptive statistics for aggregate EC scores by enthesial type and site

Site			Min	Max	Mean	Std. Deviation
El Brujo	Aggregate fibrous EC		9.00	19.00	14.6667	2.23931
	Aggregate fibrocartilaginous EC		6.00	14.00	9.5833	2.46571
	N	24				
Pachacamac	Aggregate fibrous EC		2.00	16.00	9.5938	3.85235
	Aggregate fibrocartilaginous EC		.00	10.00	5.8125	2.94887
	N	16				
Sicán Precinct	Aggregate fibrous EC		.00	15.00	7.2593	5.19314
	Aggregate fibrocartilaginous EC		.00	11.00	4.5556	3.78594
	N	27				

Table 30 - Descriptive statistics for aggregate EC scores by enthesial type and sex

Sex		N	Min	Max	Mean	Std. Deviation
Female	Aggregate fibrous EC		.00	19.00	9.6286	4.76560
	Aggregate fibrocartilaginous EC		.00	14.00	6.4286	3.90539
	N	35				
Male	Aggregate fibrous EC		.00	17.00	11.3906	5.47242
	Aggregate fibrocartilaginous EC		.00	14.00	6.9063	3.83834
	N	32				

Table 31 - Descriptive statistics for aggregate EC scores by enthesial type and status

Status			Min	Max	Mean	Std. Deviation
Non-elite	Aggregate fibrous EC		.00	19.00	11.3125	5.40025
	Aggregate fibrocartilaginous EC		.00	14.00	7.3250	3.88546
	N	40				
Elite	Aggregate fibrous EC		.00	16.00	9.2222	4.57698
	Aggregate fibrocartilaginous EC		.00	12.00	5.6667	3.64797
	N	27				

Table 32 – One-way ANOVA for status and residual aggregate fibrous and fibrocartilaginous EC scores

Fibrous	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	484.500	1	484.500	1.542	.219
Within Groups	20427.414	65	314.268		
Total	20911.914	66			

Fibrocartilaginous	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	536.796	1	536.796	1.526	.221
Within Groups	22858.027	65	351.662		
Total	23394.	66			

Table 33 – Correlation of aggregate fibrous EC scores and average age

			AgFibEC	Average Age
Spearman's rho	AgFibEC	Correlation Coefficient	1.000	.318**
		Sig. (1-tailed)	.	.004
		N	67	67

**. Correlation is significant at the 0.01 level (1-tailed).

Table 34 - Correlation of aggregate fibrous EC scores and humeral size

			AgFibEC	Size
Spearman's rho	AgFibEC	Correlation Coefficient	1.000	.349**
		Sig. (1-tailed)	.	.002
		N	67	67

**. Correlation is significant at the 0.01 level (1-tailed).

Table 35 - Correlation of aggregate fibrocartilaginous EC scores and average age

			AgCartEC	Average age
Spearman's rho	AgCartEC	Correlation Coefficient	1.000	.235*
		Sig. (1-tailed)	.	.028
		N	67	67

*. Correlation is significant at the 0.05 level (1-tailed).

Table 36 - Correlation of aggregate fibrocartilaginous EC scores and humeral size

			AgCartEC	Size
Spearman's rho	AgCartEC	Correlation Coefficient	1.000	.091
		Sig. (1-tailed)	.	.231
		N	67	67

Fibrous EC scores did have a statistically significant relationship to age (p=0.004; Table 33) and humeral size (p=0.002; Table 34), as predicted. Age explained about 10% of the variation in aggregate fibrous EC scores, and the effect size based on the correlation coefficient of 0.318 indicates a medium or typical strength to their relationship. Humeral size explained about 12% of aggregate fibrous EC scores, and the strength of relationship between these variables is also considered medium ($r = 0.349$), although may be slightly stronger than that identified for age in my sample. Aggregate fibrocartilaginous EC scores were also significantly correlated with age (p=0.28; Table 35), although age only explained about 5% of the variation and the strength of the relationship is not strong ($r = 0.235$). No statistical correlation between aggregate fibrocartilaginous EC scores and humeral size was detected (Table 36), and therefore my data are consistent with Villotte (2006), Villotte et al. (2010) and Weiss' (2015) claims that fibrocartilaginous EC scores are less influenced by size. Additionally, while age did seem to have a significant influence on fibrocartilaginous EC scores in my sample, the relationship was much weaker than that found with fibrous entheses. Overall, my results support the claims that fibrocartilaginous entheses are less prone to systemic factors, and thus may yield better information about physical activity than fibrous entheses.

CHAPTER 6

DISCUSSION

Summary of Results

In this study, I hypothesized that skeletal trauma, degenerative joint disease (DJD), and enthesial changes (ECs) would be more common and more severe among inferred Middle Sicán and Ychsma commoners relative to their elite counterparts. By testing commonly held assumptions about the relationship between manual labor and marginal social status based on western, Marxist notions of social class, I provide some clarity regarding how social inequalities were actually experienced as part of daily life in pre-Hispanic coastal Peru.

I found no significant relationship between inferred social status or sex and the prevalence or severity of skeletal trauma, DJD, or ECs in my sample. Evidence of trauma and DJD (especially in regions other than the spine) was so rare in this sample these measures were rendered ineffective for discerning patterns of activity with any degree of specificity. About as much as can be said in this regard is that overall, patterns of skeletal trauma and DJD in this sample suggest Ychsma and Middle Sicán –affiliated communities were either well-adapted to biomechanical stress and strain, or not subject to the kind of physical demands imposed during the colonial era when skeletal lesions such as DJD become dramatically more prevalent, at least on the north coast (Farnum 2002; Klaus 2008; Klaus and Chang 2011; Klaus et al. 2009). Contrary to conventional assumptions, elites did not appear to have had any discernible privilege compared to non-elites in terms of exposure to biomechanical stress and strain. Based on these results, it is clear that models which postulate a simple dominant/subordinate relationship between status groups with regards to labor have little relevance for understanding social dynamics in Middle Sicán and Ychsma societies. This is perhaps to be expected for Ychsma society, as clear archaeological evidence of marked social classes has yet to be found. Individuals in the Ychsma sample considered here (i.e. Tomb 1 – 2) and identified as "elite" based on atypical funerary treatment and grave good "wealth" were largely indistinguishable from inferred commoners with regards to patterns of physical activity, and although sample size is small this does seem contrary to expectations for a class-based, economically-specialized society. This provides further support to the growing body of literature on Ychsma society which argues that although differences in mortuary treatment may reflect special relationships between the living and the dead and perhaps some form of social ranking, there is little reason to believe this is indicative of status or "social class" as conventionally understood by western standards (Diaz 2015; Diaz and Vallejo 2005; Owens and Eeckhout 2015). Lack of correspondence between inferred social status and physical activity as measured here in the Middle Sicán context where there is good evidence of status-based health inequalities and huge discrepancies in access to resources, however, requires further exploration. Below I synthesize the results of this study with recent interpretations of Middle Sicán labor organization based on archaeological and ethnohistorical data.

Social Identity & Labor in Middle Sicán Society: A Reappraisal

Historical accounts of *parcialidades;* defined in a general sense as hierarchically ordered networks of interdependent and specialized socio-economic units, are often used as a model for interpreting labor organization in pre-Hispanic coastal Peru. Placement within the hierarchy depended to a large extent on the goods and services provided by each respective *parcialidad*, with more "specialized" groups associated with the production of elite insignia such as potters, weavers, metalsmiths, and traders, being afforded a certain degree of social prestige and exemption from menial labor tasks (Netherly 1977; Ramírez 2007). *Parcialidades* were linked together under larger regional authorities by economic exchange and interdependence, with the power of authorities being contingent upon their ability to provide for the spiritual and material well-being of their subjects (Netherly 1977). In the *parcialidad* system, aspects of social identity such as status and ethnicity were intimately tied to occupational activities, and we may reasonably expect a similar correspondence in archaeological contexts where this model seems appropriate.

Excavations in and around the Sicán Precinct attest to the presence of at least three distinct social classes, possibly divided to some extent along ethnic lines (Shimada 2014; Shimada et al. 2004). Bioarchaeological evidence of marked disparities in developmental and nutritional health between inferred ethnic Middle Sicán elites and the local, ethnically "Mochica" (i.e. affiliated with the earlier Moche archaeological culture) base attest to the overriding influence of status identity on life experience (Farnum 2002; Shimada et. al 2004), and there was good reason to assume that labor activities were an integral part of these dynamics. The sheer quantity and quality of material goods recovered from elite tombs at the Precinct suggests leaders were able to monopolize labor on a large-scale, and production contexts identify local Mochica agrarian communities as the likely "backbone" of these economic enterprises (Bezúr 2014; Klaus 2014). And yet as this study demonstrates, Middle Sicán-affiliated communities seem to have been equally protected from activity related injury and biomechanical stress, regardless of their social status or biological sex. This compliments Shimada and Wagner's (2007) assertion based on extensive excavations of Middle Sicán production contexts that elite administrators exerted little if any direct control over labor, with workers being afforded a great deal of autonomy with respect to their day-to-day operations (Shimada and Wagner 2007).

The success of the Middle Sicán power structure has been attributed to their synthesis of pre-existing belief systems and lifeways into a newly configured religious ideology, serving to justify or naturalize their position of privilege and sphere of influence (Segura and Shimada 2014; Shimada and Samillán 2014). They did not achieve power through militaristic force or total subjugation, but through religious and economic cooption. Shimada and Craig (2013) and Shimada and Wagner's (2007) characterization of Middle Sicán labor organization as "modular;" or based on a collection of small, independent, local production networks pooling resources to produce on a large scale, provides a useful model for how this economic cooption may have been achieved without placing oppressive labor burdens on any particular social group(s). If the most physically demanding tasks such as ore extraction, construction, or the cleaning and maintenance of irrigation canals were completed in a segmentary fashion by a bunch of small work collectives sharing religious and/or ethnic ties, labor obligations may have been an integral, integrated, and rewarding component of everyday life, rather than an oppressive burden or digression.

Low frequencies of skeletal trauma and degenerative joint disease in my sample as a whole, as well as the lack of variation in aggregate EC scores between elites and non-elites more specifically, suggests that labor activities played little to no role in differential life experience for Middle Sicán status groups. While contrary to assumptions about labor division and social hierarchy based on Marxist notions of social class, the data presented here are consistent with Shimada and colleagues' (Shimada and Craig 2013; Shimada and Wagner 2007) characterization of Middle Sicán labor organization. If skeletal trauma, degenerative joint disease and ECs are the result of "high impact" and "strenuous" activities performed on a habitual basis as conventional interpretations postulate, then it is clear that non-elites affiliated with Middle Sicán society were not over-burdened by oppressive labor regimes, despite significant differences in the quality of life with regards to dietary patterns and exposure to developmental stressors between inferred status groups. A more equitable distribution of labor tasks than Marxist models of social class allow for was likely present in Middle Sicán society, which may help to explain why despite marked difference in access to resources, local populations incorporated into the Middle Sicán sphere were willing to engage with "the-powers-that-be." As long as relationships between the "rulers" and the "ruled" could be perceived of as mutually beneficial, systems of social stratification could remain in place.

My research accords well with current archaeological models of labor organization in Middle Sicán society and helps to clarify the role of labor activities in differential life experience for status groups. Nevertheless, although the underlying premise that habitual muscle and joint strain will initiate bone adaptive/remodeling responses and bone hypertrophy has strong clinical support, the specific magnitude, duration, and frequency of stress episodes necessary to initiate such responses are not well understood and may be highly variable (Schlecht 2012b; Villotte and Knüsel 2013). This is particularly true for ECs, where clinical correlates and experimental studies are few. There are multiple interpretations regarding what it is that EC scores actually measure, and this can greatly limit their interpretive power for understanding patterns of activity in ancient societies. I address this issue in some detail in the following section.

Bioarchaeological Studies of Activity

ECs as markers of physical activity

Contrary to conventional ideas about the relationship between habitual muscle strain and bony changes, Schlecht (2012a; 2012b) and Villotte and Knüsel (2013) postulate that EC development in adults is largely dependent upon mechanical loading and adaptive mechanisms established during adolescence when rates of bone growth and turnover are at their peak. They argue that ECs develop only when stress levels exceed some threshold established during this critical period, and when exposure is intermittent, so as to preclude further adaptive adjustments. According to this line of reasoning, if the labor requirements fulfilled by non-elites as part of their social obligations to community leaders required similar levels of physical exertion as activities performed on a more regular basis (so that the hypothesized adaptive thresholds were not exceeded), we might not expect to see marked differences in EC scores between status groups, despite any real or significant variations in their respective range of activities and physical demands. And thus, we may explain the apparent lack of variation in EC scores between elites and non-elites in this study to be a result of consistency in the kinds of activities completed by different status groups, rather than any similarities in the kind of physical exertion required to perform them. If non-elites worked significantly "harder" than elites, but did so on a regular basis from adolescence onward, they may potentially be indistinguishable from elites or others who did not engage in physically-demanding tasks at all. While in the case of this study low rates of skeletal trauma and degenerative joint disease do support the general conclusion that non-elites were no more exposed to biomechanical stress and strain than their elite counterparts, the lack of specificity regarding the best way to interpret EC data can pose some serious limitations for their use in bioarchaeological studies of activity. Furthermore, as this and other studies have demonstrated, fibrous entheses are not particularly useful for reconstructing patterns of physical activity because they are strongly influenced by age and size. In light of these conclusions, EC studies should be limited to fibrocartilaginous entheses, as Villotte (2006); Villotte et al (2010) and Weiss (2015) have suggested. Additionally, EC scores in and of themselves may not be particularly informative about differential patterns of activity in ancient societies, because they can be interpreted in a number of different ways. Until we know more about EC etiology, ECs should be considered only in conjunction with other skeletal measures of biomechanical stress, and interpreted accordingly. In this study, correspondence between EC data, patterns of skeletal trauma and degenerative joint disease, and models of Middle Sicán and Ychsma societies based on extensive archaeological research helped to strengthen my conclusions, but such data may not always be readily available for a given context.

Directions for future research

Bioarchaeologists recognize human skeletal remains as valuable sources of information about the past precisely because of their potential to reveal aspects of human experience not typically accessible with other kinds of archaeological data. As the discipline has struggled to become more responsive to social theory and more relevant to larger anthropological issues as well as the general public, issues of identity, inequality, and embodiment have emerged as important sources of common ground. Greater engagement with post-processual ideas has ushered in a new era of self-reflection, as witnessed by the re-hashing of old debates and unresolved issues surrounding bioarchaeological studies of activity coming out of the recent Coimbra Workshop in Musculoskeletal Stress Markers. This workshop, a “task force” of sorts, was designed to outline best practices for how enthesial changes should be scored and analyzed. While these efforts and the resulting publications are a step in the right direction especially with regards to expanding dialogue between bioarchaeologists and those working in a clinical setting, many of the issues raised during initial critiques of EC studies in the mid 1990's have yet to be adequately addressed.

The biggest limitation to bioarchaeological studies of activity using ECs is lack of understanding with regards to the precise mechanisms responsible for their development and expression. Do they reflect habitual, sustained stresses, or more sporadic instances of "atypical" loading? What is the relative influence of loading intensity versus loading duration? What about nutritional, genetic, and hormonal influences, and how can these be best dealt with in a bioarchaeological context?

This study supports Villotte et. al. (2010; 2013) and Weiss' (2015) assertion that fibrocartilaginous insertion sites are less sensitive to the effects of size than the fibrous type, but it remains to be seen whether that translates into more precise, reliable behavioral interpretations. Better lines of communication between bioarchaeologists and those working in a clinical setting are a step in the right direction towards resolving these issues, as experimental studies will be essential and have thus far been rather limited (Schlecht 2012b). Until a better understanding of EC etiology is achieved, they will have limited utility for reconstructing patterns of behavior in bioarchaeological settings.

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APPENDICES

APPENDIX A

Non-Elite Skeletal Sample Inventory

Burial ID	Site	Year excavated	Storage ID	Location
El Brujo 2	Cao Viejo, El Brujo	1992	Box 8	Coordinates: S 52.70 – 53.30; E 93.40 – 94.30
El Brujo 4	Cao Viejo, EL Brujo	1992	Box 46	Coordinates: S 59; E 85
El Brujo 5	Cao Viejo, EL Brujo	1992	Box 43	Coordinates: S 58; E 84
El Brujo 6	Cao Viejo, El Brujo	1992	Box 113	Coordinates: S 58 – 59; E 85 – 86
El Brujo 7	Cao Viejo, El Brujo	1992	Box 4	Coordinates: S 53.54; E 94.74
El Brujo 8	Cao Viejo, El Brujo	1992	Box 54	Coordinates: S 54.98; 90.82
El Brujo 9	Cao Viejo, El Brujo	1992	Box 5	Coordinates: S 53.70; E 92.15
El Brujo 12	Cao Viejo, El Brujo	1992	Box 21	Coordinates: S 62.10; E 87.60
El Brujo 14	Cao Viejo, El Brujo	1992	Box 131	Coordinates: Y 53.10 R 88.10
El Brujo 15	Cao Viejo, El Brujo	1992	Box 14	Coordinates: S 58.59; E 94.74x
El Brujo 20	Cao Viejo, El Brujo	1992	Box 4	Coordinates: S 62.25; E 89.30

Burial ID	Site	Year excavated	Storage ID	Location
El Brujo 28	Cao Viejo, El Brujo	1992	Box 128	Coordinates: S 50.48; E 89 – 86
El Brujo 29	Cao Viejo, El Brujo	1992	Box 135	Coordinates: Y 52.20; R 89.35
El Brujo 31	Cao Viejo, El Brujo	1992	Box 130	Coordinates: Y 53.10; R 89.40
El Brujo 32	Cao Viejo, El Brujo	1992	Box 35	Coordinates: S 60 – 95; E 85.90
El Brujo 33	Cao Viejo, El Brujo	1992	Box 46	Coordinates S 64.85; E 79.90
El Brujo 34	Cao Viejo, El Brujo	1992	Box 60	Coordinates: S 62; E 89
El Brujo 36	Cao Viejo, El Brujo	1992	Box 11	Coordinates: S 51.30; E 91.70
El Brujo 38	Cao Viejo, El Brujo	1992	Box 52	Coordinates: S 60.75; E 86.40
El Brujo 41	Cao Viejo, El Brujo	1992	Box 3	Coordinates: S 50.92; E 93.20
El Brujo 42	Cao Viejo, El Brujo	1991	Box 62	Coordinates: S 61.85; E 88.05
El Brujo 44	Cao Viejo, El Brujo	1992	Box 51	Coordinates: S 61.62; E 89.20
El Brujo 51	Cao Viejo, El Brujo	1990	Box 3	Coordinates: S 50 – 55; E 105 – 110.98
AF	Painted Temple, Pachacamac	2006	Box 175	Tomb 1-2, upper level
BA	Painted Temple, Pachacamac	2006	Box 176	Tomb 1-2, upper level

Burial ID	Site	Year excavated	Storage ID	Location / Feature
E	Painted Temple, Pachacamac	2006	Box 169	Tomb 1-2, lower level
G	Painted Temple, Pachacamac	2006	Box 174	Tomb 1-2, lower level
O	Painted Temple, Pachacamac	2006	Box 172	Tomb 1-2, lower level
R	Painted Temple, Pachacamac	2006	Box 170	Tomb 1-2, lower level
T	Painted Temple, Pachacmac	2006	Box 179	Tomb 3, intrusion
U	Painted Temple, Pachacamac	2006	Box 171	Tomb 1-2, lower level
V	Painted Temple, Pachacamac	2006	Box 164	Tomb 1-2, lower level
Z	Painted Temple, Pachacamac	2006	Box 166	Tomb 1-2, lower level
HL NP Sac	Huaca Loro, Sicán Precinct	2008	Box 19	North platform; H-160
HR C10 1	Huaca Rodillona, Sicán Precinct	–	–	Column 10

Burial ID	Site	Year excavated	Storage ID	Location / Feature
HR C12 2	Huaca Rodillona, Sicán Precinct	–	–	Column 12
HS C 8	Huaca Sialupe, Sicán Precinct	2001	–	Central sector
HS E 5	Huaca Sialupe, Sicán Precinct	2001	–	Excavation area 5, east extension
HS M1 1	Huaca Sialupe, Sicán Precinct	1999	–	Mound 1
HS M1 C6 1	Huaca Sialupe, Sicán Precinct	2001	–	Mound 1, cemetery excavation 6

APPENDIX B

Elite Skeletal Sample Inventory

Burial ID	Site	Year excavated	Storage ID	Location / Feature`
El Brujo 13	Cao Viejo, El Brujo	1992	Box 112	Coordinates: S 58.59; E 85.86
El Brujo 39	Cao Viejo, El Brujo	1995	Box 45	Coordinates: S 68.56; E 77.98x
BB	Painted Temple, Pachacamac	2006	–	Tomb 1-2, lower level
H	Painted Temple, Pachacamac	2006	Box 168	Tomb 1-2,
N	Painted Temple, Pachacamac	2006	Box 165	Tomb 1-2
Q	Painted Temple, Pachacamac	2006	Box 173	Tomb 1-2
W	Painted Temple, Pachacamac	2006	Item 14446	Tomb 1-2, lower level
HLV SS 5	Huaca Las Ventanas, Sicán Precinct	–	–	South sector, excavation area 1, offering 3
HLV SS 7	Huaca Las Ventanas, Sicán Precinct	–	–	South sector, excavation area 1, offering 5
HLV SS 8	Huaca Las Ventanas, Sicán Precinct	–	–	South sector, excavation area 1, offering 3

Burial ID	Site	Year excavated	Storage ID	Location / Feature`
HL 06 T1 1	Huaca Loro, Sicán Precinct	2006	–	Trench 1, Tomb 1
HL 06 T1 2	Huaca Loro, Sicán Precinct	2006	–	Trench 1, Tomb 2
HL 06 Tr1 T4	Huaca Loro, Sicán Precinct	2006	–	Trench 1
HL E 5	Huaca Loro, Sicán Precinct	1991	–	East Tomb, Trench 1
HL WT 2	Huaca Loro, Sicán Precinct	1995	–	West Tomb
HL WT 3	Huaca Loro, Sicán Precinct	1995	–	West Tomb
HL WT 7	Huaca Loro, Sican Precinct	1995	–	West Tomb, Pit 3
HL WT 9	Huaca Loro, Sican Precinct	1995	–	West Tomb, Pit 4
HL WT 10	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Pit 4
HL WT 11	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Pit 5
HL WT 12	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Pit 5
HL WT 14	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Pit 7
HL WT 17	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Pit 10
HL WT 18	Huaca Loro, Sicán Precint	1995	–	West Tomb, Pit 11
HL WT 20	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Central chamber, Excavation area 1, Niche 11

Burial ID	Site	Year excavated	Storage ID	Location / Feature`
HL WT 21	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Pit 9
HL WT 24	Huaca Loro, Sicán Precinct	1995	–	West Tomb, Niche 12

APPENDIX C

Non-Elite Sample Fibrous Entheses Data

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
Sicán Precinct	HS C 8	17.5	F	-2.971	0	0	1	3	0	0	0	3	7
Sicán Precinct	HR C10 1	22	M	-0.365	0	0	0	0	0	0	0	0	0
Sicán Precinct	HS M1 1	22.5	M	-0.404	0	0	0	0	0	0	0	0	0
Sicán Precinct	HR C12 2	23.5	F	-0.249	0	0	0	0	0	0	0	0	0
Sicán Precinct	HS E 5	40	M	-0.365	0	0	0	0	0	0	0	0	0
Sicán Precinct	HS M1 C6 1	45	M	3.042	0	0	0	0	3	3	3	3	12
Sicán Precinct	HL NP Sac	45	M	0.534	0	0	1	1	3	3	0	2	10

[1] LD = Lattisiums dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
El Brujo	El Brujo 9	20.5	M	3.631	1	1	1	3	3	3	2	3	17
El Brujo	El Brujo 32	21	F	-4.038	0	0	1	1	2	1	2	2	9
El Brujo	EL Brujo 12	22	F	-0.338	1	1	1	1	3	3	1	2	13
El Brujo	El Brujo 15	23	M	3.186	1	1	2	1	3	3	2	2	15
El Brujo	El Brujo 44	25	M	0.771	1	1	1	2	2	2	2	2	13
El Brujo	EL Brujo 36	27.5	M	1.26	1	1	1	2	3	3	2	3	16
El Brujo	El Brujo 38	27.5	M	0.92	1	1	2	1	2	3	2	3	15
El Brujo	El Brujo 6	30	F	-4.645	1	2	1	2	2	1	2	2	13
El Brujo	EL Brujo 31	30	F	-2.539	1	1	1	1	2	2	2	2	12

[1] LD = Lattisiums dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
El Brujo	EL Brujo 14	30	M	2.458	1	1	2	1	3	2	2	2	14
El Brujo	El Brujo 20	30	M	4.428	1	1	2	2	3	3	2	2	16
El Brujo	El Brujo 66	32.5	M	3.806	1	1	1	1	3	3	2	3	15
El Brujo	El Brujo 33	35	F	-0.636	1	1	2	1	3	3	3	2	16
El Brujo	El Brujo 2	35	M	2.785	1	1	2	2	3	2	3	2	16
El Brujo	El Brujo 5	35	M	1.3	1	1	2	1	3	3	2	2	15
El Brujo	El Brujo 42	37.5	F	-1.391	1	1	3	2	3	3	3	3	19
El Brujo	El Brujo 34	38.5	F	-3.077	1	1	2	1	3	3	2	3	16
El Brujo	EL Brujo 41	40	F	-1.362	1	1	2	2	3	3	2	3	17
El Brujo	El Brujo 7	40	M	4.058	1	1	2	2	3	3	2	3	17

[1] LD = Lattisiums dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
El Brujo	EL Brujo 28	45	M	1.949	1	1	1	2	3	2	2	2	14
El Brujo	El Brujo 8	50	M	3.524	1	1	2	2	3	3	2	2	16
El Brujo	El Brujo 4	55	F	-2.245	0	2	0	1	3	3	3	3	15
Pachacamac	T	19.5	F	-4.431	0	0	0	0	1	0	1	0	2
Pachacamac	AF	19.5	F	-2.748	0	0	0	1	1	1	1	0	4
Pachacamac	U	27.5	M	5.125	0	0	2	0	3	1	2	1	9
Pachacamac	G	29.5	M	4.333	0	0	2	1	3	3	3	3	15
Pachacamac	E	30	M	-2.033	0	0	1	1.5	2	1.5	3	1.5	10.5
Pachacamac	BA	32.5	M	3.171	0	0	2	2	2	2	2	2	12
Pachacamac	X	34.5	0	-0.209	0	0	0	0	1	1	2	2	6
Pachacamac	O	42	1	5.143	0	0	0	0	3	2	2	1	8

[1] LD = Lattisiums dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
Pachacamac	V	44.5	1	-0.615	0	0	1	1	3	2	2	1	10
Pachacamac	Z	44.5	1	4.454	0	0	2	2	2	2	2	1	11
Pachacamac	R	47	0	-2.165	0	0	1	0	2	2	1	1	7

[1] LD = Lattisiums dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

APPENDIX D

Non-Elite Fibrocartilaginous Entheses Data

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Sicán Precinct	HS C 8	17.5	F	-2.971	0	0	0	0	0	3	3
Sicán Precinct	HR C10 1	22	M	-0.365	0	0	0	0	0	0	0
Sicán Precinct	HS M1 1	22.5	M	-0.404	3	3	0	0	0	0	6
Sicán Precinct	HR C12 2	23.5	F	-0.249	0	0	0	0	0	0	0
Sicán Precinct	HS E 5	40	M	-0.365	0	0	0	0	0	0	0
Sicán Precinct	HS M1 C6 1	45	M	3.042	0	0	0	0	0	0	0

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Sicán Precinct	HL NP Sac	45	M	0.534	0	2	1	1	1	2	7
El Brujo	El Brujo 9	20.5	M	3.631	1	1	1	1	1	1	6
El Brujo	El Brujo 32	21	F	-4.038	1	1	0	0	2	2	6
El Brujo	El Brujo 12	22	F	-0.338	1	1	1	1	3	3	10
El Brujo	El Brujo 15	23	M	3.186	1	1	1	1	2	2	8
El Brujo	El Brujo 44	25	M	0.771	2	2	1	1	2	2	10
El Brujo	El Brujo 36	27.5	M	1.26	3	3	1	1	3	3	14
El Brujo	El Brujo 38	27.5	M	0.92	1	1	1	1	1	2	7
El Brujo	El Brujo 31	30	F	-2.539	1	1	1	1	1	2	7
El Brujo	El Brujo 6	30	F	-4.645	1	1	1	1	2	2	8

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
El Brujo	El Brujo 14	30	M	2.458	3	3	1	1	3	3	14
El Brujo	El Brujo 20	30	M	4.428	1	2	1	1	2	2	9
El Brujo	El Brujo 66	32.5	M	3.806	1	1	1	1	3	3	10
El Brujo	El Brujo 33	35	F	-0.636	1	1	1	2	3	3	11
El Brujo	El Brujo 2	35	M	2.785	3	3	1	1	2	1	11
El Brujo	El Brujo 5	35	M	1.3	1	1	1	1	3	3	10
El Brujo	El Brujo 42	37.5	F	-1.391	3	2	1	2	3	3	14
El Brujo	El Brujo 34	38.5	F	-3.077	1	1	1	1	2	2	8
El Brujo	EL Brujo 41	40	F	-1.362	3	3	1	1	2	3	13
El Brujo	El Brujo 7	40	M	4.058	1	2	1	1	1	2	8

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
El Brujo	EL Brujo 28	45	M	1.949	1	1	1	1	2	2	8
El Brujo	El Brujo 8	50	M	3.524	2	2	1	1	2	2	10
El Brujo	El Brujo 4	55	F	-2.245	1	1	1	1	2	3	9
Pachacamac	T	19.5	F	-4.431	0	0	0	0	0	0	0
Pachacamac	AF	19.5	F	-2.748	0	0	0	0	3	0	3
Pachacamac	U	27.5	M	5.125	1	0	2	2	1	1	7
Pachacamac	G	29.5	M	4.333	1	0	1	1	1	1	5
Pachacamac	E	30	M	-2.033	1.5	0	1.5	0	1	1	5
Pachacamac	BA	32.5	M	3.171	0	0	0	2	0	2	4
Pachacamac	X	34.5	F	-0.209	1	2	0	0	2	1	6

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Pachacamac	O	42	M	5.143	1	2	2	0	1	1	7
Pachacamac	V	44.5	M	-0.615	2	1	1	1	2	2	9
Pachacamac	Z	44.5	M	4.454	2	2	0	0	3	3	10
Pachacamac	R	47	F	-2.165	0	2	2	2	2	2	10

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

APPENDIX E

Elite Sample Fibrous Entheses Data

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
Sicán Precinct	HL WT 18	18.5	F	0.282	1	1	1	2	1	1	2	2	11
Sicán Precinct	HL WT 12	19	F	-4.391	1	1	1	1	2	3	1	0	10
Sicán Precinct	HL WT 9	20	F	-3.583	0	0	0	2	0	2	2	2	8
Sicán Precinct	HLV SS 8	20	F	-1.997	0	0	0	0	0	2	3	3	8
Sicán Precinct	HL WT 11	20	F	-3.092	1	1	1	0	3	3	2	0	11

[1] LD = Lattisiums dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
Sicán Precinct	HL WT 14	20.5	F	-1.505	1	1	1	1	2	2	2	2	12
Sicán Precinct	HL 06 T1 2	22	F	-0.603	0	0	0	0	0	0	0	0	0
Sicán Precinct	HL WT 3	22	F	-4.586	0	0	1	0	2	2	0	0	5
Sicán Precinct	HL WT 24	22.5	F	-5.086	0	0	1	1	3	3	2	3	13
Sicán Precinct	HL WT 7	22.5	F	-1.329	1	0	2	2	2	2	2	2	13
Sicán Precinct	HL ET 5	22.5	F	-1.337	0	1	0	2	0	3	0	3	9
Sicán Precinct	HL WT 17	27	F	-1.721	1	1	1	2	2	2	1	1	11
Sicán Precinct	HLV SS 5	23.5	F	-0.603	1	1	1	1	2	2	3	2	13
Sicán Precinct	HL WT 10	23.5	F	-0.603	0	0	1	0	3	0	2	0	6

[1] LD = Lattisimus dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D[4] (R)	D (L)	AG EC[5]
Sicán Precinct	HL WT 21	30	F	-3.558	0	0	1	1	3	1	2	2	10
Sicán Precinct	HL WT 20	30	F	-1.51	0	0	2	2	2	2	1	2	11
Sicán Precinct	HL 06 Tr1 T4	30	M	-0.603	0	0	0	0	0	0	0	1	1
Sicán Precinct	HL 06 T1 1	40	F	-0.603	0	0	0	0	0	0	0	0	0
Sicán Precinct	HL WT 2	42.5	M	2.743	1	1	2	1	3	3	2	2	15
El Brujo	El Brujo 13	30	M	2.448	1	1	1	1	2	1	2	2	11
El Brujo	El Brujo 39	35	F	-0.676	1	1	1	1	2	2	2	2	12
Pachacamac	H	27	M	2.52	0	0	1	1	2	2	2	2	10
Pachacamac	Q	40	F	-0.29	0	0	0	0	3	1	3	3	10

[1] LD = Lattissimus dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

Site	Burial ID	Av Age	Sex	Size	LD[1] (R)	LD (L)	TM[2] (R)	TM (L)	PM[3] (R)	PM (L)	D [4](R)	D (L)	AG EC[5]
Pachacamac	BB	47	M	3.662	0	0	3	3	3	3	2	2	16
Pachacamac	W	57	F	0.694	0	0	0	0	2	2	2	2	8

[1] LD = Lattissimus dorsi insertion
[2] TM = Teres major insertion
[3] PM = Pectoralis major insertion
[4] D = Deltoideus insertion
[5] AG EC = Aggregate fibrous EC score

APPENDIX F

Elite Sample Fibrocartilaginous Entheses Data

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Sicán Precinct	HL WT 18	18.5	F	0.282	0	0	0	0	0	0	0
Sicán Precinct	HL WT 12	19	F	-4.391	2	1	0	1	1	2	7
Sicán Precinct	HL WT 9	20	F	-3.583	1	2	0	0	2	2	7
Sicán Precinct	HLV SS 8	20	F	-1.997	2	0	0	0	1	0	3
Sicán Precinct	HL WT 11	20	F	-3.092	1	1	1	2	2	3	10
Sicán Precinct	HL WT 14	20.5	F	-1.505	1	2	0	1	2	2	8

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Sicán Precinct	HL 06 T1 2	22	F	-0.603	0	0	0	0	0	0	0
Sicán Precinct	HL WT 3	22	F	-4.586	0	0	0	0	1	1	2
Sicán Precinct	HL WT 24	22.5	F	-5.086	2	1	1	1	3	2	10
Sicán Precinct	HL WT 7	22.5	F	-1.329	2	2	1	1	3	2	11
Sicán Precinct	HL ET 5	22.5	F	-1.337	1	2	1	1	2	2	9
Sicán Precinct	HL WT 10	23.5	F	-0.603	1	0	0	0	2	0	3
Sicán Precinct	HLV SS 5	23.5	F	-0.603	1	0	1	1	2	2	7
Sicán Precinct	HL WT 17	27	F	-1.721	1	1	1	1	2	3	9
Sicán Precinct	HLV SS 7	25	M	-1.634	0	3	0	0	0	0	3
Sicán Precinct	HL WT 21	30	F	-3.558	1	1	1	1	2	1	7

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Sicán Precinct	HL WT 20	30	F	-1.51	1	1	1	1	2	1	7
Sicán Precinct	HL 06 Tr1 T4	30	M	-0.603	0	0	0	0	0	0	0
Sicán Precinct	HL 06 T1 1	40	F	-0.603	0	0	0	0	0	0	0
Sicán Precinct	HL WT 2	42.5	M	2.743	0	0	1	1	1	1	4
El Brujo	El Brujo 13	30	M	2.448	3	2	1	2	2	2	12
El Brujo	El Brujo 39	35	F	-0.676	1	3	0	0	1	2	7
Pachacamac	H	27	M	2.52	1	1	0	0	1	1	4
Pachacamac	N	32.5	M	3.914	2	3	0	0	2	2	9
Pachacamac	Q	40	F	-0.29	0	0	2	2	2	2	8
Pachacamac	W	57	F	0.694	0	0	0	0	0	2	2

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

Site	Burial ID	Av Age	Sex	Size	BB[1] (R)	BB (L)	TB[2] (R)	TB (L)	B[3] (R)	B (L)	AG EC[4]
Pachacamac	BB	47	M	3.662	2	2	0	0	0	0	4

[1] BB = Biceps brachii insertion
[2] TB = Triceps brachii insertion
[3] B = Brachialis insertion
[4] AG EC = Aggregate fibrocartilaginous EC score

APPENDIX G

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