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Head shapes and toothaches: A study of cranial modification and dental pathology at MUNA, a late pre-Hispanic cemetery from the Archaeological Sanctuary of Pachacamac (Lima, Perú).

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A thesis submitted in partial fulfillment of the requirements for the Master of Arts degree in Anthropology
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Abstract

This thesis is a bioarchaeological analysis of cranial modification and dental pathology in a sample of human remains excavated from the pre-Hispanic MUNA cemetery. This cemetery was on the outskirts of the Archaeological Sanctuary of Pachacamac in the Lurín Valley. The cemetery was comprised of disturbed skeletal remains and relatively well preserved *fardos funerarios* (funerary bundles) from the Late Intermediate Period (1100-1470 CE) and early Late Horizon (1470-1532 CE). The results of this thesis show that the skeletal remains and fardos likely belonged to a single community, and the analyzed sample showed intra-site variation of the fronto-occipital cranial modification. The dental pathology results showed a relatively homogenous, carbohydrate-rich, and cariogenic. Comparisons with other Pachacamac and Central Coast samples suggested that the MUNA people were likely a coastal community that was local to the Central Coast and/or Pachacamac and the Lurín Valley. In the former scenario, the MUNA people could have participated in regional pilgrimage. This would be consistent with the current interpretation that during the Late Intermediate Period, Pachacamac was an important administrative and religious center in the Central Coast, but not across the Central Andes.

Keywords

Cranial modification, Dental pathology, Pachacamac, Central Coast, Perú.

Resumen

Esta tesis es un estudio bioarqueológico de una muestra de restos humanos excavados del cementerio del MUNA, ubicado las afueras del Santuario Arqueológico de Pachacamac en el valle del Lurín. Este cementerio estuvo compuesto de restos óseos y fardos funerarios del Periodo Intermedio Tardío (1100-1470 CE) y Horizonte Tardío temprano (1470-1532 CE). Este proyecto busca comparar variables de modificación craneal y patología dental para determinar si los restos óseos y los fardos pertenecen a dos submuestras diferentes o si fueron parte de la misma comunidad. Adicionalmente, este estudio busca explorar el rol de las modificaciones craneales en el cementerio del MUNA y la conexión de las personas enterradas en el mismo con Pachacamac. Los resultados de esta tesis muestran que los restos óseos y fardos probablemente pertenecieron a la misma comunidad. La muestra del MUNA mostró modificaciones craneales fronto-occipitales y los resultados de patología dental mostraron que la dieta probablemente fue alta en carbohidratos y cariogénica. Asimismo, las comparaciones con otras muestras de Pachacamac y la Costa Central sugieren que las personas que fueron enterradas en el cementerio del MUNA fueron posiblemente un grupo costero local de la Costa Central y/o Pachacamac y el valle del Lurín. En el primer caso, las personas del MUNA pudieron haber participado de peregrinaje regional. Esto es consistente con la actual interpretación de Pachacamac durante el Periodo Intermedio Tardío, el santuario fue un importante centro administrativo y oráculo en la Costa Central, mas no de los Andes Centrales en general.

Palabras clave

Modificaciones craneales, Patología dental, Pachacamac, Costa Central, Perú.

Summary for lay audiences

This research project is a study of human remains from the pre-Hispanic MUNA cemetery. This cemetery sat on the outskirts of the Archaeological Sanctuary of Pachacamac in the Lurín Valley and has been dated to the Late Intermediate Period (600-1100 CE) and the early Late Horizon (1100-1432 CE). During this time, the Lurín Valley was occupied by the Ychsma Culture, a pre-Inca coastal group which was later conquered by the Inca in the Late Horizon. The MUNA cemetery was composed of disturbed skeletal remains and relatively well preserved fardos funerarios (funerary bundles).

Through bioarchaeology, the study of human remains from archaeological contexts, this thesis aims to compare the skeletal remains and fardos to determine if they were part of a single, larger sample, or if they were two culturally distinct samples. Additionally, this study aims to explore the social organization of the people buried within the MUNA cemetery and the larger context of Pachacamac and the Central Coast. These questions will be explored using cranial modification and dental pathology.

Cranial modifications were a form of irreversible identity assigned in infancy (up to about three years of age) that have been broadly associated with ethnicity and/or socioeconomic status in the Central Andes. Dental pathology aims to study and interpret disease and anomalies in teeth and the surrounding tissues to provide information about cultural practices and physiological processes. Thus, these two variables are suitable to explore the social dynamics of the people buried within the MUNA cemetery.

The variation of cranial modifications within the MUNA sample and similarities with other Pachacamac and Central Coast samples, plus the dental pathology results, suggested that the MUNA people were a group likely local to the Central Coast and/or Pachacamac and the Lurín Valley. In the former scenario, the MUNA people could have participated in regional pilgrimage, which would be consistent with the Late Intermediate Period interpretation of Pachacamac as an important administrative and religious center in the Central Coast, but not across the larger Central Andes.

Resumen para público no especializado

Este proyecto es un estudio de los restos humanos del cementerio pre-Hispánico del MUNA. Este cementerio estuvo en la periferia del Santuario Arqueológico de Pachacamac en el valle del Lurín y ha sido datado para el Periodo Intermedio Tardío (600-1100 CE) y el Horizonte Tardío temprano (1100-1532 CE). Durante este periodo de tiempo, el valle del Lurín estuvo ocupado por la cultura Ychsma, un grupo costero pre-Inca, el cual fue conquistado por los Incas durante el Horizonte Tardío. El cementerio del MUNA estuvo compuesto por restos óseos disturbados y fardos funerarios relativamente bien conservados.

La bioarqueología es el área de la antropología que estudia los restos humanos provenientes de contextos arqueológicos. Mediante un análisis bioarqueológico, esta tesis busca comparar los restos óseos y los fardos para determinar si fueron parte de una sola muestra, o si fueron dos submuestras culturalmente distintas. Adicionalmente, este estudio busca explorar las dinámicas sociales de las personas enterradas en el cementerio del MUNA y en el contexto más amplio de Pachacamac y la Costa Central. Ests preguntas serán exploradas mediante el estudio de modificaciones craneales y patología dental.

Las modificaciones craneales fueron una forma irreversible de identidad asignada durante la infancia (hasta aproximadamente los tres años de edad) y han sido asociadas a diferenciación de grupos étnicos o a estatus socioeconómico en los Andes Centrales. La patología dental busca estudiar e interpretar enfermedades y anomalías en dientes y los tejidos que los rodean para proveer información sobre prácticas culturales y procesos fisiológicos. En este sentido, ambas variables son adecuadas para explorar las dinámicas sociales dentro del cementerio del MUNA.

La variación de las modificaciones craneales dentro del cementerio y las similitudes con otras muestras de Pachacamac y la Costa Central, junto a los resultados de patología dental, sugieren que las personas del MUNA fueron un grupo costeño local a la Costa Central y/o Pachacamac y el valle de Lurín. En el primer caso, las personas del MUNA pudieron haber participado en peregrinaje regional, lo cual sería consistente con la actual interpretación de Pachacamac como importante centro administrativo y religioso en la Costa Central, mas no en los Andes Centrales.

Acknowledgments

First and foremost, I would like to sincerely thank my supervisor, Andrew Nelson, for his continuous support, guidance, and patience throughout this process (especially for his quick turnaround of my late drafts, something that any grad student is thankful for). I would also like to thank Drew Smith, Jay Stock, and Andrea Waters-Rist for being in my defense committee and agreeing to such a tight timeline. Additional thanks to Ian *Colquhoun for being chair*.

Special thanks to Christine Wall and Lisa Hodgetts at the Department of Anthropology for their endless assistance in my grad school endeavors. I would also like to thank the Department of Anthropology and the Faculty of Social Science for majorly funding this degree through the Western Graduate Research Scholarship, the Social Science Dean Graduate Scholarship, the Henry Bogal-Szot Graduate Anthropology Fieldwork Award, the Graduate Research Awards Fund, and the Graduate Conference Travel & Research Support Fund. Additional thanks to the “Mummies as Microcosms” project for funding the fieldwork needed for this thesis.

I am deeply thankful to my former supervisor and friend, Maricarmen Vega, without whom my career in bioarchaeology would not have started. My thanks to my friends at the MNAAHP who guided me in my first year in bioarchaeology. My gratitude to Lucía Watson for her invaluable insight on her research on the Ancón sample and her helpful advice. Special thanks to the Museo Pachacamac staff, especially to Denise Pozzi-Escot and Sarita Fuentes for their collaboration in the analysis of the remains that were part of this research. I am thankful to the people who were buried at MUNA, without whom this research would not have been possible. I am honoured to have worked alongside you in this journey.

My love and deepest gratitude to all my Western Anthropology friends: Maddie, Rebecca, Izzy, Ashley, Syd, Kaylee, Natalia, Luis, Zsofía, Javier, and Kate. Your unconditional support and cheering throughout these two years, particularly in the last few months of thesis writing, were priceless. You all were (and continue to be) amazing friends, thank you for sharing our struggles, meltdowns, and laughter. Thank you to Ashley, Izzy, Syd, and Kaylee for being the best office mates I could have wished for, go Beasts of 3033.

To my forever friends from home: Giuli, Hidemi, Rosita, Carmen, Estrellita, Taís, Aki, Juanca, and Reggie. Thank you for your being a constant in my life and for providing endless emotional and moral support throughout the years. Special thanks to Giuli, Reggie, and Juanca for listening and reading my thesis ramblings (and a multitude of other topics). Your opinions and advice were incredibly helpful and enriching, lets keep the ridiculous random conversations going.

Last, but certainly not least, my deepest and endless gratitude and love to my family for their unconditional support and love. Special thanks to my aunties for their incredibly generous financial support, which was critical for my move across the continent. I will forever be grateful to my amazing mom, who against all odds, has supported and lifted my sister and I our entire lives. To my sister, Kaori: I probably do not say this enough, but I am incredibly grateful and honored to be your big sister. Thank you for always being there for me, for better or worse, I know I can always count on you, and I can only hope you feel the same way.

Finally, I am incredibly grateful to my Nowis and Yokis, my two babies who have filled my days with joy and love in ways I could have never imagined.

Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1

1 Introduction

This master's thesis studies two subsamples, one of skeletal remains and another of *fardos funerarios* (funerary bundles), from the Late Intermediate Period (LIP) (1100-1470 CE) excavated from the archaeological site of Pachacamac in Lima, Perú. This project analyzes and compares cranial modification and dental pathology to determine if the subsamples were part of a larger single sample, or if they were two culturally distinct subsamples. Additionally, this research explores the role of cranial modification in the social dynamics of the people buried in the cemetery, and the connection of the people to Pachacamac. These questions will be explored with a bioarchaeological examination of the remains, and the analysis of mortuary practices and ethnohistoric sources. Overall, this study will contribute to the understanding of cranial modification as a proxy for social organization in the MUNA cemetery in the context of Pachacamac and the larger Central Coast region during the LIP.

1.1 Background

Body modifications have occurred throughout history and have been commonly associated with social or political differentiation between groups of people (Tiesler, 2014). Cranial modification was a common practice in many different cultures and resulted in visible variability in people's head shapes, which can be interpreted as a proxy for social identity, for example, ethnicity or economic status (Torres-Rouff, 2007, 2020). This practice has been subject to anthropological research for many years, and in the Andes, the research has indicated that, depending on the archaeological context, it can be used to characterize time periods, social categories, and kin relationships (Weiss, 1961). Dental pathology can provide information connecting dental disease and irregularities to cultural and genetic factors (Lukacs, 2012). In bioarchaeology, the former has been the most used avenue of study of teeth because it can give us information about diet, subsistence, nutrition, and cultural practices, which are variables that help us understand communities in the past (Lukacs, 2012).

During the LIP, after the fall of the Wari Empire, small political groups started forming along the coast of Lima, a region in the Central Coast of Perú (Covey, 2008). These communities most likely had stratified social and political organizations associated with lineages (*ayllus*) or economic specialization (fishing and agriculture)—which could have been the same for some communities (Covey, 2008; Marcus et al., 1999; Rostworowski, 2002). Pachacamac is in the Lurín Valley of Lima and is considered one of the most important archaeological complexes on the Central Coast (Eeckhout, 2004; Rostworowski, 2002). During the LIP, Pachacamac was occupied by the Ychsma, a pre-Inca society whose sociopolitical organization is still a topic of debate (Eeckhout, 2004; Espinoza Soriano, 2015). Researchers have proposed that the Ychsma were organized as a chiefdom (*señorío*) subdivided by smaller groups (*curacazgos*) arranged along the valleys of the Lurín and Rímac rivers, with the main chief established at Pachacamac (Eeckhout, 2004; Espinoza Soriano, 2015; Rostworowski, 2002). The coastal economic model by María Rostworowski proposed that in the coastal regions of the Andes, the basic means of subsistence, fishing and agriculture, were also the basis for social differentiation in pre-Hispanic times (Rostworowski, 2000). Fishing was performed by communities near the ocean and the lower valleys, and farming was practiced in the fertile middle valleys (Rostworowski, 2002). The surplus of resources allowed the coastal communities to engage in trade to obtain the products and materials they needed (Rostworowski, 2002, 2004, 2016).

Following the previous hypotheses about the Ychsma, it is reasonable to propose that cranial modification in this society was used to differentiate social groups that were representative of the sociopolitical and economic divisions of the land. Due to its status as a prominent pre-Hispanic administrative center and important oracle, Pachacamac was visited by pilgrims from different locations in the Andes for many centuries (Eeckhout, 2004; Rostworowski, 2002). However, it is possible that pilgrims in the LIP were not travelling very long distances, as was the case during the Late Horizon with the Inca Empire (1470-1532 CE). Rather they may have been regional travelers (Eeckhout, 2008). Additionally, it was believed that the god Pachacamac had healing powers, and it is thought this attracted the ill to the site (Owens & Eeckhout, 2015). Furthermore, earthquakes were attributed to the god of Pachacamac, which only increased the sanctuary's religious hold over the Andes, a region historically known for its seismic activity (Rostworowski, 2002).

In terms of their mortuary behaviour, the Ychsma buried their dead in temples, walls, and cemeteries, the latter being the most common and characterized by being separated from permanent buildings (Diaz & Vallejo, 2004; Owens & Eeckhout, 2015). In these cemeteries, the Ychsma generally buried their dead in flexed, sitting positions (the youngest non-adults[1] were buried in supine position on their backs), wrapped in multiple layers of textiles to form what we now refer to as fardos funerarios (Díaz & Vallejo, 2004; Owens & Eeckhout, 2015).

During the months of March and May 2015, a team of archaeologists led by Jhon Baldeos excavated a cemetery on the outskirts of the main sanctuary of Pachacamac (Baldeos, 2015). According to Baldeos (2015), the burials from the upper most layer were mostly disturbed, disarticulated, and incomplete skeletal remains or secondary burials (Appendix 1). In contrast, most burials in the deeper layers were found as relatively undisturbed fardos (Baldeos, 2015). Baldeos (2015) proposed that the disturbance observed in the upper most layer was due to anthropogenic factors, such as sand mining in the 1960s. His team found diagnostic Ychsma—and potentially Inca—pottery and textiles across most layers, which suggested that this cemetery was culturally associated with the Ychsma (Baldeos, 2015).

It is not fully understood if the drastic differences in preservation (skeletonized remains vs fardos) was solely because of modern disturbances. The relationship between the people in both subsamples is also not completely clear. Furthermore, the connection between this cemetery and the rest of the site of Pachacamac has yet to be determined, and it is not clear if the individuals are locals to Pachacamac or pilgrims from other sites. Therefore, the relationship between the skeletal and fardo subsamples and their larger connection to Pachacamac remain unclear.

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[1] In this thesis, the term 'non-adults' is used as an umbrella term for all individuals under the age of 20.

This project will explore three main research questions using bioarchaeological, archaeological, and ethnohistorical information: 1) are the skeletal and fardo subsamples part of a single community or are they culturally distinct? 2) what can cranial modification and dental pathology tell us about the social dynamics of the people who were buried within the MUNA cemetery? And 3) what was the connection between the people interred in this cemetery and the rest of the site of Pachacamac and the surrounding areas?

The first question will be answered by comparing cranial modification and dental pathology variables between the subsamples to determine if they have (or not) statistically significant differences. The second and third questions will be explored by comparing the cranial modification and dental pathology results to other late pre-Hispanic Pachacamac and Central Coast samples.

1.2 Theoretical framework

The biocultural model has provided an integrated approach to anthropology, one that synthetizes multiple areas of expertise to bring forward a comprehensive study of humans (Zuckerman & Martin, 2016). By using this approach, I will be connecting biological and cultural data as I address questions about the relationship between the skeletal and fardo subsamples, the social organization of this community, and the connections of the people to the site of Pachacamac through the study of cranial modifications and dental pathology.

In anthropology, the study of humans as material culture is based on the premise that our bodies are shaped by social and historical forces (Sofaer, 2006; Tiesler, 2014; Tung, 2014). In bioarchaeology, this approach seeks to bring forward the experiences and histories of people, alongside the biological variables influencing their bodies, as part of the toolkit which we use to interpret humans to study their bodies as the “nexus between biology and culture” (Sofaer, 2006, p. 30). In the context of the pre-Hispanic Andes, cranial modification can be understood as the embodiment of multiple things, such as kin group identity and socioeconomic groups. Furthermore, cranial modification and its variations can be a way of tracing the embodiment of identity through time and space

(Velasco, 2018). Similarly, the teeth of people, studied through dental health attributes, can be interpreted as material culture that embodies variables like dietary practices, cultural behaviours, health, and disease (Lukacs, 2012).

The interactions between individuals in a society can depend on the culturally conferred age and phase in life, both of which are associated with biological aspects of the body (e.g., reproductive potential, height) (Tiesler, 2014). The heads of infants were intentionally shaped by their adult caretakers, as heads are only malleable during infancy and early childhood (Tiesler, 2014). In this sense, cranial modification was a form of irreversible and imposed assigned identity, rather than achieved status (Gowland & Thompson, 2013; Tiesler, 2014). Thus, understanding cranial modification as a practice that transcended generations and was associated with the relationships between adults and non-adults is key. Situating the theoretical approaches of embodiment within the biocultural model will allow me to interpret the results of this research project more holistically.

1.3 Organization of this thesis

This thesis is organized into seven chapters. The first chapter is this introduction. Chapter 2 covers the ethical considerations taken in the research and writing for this thesis. Chapter 3 is the literature review, which is subdivided in four parts. First, the ecological and geographical background of the Central Coast. Second, the cultural history of the Central Coast with a focus on the LIP and Pachacamac. And lastly, two sections of methodological background on cranial modification and dental pathology. The sample and methods will be described in Chapter 4. Chapter 5 will present the results of the cranial modification and dental pathology analyses divided into two parts. First, I will compare the results between the subsamples and determine if they are significantly different or not. Afterward, I will present comparisons between different subgroups within the MUNA sample[2] (e.g., female vs male adults) to explore other possible axes of social differentiation through cranial modification and dental pathology. Chapter 6 will discuss and interpret the results of the analyses within the context of the Pachacamac—and the larger Central Coast region—during the LIP. Additionally, this chapter will include suggestions for future research regarding the MUNA collection. The last chapter, Chapter 7, will present the conclusions of the project.

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[2] The term 'MUNA sample' refers to the group of remains from the MUNA collection analyzed for this thesis. The term 'MUNA collection' refers to *all* the remains excavated from the MUNA cemetery, which includes the analyzed MUNA sample and the remains that were not analyzed for this thesis.

Chapter 2

2 Ethical considerations

As this research project worked with human remains, it was imperative to have a code of ethics to adhere to. In 2003, the American Association of Biological Anthropologists (AABA, previously the American Association of Physical Anthropologists) published its Code of Ethics based on other fields' guidelines and US legislation (Turner et al., 2018). I have adhered to this code of ethics and its standards in the process of making this thesis. Additionally, Andrew Nelson's SSHRC project "Mummies as Microcosms: The Bioarchaeology of the Inca Occupation of the Central Coast of Peru," which includes this thesis, has been reviewed and approved by Western University's Human Subject Research Ethics Board (UWO HSREB #114146).

The direct analysis of the skeletal remains was almost exclusively non-invasive and non-destructive (although minimally invasive samples were taken for radiocarbon dating and isotopic analysis as part of the larger "Mummies as Microcosms" project). As there are no known living descendants for these remains, following Thomas and Krupa's (2021) guide. I have taken into consideration the wishes and opinions of local researchers and authorities and complied with the legal norms of the Peruvian Government, Ministry of Culture, and especially Museo Pachacamac, a collaborator in this project. I have approached these remains with respect, and as a Peruvian scientist I have cherished this opportunity to work with past people of my country.

Computed tomography and X-rays have allowed bioarchaeologists to virtually analyse mummies in a non-invasive way, and thus represent a great technological advance in the field (BABAO, 2019). The digital images produced with these methods are invaluable in the study of human remains and the dissemination of research, but create ethical issues that did not exist in the past (BABAO, 2019). The current AABA Code of Ethics has little to no mention of how to properly handle digital images of human remains, and an initial debate concluded that conversations around the ethics surrounding these images were not enough (Williams & Atkin, 2015). It is fundamental that the process and context in which the images are taken, and the sharing of said images, follow ethical considerations that ensure respect and dignity for the deceased (Aris, 2020; BABAO, 2019). In March 2020, the journal 'American Anthropologist' was heavily criticized online for using an archival photograph of Dr. Margaret Mead, a white anthropologist, posing with indigenous modified crania from New Guinea in their front cover (Aris, 2020). This event led to a nuanced conversation about the context in which this photo was taken, and the racism and colonialism coursing through anthropology at that time.

More recent conversations have discussed the issues of sharing photographs of the dead, especially considering that today the digitalization of photographs allows for the unlimited reproduction of images through various online platforms, like social media (BABAO, 2019; Harries et al., 2018). In their discussion of photography, Harries and colleagues (2018) emphasized the importance of informed consent when the photo is taken to avoid appropriation.

In the case of the sample studied in this thesis, acquiring informed consent from the dead or any living descendants is an impossible task. In this sense, I followed the 2019 recommendations of the British Association of Biological Anthropology and Osteoarchaeology (BABAO). In this document, they encourage that making or using replicas of human remains, whether physical or digital, should only be carried out with scientific reasons for research, education, and/or public knowledge (BABAO, 2019). In their statement, BABAO highlighted 'preservation' and 'analysis' as two of the main benefits of using replicas of human remains in research, as they "prevent damage, degradation, and/or destruction of the skeletal materials" (which can be expanded to mummified and partially mummified remains like fardos) and "offer powerful analytical tools for the study of morphological-based changes to human remains" (BABAO, 2019, pp. 5–6). For this research project, both preservation and analysis were the primary reasons behind the use of 3D and 2D digital images of the fardos. In sum, I drew from the AABA and BABAO codes of ethics and recommendations to prioritize respect and dignity for the dead.

Lastly, I would like to discuss the language in some of the sources I have used for this thesis. I recognize that some of the sources employed inaccurate, unethical, and morally incorrect language, which I do not support. Similarly, I recognize that some anthropologists and ‘explorers’ of the past have been criticized for their racist, sexist, and homophobic views and writings. For historical and academic accuracy, I have decided to cite some of these sources with the disclaimer that anthropology and the language used in the field has evolved from what it used to be in the 1800-1900s to counteract the racist and prejudicial terminology of the past.

A relevant example in this thesis is the language used to describe cranial modification. In the past, the practice and its results have been called “cranial deformations,” “barbarities,” “ethnic mutilations,” “distorted specimens,” among other things (Dingwall, 1931). This terminology has given cranial modification negative connotations, and it is a projection of Western, colonial, and modern biases from anthropologists and the Spanish chroniclers. Although cranial modifications continue to be commonly known as cranial deformations, even in academic spaces, I believe it is important to begin a change in language in the field.

Chapter 3

3 Literature review

This chapter will provide the archaeological and methodological backgrounds to interpret the results of the analyses. It is divided into four parts. The first section describes the geographical and ecological background of the Central Coast. The second part presents the archaeological and bioarchaeological background, which focuses on the cultural history of the Central Coast, specifically the LIP and Pachacamac. The third and fourth parts are the methodological backgrounds on cranial modification and dental pathology, respectively.

3.1 Geographical and ecological background

The Peruvian marine environment is part of the Warm Temperate Southeastern Pacific marine ecoregion and has five currents going through it (Brack & Mendiola, 2004; Spalding et al., 2007). One of the most important currents within this system is the Humboldt Current, which travels deep south-to-north from Chile to the northern coast of Perú; is characterized by its low temperatures, salinity, and oxygen levels; and is an important factor in the upwelling of nutrients (Montecino & Lange, 2009). This last characteristic makes the Peruvian Sea the most biologically productive sea of pelagic fauna in the world, a factor that has positively influenced the lives of the people living in the coast for millennia, especially in the Central Coast, where this productivity continues year-round (Beresford-Jones et al., 2021; Brack & Mendiola, 2004; Chavez et al., 2008; Montecino & Lange, 2009). The low temperature of this current reduces temperatures inland along the coast, lowers precipitation levels, and produces heavy fog during winter (Brack & Mendiola, 2004; Lanning, 1967; Quilter, 2014). Occasionally, the Humboldt Current is disrupted by El Niño Southern Oscillation (ENSO) events, which elevates sea temperatures, increases precipitation levels along the coast, and alters the local marine fauna (Brack & Mendiola, 2004). The intensity of the ENSO events decreases from north to south, and thus the effects on human lives vary. It can bring the collapse of the fishing industry, flooding of agricultural lands due to increased rain, salinization of soil, infrastructural damage, increase the geographical range for infectious diseases, etc. (Brack & Mendiola, 2004; SENAMHI, 2014).

The Peruvian coast is a long and narrow region, part of one of the driest deserts in the world (Brack & Mendiola, 2004; Lanning, 1967). The coastal plains and low mountains extend about 30 to 60 km wide with a maximum elevation of 1000 meters above sea level (Brack & Mendiola, 2004). Due to being bordered by the Pacific Ocean to the west and the Andean highlands to the east, the climate is characterized by low annual precipitations, high relative humidity (fog), and temperate temperatures with some seasonal variations (Brack & Mendiola, 2004; Pulgar, 2014). Despite the extreme dry conditions, the Peruvian coast has a wide range of ecosystems and biodiversity thanks to fog oases known as *lomas* and rivers that cut the coast transversally east to west, creating fertile fluvial valleys (Brack & Mendiola, 2004). During winter, the moisture condenses into dense fog and light precipitation (locally known as *garúa*) and creates the lomas, patches of fog vegetation between 200 and 800 meters above sea level (Lanning, 1967; Nieuwland & Mamani, 2017; Quilter, 1989). The flow of the rivers varies greatly by season, most of them increase their flow during summers (December to March) when it rains in the Andean highlands, and only the largest ones (Chancay, Chillón, Rímac, Lurín, and Cañete) have water all year round (Brack & Mendiola, 2004; Bueno Mendoza, 1974; Lanning, 1967). Similarly to the ocean, the lomas and river valleys, have played a key role in the lives and sustenance of coastal communities since ancient times (see Table 3.1 for examples of food resources) (Beresford-Jones et al., 2021; Engel, 1957, 1970, 1973; Lanning, 1967; Patterson & Lanning, 1964).

Table 3.1 Summary of crops, wild plants, and faunal resources used in the Andes during pre-Hispanic times (Lanning, 1967; Quilter, 2014)

	Type	**Examples**
Flora	*Grains*	Maize, quinoa, *cañihua*, amaranth.
	Legumes	Beans and peanuts.
	Cucurbits	Squashes and gourds.
	Roots	Potatoes, sweet potato, oca, *ulluco*, *añu*, *achira*, *jíquima*, *arracacha*, manioc.
	Fruits	Pineapple, soursop, avocado, *molle*, cucumber, *chirimoya*, guava, *pacae*, lúcuma, *sapote*.
	Others	Coca, cotton, chili peppers, tobacco, San Pedro cactus, *ayahuasca*, *junco*, *totora*, *caña*, *maicillo*, carob tree.
Fauna	*Terrestrial*	Andean camelids (guanaco, llama, vicuña, and alpaca), white-tailed deer, Andean fox, *vizcacha*, Muscovy duck, guinea pig, Peruvian hairless dog, *guacamayos*.
	Aquatic	Fish (e.g., sardines, anchovies) sea birds, mollusks, crustaceans, *Spondylus*, sea mammals.

The "Central Coast" is an archaeologically defined geographical area that has varied in length throughout history, and studies often only include the low and middle valleys (Bueno Mendoza, 1974; Lanning, 1967; Marcone, 2022; Rostworowski, 2002; Villacorta, 2004). The longest range attributed to the Central Coast includes nine rivers, north to south: Huaura, Chancay-Huaral, Chillón, Rímac, Lurín, Chilca, Mala, Omas, and Cañete (Figure 3.1) (Marcone, 2022). Oftentimes, the Central Coast is limited to the Chillón, Rímac, and Lurín Valleys—or these valleys are interpreted as the 'core' (Díaz, 2008; Rostworowski, 2002). This is perhaps a bias that reflects a preference to study late pre-Hispanic periods and cultural developments, as these three valleys were the lands in which some of the most prominent coastal cultures developed.

Figure 3.1 Map of the maximum extent of the Central Coast (maps adapted from *Mapa de Cuencas Hidrográficas Del Perú*, 2003; Waterloo1883, 2020, 2023)

The lower valley or *yunga* includes the area closest to the Pacific Ocean, up to about 200 meters above sea level, and has fertile, cultivable lands despite the dryness of the desert (Figure 3.2) (Dillehay, 1976; Lanning, 1967; Marcone, 2022). Ethnohistoric descriptions of the lower valley include multiple fresh water sources besides the rivers, such as estuaries, lagoons, and swamps (e.g., the Urpi Kocha lagoon near Pachacamac) (Rostworowski, 2005). Furthermore, the lomas ecosystem provided a wide variety of resources and would have sustained camelid herding (Rostworowski, 2005). The middle valley—or *chaupiyunga*—ranges between approximately 200 to 1000 meters above sea level, and its topology is characterized by deep valleys, canyons and slopes, and heavy rains that can lead to landslides (Figure 3.2) (Brack & Mendiola, 2004; Pulgar, 2014). The middle valley represents a connection between the ocean and the highlands, and supported the cultivation of the coca leaf, an important element in Andean culture to this day (Dillehay, 1976; Marcone, 2022; Rostworowski, 2002). The ecology of the Central Coast valleys favored the middle valleys with the control of the river flow downstream, which influenced the tight relationship between the people living in these two different zones (Rostworowski, 2002).

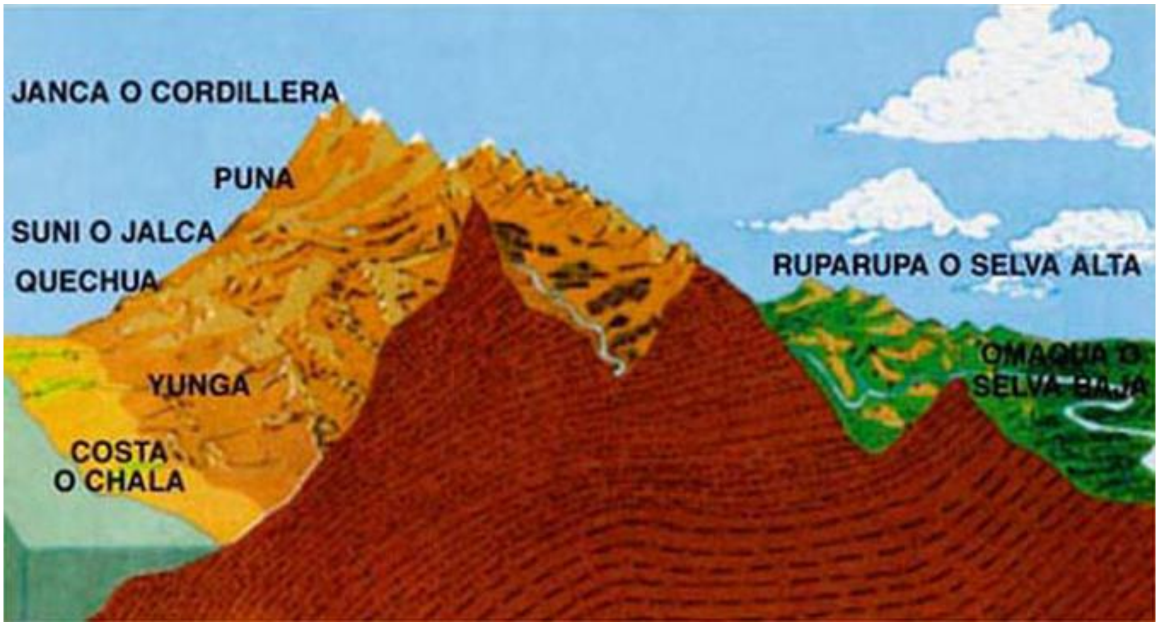

Figure 3.2 Altitudinal cross-section of the Andes according to Javier Pulgar Vidal (Pulgar, 2014). In this image, the “costa” or “chala” is the lower valley, while the “yunga” is the middle valley.

The Archaeological Sanctuary of Pachacamac was one of the most important sites in the pre-Hispanic Central Coast. It sits in the Lurín Valley, approximately 25 km south of the metropolitan city of Lima (Museo Pachacamac, n.d.-b). Pachacamac lies on the edge of a slope overlooking the mouth of the Lurín River, the Pacific Ocean, and the remains of the Urpi Kocha lagoon (Winsborough et al., 2012). Additional connections to water are the *puquios*, a series of aqueducts and wells spread throughout the sanctuary (Shimada et al., 2022). This confluence of bodies of water and the cliff-top vantage point is unique on the Central Coast, and the presence of aquatic iconography was prevalent in many—if not all—the cultures that occupied Pachacamac in pre-Hispanic times (Winsborough et al., 2012). In their paleoenvironmental study at the Urpi Kocha lagoon, Winsborough and colleagues (2012) found evidence of four major floods that affected Pachacamac and its surrounding area. The most relevant occurred around the 6th century CE, the transition period between the Early Intermediate Period and the Middle Horizon (Lima Culture); the second, also known as the ‘Naylamp flood’, around 995 - 1008 CE, the transition between the Middle Horizon and the Late Intermediate Period (Ychsma Culture)

(Winsborough et al., 2012). These two floods and their potential impacts on the cultures they affected will be discussed in the section below.

3.2 Archaeological background: The cultural history of the Central Coast

The current section of this literature review describes the pre-Hispanic cultural history of the Central Coast using established chronologies and geographical organizations through ethnohistorical, archaeological, and bioarchaeological evidence (Table 3.2). Given the focus of this thesis on cranial modification, dental pathology, and funerary patterns of late pre-Hispanic periods at Pachacamac, I will focus this literature review on those themes during the Late Intermediate Period and Late Horizon. Additionally, I will focus on the developments and changes in the Chillón, Rímac, and Lurín rivers, as they are the most relevant in the study of Pachacamac. I will also include the Chancay-Huaral Valley (or simply Chancay) to a lesser degree.

Table 3.2 Summary of the pre-Hispanic cultural history of the Central Coast and occupation at Pachacamac from the Preceramic to the Late Horizon periods (Burger, 1992; Lanning, 1967; Marcone, 2022; Quilter, 2014; Rowe, 1962).

Period	**Dominant traditions/cultures** (Regions and sites)	**Occupation at Pachacamac** (Cultures/traditions and associated architecture)
Late Horizon (LH) 1470-1532 CE	**Inca Empire** - *Rímac:* Maranga, Armatambo, Puruchuco-Huaquerones, Rinconada Alta - *Lurín:* Pachacamac, Panquilma, Quilcay	**Ychsma-Inca** Temple of the Sun, Pilgrims' Plaza, walled streets, Taurichumpi
Late Intermediate Period (LIP) 1100-1470 CE	**Chancay Culture** - *Huaura:* Acaray, Cerro Colorado - *Chancay:* Carabayllo, Pisquillo Chico, Lauri, Cerro Pasamayo - Ancón **Colli Culture** - *Chillón:* Collique **Ychsma Culture**	**Early, Middle, Late Ychsma, and Ychsma-Inca** Pyramids with Ramps

	- *Rímac:* Maranga, Armatambo, Mateo Salado, La Rinconada Alta, Puruchuco-Huaquerones, Huallamarca - *Lurín:* Pachacamac, Pueblo Viejo-Pucará, Panquilma, Pampa de Flores, Quilcay	
Middle Horizon (MH) 600-1100 CE	**Late Lima and Wari** - Ancón - *Chillón:* Copacabana - *Rímac:* Cajarmarquilla, Catalina Huanca/Vista Alegre, Maranga, Huaca Pucllana - *Lurín:* Pachacamac	**Lima Wari-related and Pachacamac styles** Old Temple, Mud-brick Compound, Painted Temple.
Early Intermediate Period (EIP) 200 BCE-600 CE	**White-on-red > Lima Culture** - *Chancay:* Cerro de Trinidad - Ancón - *Chillón:* Cerro Culebra, Playa Grande, Copacabana - *Rímac:* Maranga, Cajamarquilla, Huaca Pucllana, Catalina Huanca/Vista Alegre, Nievería - *Lurín:* Pachacamac, Tablada de Lurín	**Lima Culture** First monumental architecture built around 400 CE. Old Temple, Mud-brick Compound, Painted Temple.
Early Horizon (EH) 900-200 BCE	**Chavín** - Ancón - *Chillón:* Garagay - *Chilca:* Curayacu	**First occupation** White-on-red style
Initial Period (IP) Circa 1800-900 BCE	**Manchay, U-shaped temples** - *Chancay:* Río Seco, San Jacinto - *Chillón:* Canto Grande, Ancón - *Rímac:* La Florida, Garagay - *Lurín:* Mina Perdida, Parka, Huaca Candela, Manzano, Cardal, Manchay Bajo, Pampa Cabrera, Malpaso	

Preceramic Circa 14000-1500 BCE	**Seasonal camps > monumental mounds** - *Huaura:* Bandurria, Punta Quilca - *Chancay:* Río Seco - *Ancón:* Arenal, Luz Complex, Canario, Corbina, Encanto, Tank Site - *Chillón:* The Red Zone, Oquendo, Chivateros 1, Chivateros 2, Pampa, El Paraíso, Río Seco, Buena Vista, Salamanquejo - *Rímac:* Punta Grande - *Chilca:* Paloma, Chilca I	

3.2.1 Late Intermediate Period (600-1100 CE)

The Late Intermediate Period (LIP) is classically considered the ‘transition’ time between the Wari-Tiwanaku and Inca Empires with a predominance of regional states and polities controlling different parts of the Central Andes[3], similar to the EIP (Lanning, 1967; Quilter, 2014). This decentralized sociopolitical organization was reflected in diverse styles of pottery, textiles, and architecture. In general, coastal societies were more complex than their highland counterparts, and the lower valley groups had less defensive architecture and settlement patterns than upper valley or highland communities (Dulanto, 2008; Krzanowski, 2016). In contrast, violence levels in the Central Coast, especially in the Rímac and Lurín Valleys, were higher and more lethal in the LIP than at the end of the MH (Vega, 2016).

Despite the high quality and technological advances made in the craft of pottery, by the LIP, the artistic range was limited compared to the earlier styles, which could have been due to a higher demand for pottery accelerating production, or vessels serving a more

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[3] The Central Andes generally encompasses Ecuador, Perú, Bolivia, and northern Chile, and northwestern Argentina (Quilter, 2022).

utilitarian purpose (Díaz, 2022; Lanning, 1967; Quilter, 2014; Vallejo, 2004). The few centers that still produced elaborate and decorative pieces would trade these as luxury goods (Lanning, 1967). Architectural ornaments, similarly to pottery, seemed to decline in the LIP compared to previous periods, but the coast kept its carved and painted murals on their constructions (e.g., Painted Temple at Pachacamac) (Lanning, 1967). In contrast, textile production was incredibly elaborate, and the skill was perceived to be of high prestige; most museum exhibits have LIP tapestries (Lanning, 1967). Metallurgy of ornamental pieces and tools was another craft that grew, perhaps due to North Coast influence (Lanning, 1967).

Coastal populations in the Central Andes were largely supported by the exploitation of marine resources and intensive and extensive agriculture with the extension of the existing irrigation systems (Covey, 2008; Díaz, 2022). Not all the crops in Table 3.1 were produced in the lower valleys, which meant trade occurred both horizontally across the Central Andes and vertically across different altitudes (Covey, 2008; Espinoza Soriano, 2015; Lanning, 1967). In addition to trade, important sites like Pachacamac, also received tribute from different places, making it possible for the center to have a wide variety of crops all year round despite not having available water for such production all 12 months (Espinoza Soriano, 2015). Central Coast iconography found in pottery, textiles, and murals had a clear connection to the ocean with motifs of the sea, birds, and fishes (Díaz, 2008, 2015). This suggested that the ocean had ties to not only their economic activities, but likely their social ideologies as well (Díaz, 2008). Sometimes, these motifs were also found in tattoos (Díaz, 2015).

For María Rostworowski, a Peruvian historian widely known for her work with ethnohistorical accounts, the sociopolitical organization of the Central Coast during the LIP was a series of politically independent señoríos or chiefdoms, all of which formed a sort of religious coastal confederation (*confereración yunga*) under the religious cult of Pachacamac (Espinoza Soriano, 2015; Rostworowski, 2002, 2016). Each señorío was subdivided into smaller political units called curacazgos or ayllus, in which the curacazgos could have been divided by the irrigation canals or the lands that each canal could water (Espinoza Soriano, 2015; Rostworowski, 1977; Villacorta, 2004). Each curacazgo had their own *curaca* or lord, who was the leader and organizer of the people, the lands, and the resources, but not necessarily their owner (Díaz, 2022; Espinoza Soriano, 2015; Rostworowski, 1977). It is possible that coastal elites were leaders of communities, instead of heads of lineages, although kin-based organization likely continued to be used as well (Covey, 2008). It is also possible that these two types of organization were the same in pre-Hispanic times.

According to Rostworowski (2004, 2016) the socioeconomic organization of coastal communities was based on labor specialization, which overall divided the occupations into fishers and agriculturalists. In her framework, the surplus allowed these communities to trade with each other for the resources they needed, and thus generally people did not have multiple jobs, which progressively supported the growth of other crafts, such as metallurgy, textile production, ceramics, etc. (Rostworowski, 2004, 2016). This exclusive labor specialization mostly occurred in the coast, and the differences in labor were not as marked in the highlands (Rostworowski, 2016).

A stable isotope study comparing diets from two coastal sites, Armatambo and Rinconada Alta—a fishing and agricultural community, respectively—found differences in diet, in which Armatambo had evidence of increased consumption of marine resources than Rinconada Alta (Marsteller et al., 2017). Additionally, the study suggested a moderate degree of trade between agricultural and fishing specialists, as results for Rinconada Alta showed a reliance of C_4 and C_3 plants, plus a relatively smaller proportion of marine resources or the consumption of lower trophic level species (Marsteller et al., 2017). The relationship between the lower valley people (Yungas) and the middle-upper valley people (Yauyos) was complex in the Central Coast because, geographically, the Yauyos controlled the irrigation systems' intake and lands to cultivate coca leaves in the middle valleys (Rostworowski, 2002). Ethnohistorical sources described this relationship as intermittent periods of conflict (possibly ritual warfare) in between periods of peace and intense trade between the two groups (Rostworowski, 2002).

Geographically, the Central Coast was divided into two different cultural developments during the LIP: the Chancay and Ychsma[4] (see Figure 3.3 for the most important late pre-Hispanic sites). The Chancay Culture occupied the Huaura and Chancay Valleys, with influence over the Supe Valley to the north and the Ancón area to the south; while the Ychsma developed in the Rímac and Lurín Valleys, although evidence of influence has been found south in the Mala Valley (Díaz, 2008, 2022; Dulanto, 2008; Espinoza Soriano, 2015; van Dalen Luna, 2004). The Chillón Valley has been interpreted as a buffer zone between the Chancay and Ychsma, although more evidence is necessary. Other sources separate the lower Chillón Valley and describe it as being occupied by the Collique society under the organization of the *Colli Capac,* their curaca (Dulanto, 2008; Espinoza Soriano, 2015; Rostworowski, 2002, 2016).

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[4] 'Ychsma' has also been spelled as Ichma, Ychma, Yschma, Ychsma, Ichmay, Irma, Izma, Ishmay, or Ishma. After 2004, with the conference 'Primer Coloquio de los Periodos Tardíos de la Costa Central Peruana' researchers started to standardize the spelling to 'Ychsma' (Díaz, 2022).

Figure 3.3 Map of the Central Coast during the late pre-Hispanic periods with relevant archaeological sites (Lanning, 1967; *Mapa de Cuencas Hidrográficas Del Perú*, 2003; Quilter, 2014; Waterloo1883, 2020).

The Chancay Culture was a stratified society with different social groups such as priests, farmers, artisans, etc. (van Dalen Luna, 2004). A study of dental health from the

Cemetery of Los Pinos indicated that across all statuses, people adhered to a relatively cariogenic diet with no significant differences (Pezo-Lanfranco & Eggers, 2016). However, dental markers suggested that cultural practices, such as coca chewing and the consumption of *chicha*[5], were more common among high and middle status individuals, which aligned with the Andean ceremonial, ritual, and prestigious perception of foods like maize and coca (Pezo-Lanfranco & Eggers, 2016). Cranial modification analysis from the Necropolis of Miramar at Ancón determined that the crania presented fronto-occipital modifications (Watson, 2016).

Chancay sites include Acaray and Cerro Colorado in the Huaura Valley; Pisquillo Chico, Lauri, Cerro Pasamayo, Carabayllo, and Collique in the Chancay Valley; and Cerro de San Pedro and the Necropolis of Miramar in Ancón (Dulanto, 2008; Krzanowski, 2016; Watson, 2016). The two largest cities were Pisquillo Chico and Lauri, and they both had public architecture, elite and commoner housing, and cemeteries (Dulanto, 2008). Some of the public buildings had architectural similarities, such as a rectangular base, the presence of a small pyramid, a ramp, rooms, and patios, which were called "*montículos piramidales*," and are comparable with the Pyramids with Ramps, a type of monumental architecture classically associated with the Ychsma (see below for more details) (Dulanto, 2008; Eeckhout, 1999; Krzanowski, 2016; van Dalen Luna, 2004). Chancay art was characterized by its black-on-white pottery styles and their highly elaborate textiles (Quilter, 2014; van Dalen Luna, 2004). Textile and ceramic figurines—also known as 'Chancay Dolls' and *cuchimilcos*, respectively—were common grave goods found in Chancay burials and have been attributed a funerary-ceremonial use (Quilter, 2014; van Dalen Luna, 2004). Some pottery figurines depicted cranial modification practices (Weiss, 1961, 1962).

The level of control that the Chancay polity had on rural communities around the Huaura and Chancay Valleys is not clear, but the widespread nature of Chancay pottery and textiles, especially as grave goods in burials, has suggested that the acquisition of these

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[5] Chicha is a fermented drink made with maize and it was traditionally made by chewing maize.

goods was an important element of how this culture was organized socially, politically, economically, and/or religiously (Quilter, 2014). Archaeological evidence indicates that the Chancay traded goods with communities in the Amazon (macaw feathers) and North Coast (*Spondylus* shells) (van Dalen Luna, 2004).

The Ychsma society was one of the most important señoríos from the Central Coast, and their lord resided at Pachacamac, although Maranga and Armatambo in the Rímac Valley were also important sites (Díaz, 2022; Espinoza Soriano, 2015; Rostworowski, 2016). Luisa Díaz has suggested that the Ychsma territory can be understood as Pachacamac and the Lurín Valley as the "nuclear area," with the Rímac and Mala Valleys as the northern and southern peripheries, respectively (Díaz, 2008, p. 122). According to ethnohistorical accounts, the lower Rímac and Lurín Valleys were possibly a political unit under a single curaca, and the neighbouring areas would call these two areas '*Yscay mayo'* or 'two rivers' (Espinoza Soriano, 2015; Rostworowski, 2002).

The Ychsma occupied all three major coastal ecosystems mentioned in sections above: the littoral, the lower and middle valleys, and the lomas (Espinoza Soriano, 2015). Similarly to the Chancay Culture, the Ychsma were a stratified society, which was reflected in mortuary practices, architecture, among other things (Díaz, 2015; Eeckhout, 1999). In the Lurín Valley, the Ychsma were subdivided into four ayllus: Ychsma/Pachacamac[6], Manchay, Quilcay, and Caringa; the Rímac Valley division is less clear, but it can be loosely subdivided into six curacazgos: Surco, Guatca, Lima, Maranga, Gualcay, and Callao (Cornejo, 1999; Eeckhout, 2004, 2008; Rostworowski, 2002, 2016). The ayllus division in the Lurín Valley seemed to be the LH organization of the region and was associated with different economic activities: Manchay and Pachacamac were related to agriculture, Quilcay was a fishing village, and Caringa was associated with the cultivation of crops and camelid pastoralism in the lomas (Bueno Mendoza, 1974; Díaz, 2022).

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[6] Ychsma was likely the pre-Inca name of the region, and possibly the archaeological center and associated oracle and god. It is thought that it was later changed to Pachacamac by the Inca.

Pottery stylistic studies have established an Ychsma chronology in which Early Ychsma corresponded approximately to the end of the MH and beginning of the LIP, the Middle Ychsma styles were largely developed in the LIP, and the Late Ychsma styles included the latter part of the LIP (A) and the arrival of the Inca (B) (Vallejo, 2004). The Late Ychsma styles can be generally divided into three subtypes: the Ychsma style, the 'Inca cuzqueño', and a hybrid of the two with northern influences, the 'Inca Regional' (Vallejo, 2004).

The main type of Ychsma architecture was the archaeological complex known as Pyramids with Ramps (PWRs, *Pirámides con Rampa*) (Dulanto, 2008; Eeckhout, 1999, 2004). However, not all LIP Ychsma sites have this type of architecture (Dulanto, 2008). Peter Eeckhout (1999) defined a PWR with three criteria based on previous work by Paredes: the presence of a courtyard, a platform, and a ramp. PWRs are generally found in the Lurín (e.g., Pachacamac, Panquilma, Tijerales, Pampa de Flores, Huaycán de Cieneguilla) and Rímac Valleys (e.g., Armatambo, El Olivar, Puruchuco-Huaquerones) (Díaz, 2004, 2008; Eeckhout, 1999; Villacorta, 2004).

There have been two main hypotheses on the function of the PWRs, one of religious embassies and another of elite palaces (Bueno Mendoza, 1974; Eeckhout, 1999; Jiménez Borja & Bueno Mendoza, 1970; López Hurtado, 2016). The first hypothesis interpreted each PWR as a religious embassy for a lesser god at the sanctuary of Pachacamac, these gods were part of the Ychsma mythical pantheon and 'family members' of Pachacamac the god (Eeckhout, 1999). In this sense, the Sanctuary of Pachacamac and its cult served as a unifying center for the señorío of Ychsma, and the PWRs were civic-ceremonial centers of Ychsma elite groups who served the sanctuary and believed in the god of Pachacamac (Eeckhout, 1999; Jiménez Borja & Bueno Mendoza, 1970; Rostworowski, 2002). This hypothesis has not been supported by archaeological evidence—e.g., there were no foreign ceramics and textiles—and this interpretation has been criticized for being heavily influenced by ethnohistory (Eeckhout, 1999, 2003).

The second hypothesis of elite palaces was proposed by Eeckhout after his excavations and research at Pachacamac (Eeckhout, 1999, 2003, 2004). The pyramids were successive curaca palaces, thus only one was actively used at a time at Pachacamac, and it was abandoned when there was a change in leadership (Eeckhout, 1999, 2004; Michczyński et al., 2003). In this framework, Pachacamac was a religious, political, and economic center during the LIP, and the Lurín Valley was a politically unified and stratified region under the organization of the priests, who were also political elites (Eeckhout, 1999, 2004). The archaeological evidence supporting this hypothesis at Pachacamac includes a chronological succession of the construction and use of the pyramids (including offerings that corresponded with the foundation and remodeling/abandonment of the buildings), evidence of feasts and domestic occupation, storage spaces for food and crafts, and elite burials associated with the abandonment of each PWR (Eeckhout, 1999, 2003, 2004). Considering that the main curaca was buried in their corresponding PWR, these buildings could also be associated with ancestor veneration, in which the surviving members of the community left offerings after the burial (Farfán, 2004).

PWRs across the Central Coast vary in size and spatial organization, some of which have raised different interpretations, such as being simplified versions of their counterparts at Pachacamac (Villacorta, 2004). PWRs with offset ramps have been excavated at Panquilma and Tijerales, both sites in the Lurín Valley east of Pachacamac (Estrada & López-Hurtado, 2017). At Panquilma, the architectural organization of the pyramid complexes and the presence of Late Ychsma pottery at two different pyramids have suggested that the PWRs were contemporaneous and used for ritual and ceremonial purposes by elites for a select group (Estrada & López-Hurtado, 2017; López Hurtado, 2016). Additionally, excavations in the public spaces have shown evidence of ritual practices associated with buried offerings, not feasts as seen at Pachacamac (López Hurtado, 2016). Some other PWRs do not have evidence of residential areas and others are too small to be considered elite residences (e.g., Pachacamac, Huaquerones, and Pampa de Flores), in which case it has been suggested that there were non-residential PWRs that were used for specific ceremonies periodically or cyclically (Villacorta, 2004). Some of these PWRs were surrounded by smaller constructions, which have been interpreted as complementary infrastructure to the palace for storage and craft production (Villacorta, 2004). The different sizes of PWRs throughout the Central Coast could have reflected a hierarchy in relation to Pachacamac, or differences in power of each curaca

(Villacorta, 2004). Even though archaeological surveys have not found much foreign material culture at the PWRs to support the model of religious embassies, it is possible that between the LIP and the LH the PWRs shifted in their use, from elite palaces to religious temples for pilgrims (Eeckhout, 2004). Not a single model fits for the interpretation of all PWRs, and the sequential palace hypothesis can be used at Pachacamac, but not at peripheral centers (Eeckhout, 1999, 2003, 2004).

Early and Middle Ychsma cemeteries, differently to the Inca, were separate from their monumental architecture (Díaz, 2004; Díaz & Vallejo, 2005). However, Late Ychsma burials were near monumental architecture, sometimes even intrusive to it, especially the ones closer in time to the LH (Díaz, 2004; Díaz & Vallejo, 2005). Furthermore, the number of people buried in a single grave increased over time. Early, Middle, and Late Ychsma A burials tended to be mostly individual, whereas Late Ychsma B burials often included multiple individuals per grave, which had anthropogenic characteristics, such as adobe or stone structures surrounding the pit (Díaz, 2015). At Pachacamac, Owens and Eeckhout (2015) found a pattern of crowding and tomb disturbance with proximity to the Sacred Precinct, in which more crowded pits were found closer to the temples. This pattern increased over time from Lima to Ychsma to Inca burials (Owens & Eeckhout, 2015).

LIP burial practices in the Central Coast reflected the social hierarchy of the time, with labor specialization and ancestor veneration through the maintenance of lineages (Covey, 2008). Ethnohistorical accounts described the Ychsma mortuary rituals to be elaborate, with bodies being buried dressed and “mummified,” with their personal items (Espinoza Soriano, 2015, p. 140). Unfortunately, the term “mummified” was not defined. Bioarchaeological research has not showed evidence of artificial mummification (Type III)[7] on the Central Coast (Díaz, 2004, 2015). This suggested that the Spanish accounts were likely referring to intentional natural mummification (Type II), which refers to the mummification of the body by environmental factors by intentionally selecting burial

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[7] I am following Vreeland’s (1998) classification for mummification types, in which ‘artificial mummification’ includes practices such as the intentional removal of internal organs, heat treatments, and/or embalming.

locations that favor natural desiccation, and/or the use of highly absorbent materials (e.g., textiles) (Vreeland, 1998).

The Ychsma burial practices continued the MH Andean tradition of fardos, with variations in fabrics and elements that built the textile bundle (Díaz, 2004). Díaz and Vallejo (2005) indicated that the change in mortuary practices between the Lima and Ychsma was gradual, rather than abrupt. Furthermore, ancient DNA analyses showed evidence of genetic continuity from the MH to the LIP (Valverde et al., 2016). Oftentimes, high status fardos also included funerary masks and/or *falsas cabezas*[8] (false heads) (Díaz & Vallejo, 2005; Eeckhout, 2021). The orientation of the fardos inside the circular burial pits varied across cemeteries, which some have associated with the position of the Ychsma temples (Díaz & Vallejo, 2005). In general terms, the fardos were cylindrical and consisted of two to three layers of simple textiles wrapping a flexed body, adult or non-adult (although the youngest non-adults were often buried extended), and sometimes the layers included junco mats or vegetable sticks on the sides (Díaz, 2004, 2015; Díaz & Vallejo, 2005). Normally, the most simple textiles were on the outer layers, while the most elaborate and multicolored textiles were near the body (Díaz, 2015). The presence of ropes around the body has only been reported for Late Ychsma burials, and the junco structures could have been associated with a form of social stratification (Díaz, 2004, 2015).

One unique Ychsma trait, mostly found in Middle and Late burials, was the presence of a *mate* (bowl or plate made of gourd) filled with ash used as a sitting place for the person inside the fardo (Díaz, 2004). Similarly, cinnabar was often found in Ychsma burials on painted faces and on the outer layer of the fardos (Díaz & Vallejo, 2005). The presence of *Spondylus* shells was more prominent in this period and the following LH than previous times. Díaz proposed that this shell was not introduced into the Lima region until the Inca arrival (Díaz, 2004, 2008). However, *Spondylus* shells have been found in LIP burials, especially Late Ychsma contexts, and were common in Ancón burials (Díaz, 2004; Watson,

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[8] In this thesis, funerary masks are understood as the wooden masks that were placed on the front of a fardo or a falsa cabeza to represent a face. A falsa cabeza, or false head, is a ‘bump’ or protuberance of textiles that is added on top of the fardo, as part of the structure, to represent the head.

2016). This could be interpreted as the shell being more common in the Central Coast during the LH in comparison with the LIP due to a increase of exchange with the Peruvian North Coast and Ecuador (cf. Díaz, 2004).

Male individuals were usually dressed in *uncus* and/or loincloths, while female individuals were dressed in tunics (Díaz, 2015). Male grave goods often included fishing paraphernalia, slings, or tweezers, while female burials were associated with weaving tools, such as spindles, needles, and yarn (Covey, 2008; Díaz, 2015; Prieto, 2014; Watson, 2016). The placement of metals was limited to small pieces on the face (more often on male individuals) or hands (more often on female individuals) (Díaz, 2004, 2015). Unlike the other traits mentioned, some treatments of the bodies, such as cutting the hair very short, happened regardless of skeletal sex (Díaz, 2004).

Atypical Ychsma burials include extended adult individuals on a stretcher (Díaz, 2004; Díaz & Vallejo, 2005). Non-adult burials accompanying adults were often very simple and it has been interpreted that the non-adults were part of the associated grave goods of the adults (Díaz & Vallejo, 2005). At Armatambo, Díaz (2015) found an atypical burial of an extended male adult with Ychsma mortuary traits, including Ychsma clothes and grave goods. This male individual exhibited a potentially violent death, this, in addition to the Ychsma mortuary traits, has been interpreted as a form of punishment or sacrifice (Díaz, 2015). Díaz and Vallejo (2005) indicated that the occurrence of atypical Ychsma burials increased towards the Late Ychsma phase.

The overall monumental landscape at Pachacamac can be understood as a successive superposition of architecture that started in the second half of the EIP, with the Lima Culture, and ended in the Late Horizon, with the Inca Empire (Makowski, 2017; Makowski et al., 2020). Interestingly, there is no evidence of continuous architectural design or pattern (Makowski, 2019; Makowski et al., 2020). The Lima buildings are located in the southwest section of the sanctuary (Kaulicke, 2000; Marcone, 2000; Uhle, 1991 [1903]) (Figure 3.4).

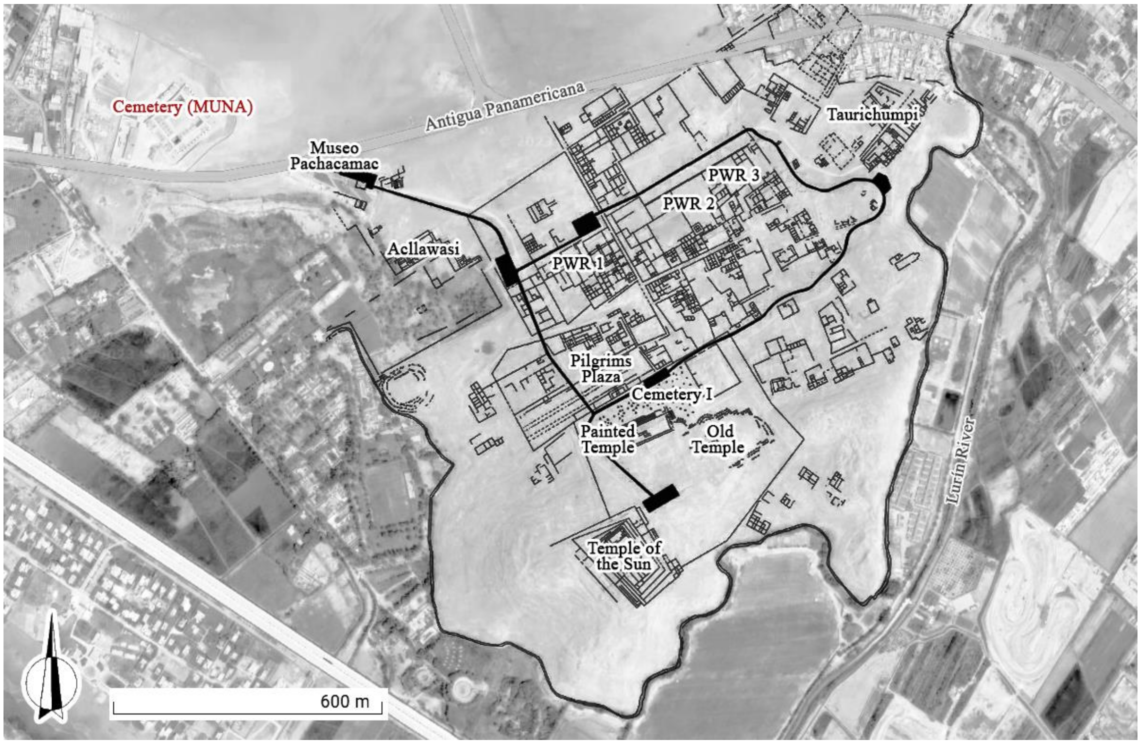

Figure 3.4 Map of the Archaeological Sanctuary of Pachacamac, the MUNA cemetery in red (Google Maps, n.d.; Museo Pachacamac, n.d.-a).

At Pachacamac, Early and Middle Ychsma adobes have been found in some LIP constructions, and there have also been Early Ychsma ceramics present near the Urpiwachac Temple (Díaz, 2004). After the end of the Lima development, the reorganization of Pachacamac began with the appearance of the PWRs, a process that has been found at other Central Coast locations, such as Cajamarquilla and Pisquillo Chico (Franco, 2004). Scarce archaeological evidence of pigments, metals, and warm water mollusks (e.g., *Spondylus*) in LIP burials has suggested that long-distance exchange was somewhat restricted during the LIP in comparison with the LH (Díaz, 2004). In this sense, the spread of the cult of Pachacamac throughout the Central Andes could have also been restricted until the arrival of the Inca, whose pan-Andean networks allowed for long-distance trade of goods and ideologies, especially from and towards important sites, such as Armatambo and Pachacamac (Díaz, 2004). Furthermore, Owens and Eeckhout (2015) have suggested that pilgrimage to Pachacamac during pre-Inca times was restricted to local or regional levels.

3.2.1.1 Late Intermediate Period summary

The Late Intermediate Period was a phase of regional and local cultural developments across the Central Andes. Although evidence of trade is present, it is likely that with the fall of the Wari and Tiwanaku Empires, exchange between communities became more restricted and was limited to a local and regional level. Evidence of specialist craft production was common, and so were well-defined social groups. Ethnohistorical information suggested that the Central Coast was a stratified region, sociopolitically organized in relatively independent señoríos, all of which formed a religious confederation under the cult of Pachacamac. These señoríos were subdivided into curacazgos, and each level of organization was ruled by a curaca. The two major cultural developments in the Central Coast were the Chancay in the Huaura and Chancay Valleys, and the Ychsma in the Rímac and Lurín Valleys. The Chillón Valley has been understood as a buffer zone between these two polities, although it is possible that a third society, the Collique, developed in the lower Chillón Valley. The Ychsma Culture, the most relevant in this study, was characterized by its monumental architecture called Pyramids with Ramps, which have been interpreted as elite palaces and/or cyclical ritual spaces. Ychsma cemeteries are generally separated from their monumental architecture, although by the arrival of Inca influence (Late Ychsma B), intrusive burials in older buildings became common. Typical Ychsma burials were flexed fardos interred in circular pits with grave goods that included personal and everyday items. Male individuals were generally buried with fishing, agricultural, or hunting instruments; while female individuals were found associated with weaving tools. The fardos sometimes included a false head, a tradition that carried over from the Middle Horizon. The cult of Pachacamac and pilgrimage to the site during the LIP could have been limited to the Central Coast, as archaeological evidence of long-distance trade during this period is scarce.

3.2.2 Late Horizon (1470-1532 CE)

The Late Horizon (LH) is the last period in the pre-Hispanic sequence of the Andes, and it is largely known as the time of the Inca, a highland polity from Cuzco that rapidly expanded throughout the Central Andes (Tantaleán, 2021). The origins of the Inca expansion outside of Cusco can be dated to their victory over the Chancas in the

Apurímac Basin, after which Pachacuti Inca Yupanqui was named the *Sapa Inca*, or Inca king, and launched the start of the empire in the first half of the 1400s (Lanning, 1967; Quilter, 2014). Around the 1460s, Topa Inca started a conquest campaign from Ecuador in the north to the Lurín Valley in the south, which included the annexation of the Chimú territory (Lanning, 1967). It is thought that when Topa Inca became Sapa Inca in 1471 CE, he extended the empire to its full extent, with his successor, Huayna Capac only conquering smaller areas in his reign (Lanning, 1967). The Central Coast was part of the Chinchaysuyo, the second largest and northern part of the Tawantinsuyu, or Inca Empire (Figure 3.5) (Quilter, 2014). The extensive territory was connected by the Qhapac Ñan, also known as the Andean or Inca Road System, a network of roads over 30000 km long (Tantaleán, 2021; UNESCO, n.d.). In contrast to their conquering abilities, the Inca were not inventors, rather they were effective distributors of known technologies, such as the irrigation systems of the Lima and Ychsma, the *andenes* (agricultural terraces) of the Tiwanaku, and the metallurgy expertise of the Chimú (Lanning, 1967).

Figure 3.5 Map of the Tawantinsuyu or Inca Empire divided into its four regions (EuroHistoryTeacher, 2010).

Just as with the Wari, the conquest of different regions by the Inca required different imperial strategies (Lanning, 1967; Quilter, 2014; Tantaleán, 2021). Evidence for the Central Coast has indicated that the Inca adapted many of the regional traditions and artistic styles (e.g., architecture, mortuary customs, ceramics) with gradual shifts towards Ychsma-Inca hybrids, rather than a complete replacement of local styles for Imperial ones (Díaz & Vallejo, 2004; Villacorta, 2004). For example, the Inca imposed their own religion while adopting local and regional gods into their pantheon, such was the case with the Ychsma god at Pachacamac (Lanning, 1967; Quilter, 2014; Rostworowski, 2002). Architectural continuity between Ychsma and Inca occupations at Armatambo indicated a considerable change for new imperial uses, but the shift was gradual with no apparent abrupt change (Díaz, 2004; Díaz & Vallejo, 2002).

A known Inca strategy was the *mitmaqs* or *mitimaes*, the transference of entire communities to an area different to their original homes (Tantaleán, 2021). In the Central Coast, this has been recorded in upper valley and highland señoríos in the Chillón, Rímac, and Lurín Valleys (modern day Canta and Huarochirí) and Pachacamac, where Inca allies from highland regions were moved to the coast (Bethard, 2013; Cornejo, 2002; Eeckhout & López Hurtado, 2018; Rostworowski, 2002, 2004; Tantaleán, 2021). A bioarchaeological study from Maranga concluded that the arrival of the Inca and their policies did not significantly impact everyday stress levels in the Central Coast (Boza, 2010). Similarly, overall violence levels suggested that the Central Coast was integrated into the Inca Empire relatively peacefully and violence remained low in contrast with the LIP, although military tactics were likely used when necessary, especially in the Ychsma periphery (Boza, 2010; Vega, 2016).

Under the Inca, agriculture and farming was highly organized, with the irrigation systems of the coast now running under a single authority (Lanning, 1967). The resources were distributed into three major groups: the Inca and local curacas; the specialists, such as the priests, artisans, and military; and the commoners, who made up most of the population and included agriculturalists, farmers, and fishers (Lanning, 1967). As in the LIP, the food economy of the LH included the crops, wild plants, and animals of Table 3.1, which offered a mixed diet (Lanning, 1967). It is understood that essential resources, such as food, were traded locally thanks to the high variability of ecosystems across altitudes; meanwhile luxury goods, such as *Spondylus* shells and elaborate textiles, were exchanged from all parts of the empire (Lanning, 1967).

On the Central Coast, some of the large cities of the Ychsma—such as Carabayllo, Armatambo, La Rinconada, and Pachacamac—continued to be occupied and used (Díaz & Vallejo, 2002; Lanning, 1967). Many PWRs continued to be used during the LH, although possibly only as temporary domestic spaces and burial sites (Díaz & Vallejo, 2002, 2004, 2005; Eeckhout & López Hurtado, 2018; Owens & Eeckhout, 2015). It is thought that the sociopolitical and economic organizations of the Central Coast did not go through abrupt changes during the LH, and that the Inca relied on the already organized señoríos to control the area (Rostworowski, 2002; Villacorta, 2004).

In the case of Pachacamac, the oracle continued to have an important role in the Central Andes and was one of the most important *huacas*[9]due to its regional prominence and strategic position, although some have suggested that its importance diminished due to the introduction of the Inca religion (Eeckhout & López Hurtado, 2018; Lanning, 1967; Rostworowski, 2002). The Inca undoubtedly reorganized the landscape at Pachacamac. For instance, they built several corridors and rooms that went over part of Cemetery I (Owens & Eeckhout, 2015). Additionally, they built the Temple of the Sun; the Acllahuasi or House of the Chosen Women; and the Taurichumpi, the residence of the curaca (Eeckhout & López Hurtado, 2018; Lanning, 1967).

Pilgrimage to Pachacamac reached its peak with the Inca (Eeckhout, 2013). This was reflected in the construction of the Pilgrims' Plaza, the transit system that controlled the flow of the pilgrims into said plaza, and the accommodations made to house the pilgrims before they could reach the oracle (Eeckhout, 2013; Eeckhout & López Hurtado, 2018). Many PWRs at Pachacamac were likely abandoned, reused as temporary pilgrims' camps, or built upon during the LH (Eeckhout, 2010; Eeckhout & López Hurtado, 2018). In all, Pachacamac most likely served a religious and administrative function for the Inca (Eeckhout, 2013; Eeckhout & López Hurtado, 2018).

Overall, the mortuary practices of the Central Coast seemed to have changed gradually with the Inca. The flexed fardo remained as the norm for most individuals, although the interment patterns changed (Díaz & Vallejo, 2002). As mentioned before, the Early and Middle Ychsma single burial pattern changed towards the Late Ychsma/Ychsma-Inca

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[9] Huacas are broadly described as a sacred object or place.

multiple burial pattern (Díaz & Vallejo, 2002, 2004, 2005; Owens & Eeckhout, 2015). During the Ychsma-Inca phase, the repurposing of old buildings as burial spaces became common, as did intrusive interments in both Ychsma and Inca constructions (e.g., La Rinconada, Armatambo) (Díaz & Vallejo, 2002, 2004, 2005). The crowding pattern observed by Owens and Eeckhout (2015) in Cemetery I at Pachacamac also became more prominent in Ychsma-Inca layers than in older phases. Manchay Bajo in the Lurín Valley, which was abandoned as a public center in the Initial Period, was still viewed as a powerful huaca during the Late Horizon and was repurposed, as excavations have unearthed Late Horizon offerings of *Spondylus*, metal artifacts, and seed necklaces (Burger & Salazar-Burger, 1991).

The elaborateness of the fardos during this period increased in comparison with the Middle Ychsma phase, both in size and complexity of the textiles (Díaz & Vallejo, 2002). The presence of luxury goods (e.g., *Spondylus*) as a distinction of status was almost constant during the Inca Period in the Central Coast (Díaz & Vallejo, 2002). The number of Inca grave goods increased during Late Ychsma B and Ychsma-Inca burials (such as Inca pottery and *quipus*, a form of accounting tool), although the presence of local variations was still prevalent, thus there was clear interaction between both styles (Díaz & Vallejo, 2002; Eeckhout & López Hurtado, 2018). Facial red paint in the form of cinnabar was also present in Ychsma-Inca fardos, as well as tattooed individuals with marine motifs (Díaz & Vallejo, 2002).

3.2.2.1 Summary

The Late Horizon is widely known as the period in which the Inca Empire ruled over the Central Andes. In the Central Coast, although the changes were substantial in some respects, most of them occurred gradually, which implied a combination of Ychsma and Inca styles and practices, rather than a replacement of the former for the latter. Among the most important changes we can include the shifts in architecture, both in the construction of new buildings and the repurposing of others. At Pachacamac, the Inca built several structures like the Temple of the Sun, the Acllawasi, and the Pilgrims' Plaza. The presence of Inca migrants in the Central Coast has also been recorded, especially at Pachacamac and the upper valley/highland regions. Ychsma mortuary rituals gradually shifted from single burials to multiple burials near monumental architecture and intrusive burials in pre-Inca and Inca spaces, although the general forms of the fardos remained similar.

3.3 Methodological background I: Cranial modification

Cranial modification was a common practice which resulted in visible variability of people's head shapes and is one of the most common biocultural practices of the past, as it can be found around the world (Gowland & Thompson, 2013; Tiesler, 2014). This practice and its results have been subject to anthropological and archaeological research for many years, especially in the Americas, as it is direct and visual evidence of culture imposed on the human body (biology), and it can be found in the archaeological record (Gowland & Thompson, 2013; Tiesler, 2014; Torres-Rouff, 2020). The reasons behind cranial modification were as varied as the practice itself, but it has been broadly associated with identity, encompassing "group membership at any one of a number of levels: regional, community, and/or lineage" (Gowland & Thompson, 2013; Hoshower et al., 1995, p. 148; Tiesler, 2014; Verano, 1997).

Despite its cultural nature, the study of cranial modification has classically focused on the construction of typologies and classifications based on head shape, geographical distribution, and/or modifying appliance (Allison et al., 1981; Dembo & Imbelloni, 1938; Dingwall, 1931; Hrdlička, 1919; Munizaga, 1987; Weiss, 1961, 1962). That is changing, as new research has studied the results of this practice in association with cultural meaning, morphological changes, and potential risk of pathology (see paragraphs below). Similar to the shift in the interpretations of cranial modification, the methods used to study modified crania have changed as well. While most studies started with qualitative descriptions, in recent times some have used craniofacial measurements to provide more standardized and objective results (O'Brien & Stanley, 2013; Pomeroy et al., 2010; Stewart, 1936). To comprehensively study the practice of cranial modification, it is crucial to include both the presence and absence of such modifications. The decision to not modify an infant's head in a region where cranial modification was prevalent could also be a reflection of a cultural trait in it of itself (Weiss, 1961, 1962). Because of the ubiquitous nature of cranial modification throughout human history, this section of the thesis will be limited to cranial modification and its related practices in the context of the Central Andes.

The process of modifying a person’s head took place in infancy (until around 3 years of age), as that is the period of time when the cranial bones are still plastic and malleable for modifications (Dingwall, 1931; Gowland & Thompson, 2013; Guillén et al., 2008; Lozada, 2011). Because this practice took place in such an early stage of life, cranial modification was imposed on infants by close kin, usually female adults, and it was an irreversible form of assigned identity, not earned status (Gowland & Thompson, 2013; Tiesler, 2014). This process was not a single event, it required prolonged and continuous application of pressure to constrict and compress the infant’s head to obtain the desired shape, which could have led to discomfort or risk of injury (Gowland & Thompson, 2013; Lozada, 2011; Tiesler, 2014). Vera Tiesler has proposed that cranial modification practices in pre-Hispanic America were a part of childcare, and as such, they “were deemed a means to protect the infant’s health and integrity, sought to avoid any such side effects, although some nuisances may have been accepted by the caretakers for the sake of the expected benefits” (2014, p. 55). The devices used in cranial modification practices varied, but generally speaking they were made of cloth strips, cords, pads, and/or harder materials, such as wooden sticks and boards (Allison et al., 1981; Gowland & Thompson, 2013; Weiss, 1961). The archaeological evidence for these devices is scarce in the Central Coast, but the few case studies of children’s burials containing such items, iconography depicted in pottery, and ethnohistorical accounts have provided archaeologists with some evidence of how this practice may have looked like in the past (Weiss, 1961, 1962).

Generally speaking, there were two types of cranial modification: the annular and tabular shapes (Gowland & Thompson, 2013; Guillén et al., 2008). The tabular or fronto-occipital type was the result of anterior and posterior compression of the cranium, which resulted in an increase in cranial breath, decrease of cranial length, often lateral bulging of the parietals, and sometimes posterior asymmetry (Gowland & Thompson, 2013; Guillén et al., 2008). The annular type resulted from the circumferential or conical wrapping of the head, in this case the length of the cranium increased while the breath decreased (Gowland & Thompson, 2013; Guillén et al., 2008). Dembo & Imbelloni’s typology (1938), one of the most commonly used, added two subtypes to each type, ‘erect’ or ‘oblique’ referring to the orientation of the occipital relative to the face. In the former, the flattened occipital was almost parallel to basion-bregma, while the latter was flattened to an angle of about 120 degrees.

In the Andean world, the tabular shapes are often found in coastal sites, while the annular shapes are mostly found in highland sites (Verano & Lombardi, 1999; Weiss, 1961, 1962). It is worth noting that when the Inca Empire, a highland culture, conquered the Central Coast, they did not impose a highland type of cranial modification, rather the coastal communities continued using tabular shapes, which Weiss (1961) called 'Inca-Costeño', and mostly differed from his previous coastal type by being less severe. This hypothesis could explain the low prevalence and mild severity of occipital flattening in two studies at Rinconada Alta, a LH site (Salter-Pedersen, 2011; Sutherland, 2019). Some research has questioned the intentionality of occipital flattening in some instances and has proposed that unintentional modifications could have happened if an infant slept on a relatively hard surface for an extended period, a phenomenon that has been seen in modern populations (Ortner, 2003; Verano, 1997).

Asymmetry is commonly found in modified crania across the Andes, especially in the fronto-occipital types, which could be evidence of failure to control the growth of the skull during the modification process or the intentional positioning of the modifying appliance (Guillén et al., 2008). It is important to note that the infants wearing cords and pads around their heads were still living and playing, as any other infant in modern times, which would have likely moved the appliances around their heads (Weiss, 1961). Furthermore, a cradle modifying device found by Stewart in the North Coast (Chimú Culture) had enough space for the head of the infant to move around and turn, potentially increasing the chances of asymmetry (Stewart, 1943).

The tabular or fronto-occipital type is the most relevant to this thesis, as the cemetery examined was on the Peruvian Central Coast. This type of modification has been associated with the use of cloth strips, chords, boards, and cradle-like modifying appliances (Dingwall, 1931; Munizaga, 1987; Stewart, 1943; Weiss, 1961, 1962). Weiss (1961, 1962) identified a strong association between his fronto-occipital coastal type and the presence of suprainiac lesions. Additionally, he mentioned the appearance of 'green stains' on the skeletal remains, an indicator of copper pieces added as part of funerary rituals, which he noted became more common during Inca times, but it is unclear if this is related to cranial modification or mortuary practices (Weiss, 1961, 1962).

The earliest evidence of cranial modification in the Central Coast was found in skeletal remains from Preceramic sites in Asia and Culebras, both excavated by Engel (1957) and later analyzed by Weiss (1961), who noted that the crania had fronto-occipital modification. Despite the large number of modified crania from Perú, including the coast, there is no substantial archaeological evidence of cradles or boards directly associated with the practice in this region, one of the few being the Chimú cradle (North Coast) mentioned above (Stewart, 1943; Weiss, 1961). On the other hand, there has been evidence of pads and pillows filled with cotton or other organic fibers, which could have been associated with cranial modification (Weiss, 1961). Weiss (1961) indicated that cranial modifications continued well after the Spanish conquest despite the colonists' efforts to stop the practice, which indicated the social and cultural importance of head shaping in the pre-Hispanic and Early Contact Peruvians.

Across the Central Andes, cranial modification held multiple meanings depending on the cultural, geographical, and temporal contexts (Tiesler, 2014). This practice has been interpreted as a marker for identity, social status, war status, lineages or ayllus, among others (Blom, 2005; Galvez Calla et al., 2014; Hoshower et al., 1995; Lozada, 2011; Tiesler, 2014; Torres-Rouff, 2007, 2020; Velasco, 2018). Spanish chroniclers wrote that people started the process of head shaping as soon as babies were born, tying them with cloths and bandages, and that all main provinces had different cranial shapes (Cieza de León, 2005 [1540-1550]; de las Casas, 1892 [1561]; Garcilaso de la Vega, 1961 [1609]). Garcilaso de la Vega (1961 [1609], p. 301) briefly mentioned the use of an apparatus made of "two planks, tied together at the ends, which they tightened a little every day," De las Casas (1892 [1561]) described how the Inca had three different head shapes, and they shared these with lords from other provinces, that were not biologically related to the Inca, as a form of privilege.

Lozada (2011) found that among the pre-Inca Chiribaya, cranial modification was associated with ethnicity and economic specialization (fishers vs agriculturalists). For the Tiwanaku, the homogeneity of cranial modification within the colonies and the heterogeneity in the core of the empire suggested migration from across the Tiwanaku land to the core, with cranial modification functioning as a symbol to differentiate people from different regions (Blom, 2005). In the Atacama Desert, Torres-Rouff (2007, 2020) found high diversity of cranial shapes and studied the complex relationship between cranial modification, the consolidation of group identity, and mortuary practices. Velasco (2018) found evidence that cranial modifications in the LIP increased in prevalence and uniformity in the Colca Valley, which suggested the consolidation of group identity, while at the same time, differences in cranial shapes may have given social privileges to certain individuals, thus perhaps increasing social inequality.

Cranial modifications have been studied within the realm of 'trauma' in paleopathology, the area of anthropology that studies diseases in the past (Aufderheide et al., 1998; Ortner, 2003; Ortner & Putschar, 1985; Roberts & Manchester, 2010). Ortner and Putschar described cranial modifications as "chronic, low-grade trauma over an extended period of time," but warned that cultural modifications should not be confused with pathological conditions, such as osteomalacia, and that cranial modifications are not generally associated with health complications (Guillén et al., 2008; Ortner & Putschar, 1985, p. 90). Due to the cultural nature and implications of this practice, and the negative connotations surrounding traumatic injuries (e.g., blunt force trauma, gunshot wounds), this is not the best approach to study cranial modifications.

The most significant changes associated with cranial modification have been related to cranial and facial morphology. As previously mentioned, the prevalence of asymmetry was high in pre-Hispanic modified heads, especially when harder materials were used (Tiesler, 2014). Cranial modification would have also affected facial features, such as the orbital shape, which could factor in studies using craniofacial measurements to assess biological affinity (Boston et al., 2014). Due to the forces compressing the infant's cranium, it is no surprise that premature closure of cranial sutures has been associated with cranial modification practices (Allison et al., 1981). Similarly, there is evidence of superposition of cranial bones (e.g., the parietals at the squamous suture), which produced a prominent suture line (Allison et al., 1981). The thickness of the cranial walls and the shape of the cavities, such as the sinuses, have shown to have changed due to cranial modification, but the volumes remained the same (Khonsari et al., 2013). The prevalence of Wormian bones could have been increased by the practices of head shaping, especially those around the posterior area of the cranium (O’Loughlin, 2004). In all, morphological changes in the cranial and facial bones were mostly innocuous to the people in the past.

Most studies have concluded that cranial modifications did not lead to major health issues (Allison et al., 1981; Guillén et al., 2008; Ortner & Putschar, 1985). Research has shown a lack of evidence of negative impacts on brain function and cognitive abilities, as studies have found an adaptative compensatory effect to avoid the compression of the brain when premature ossification of the sutures occurred, and there is no association with pathological conditions related to atypical cranial morphology, such as microcephaly (Allison et al., 1981; Aufderheide et al., 1998; Guillén et al., 2008; Lekovic et al., 2007; Tiesler, 2014; Weber et al., 2008). On the same note, Okumura (2014) found no significant correlation between cranial modification and osteological and dental markers, such as cribra orbitalia and dental caries. Furthermore, Jimenez and colleagues (2012) found that cranial modification did not affect dental occlusion.

However, some researchers agree that some cranial modification practices could have led to health complications, or even death, due to the compression of the soft tissues around the head and the potential lack of hygiene, air flow, and blood circulation (Guillén et al., 2008; Mendonça de Souza et al., 2008; Tiesler, 2014). However, these secondary effects have not been systematically examined, and any pathological conditions that only affected soft tissues, such as nerves and vessels, would not be discernible on skeletal remains (Tiesler, 2014). Guillén (1992) noted that the bone surrounding the suture lines may have reacted by creating porosities, and it could have been associated with the closure of the sutures. There was a case of an infant with cranial modification in which necrotic bone and periosteal new bone formation were found on both parietals (Allison et al., 1981). Mendonça de Souza, Reinhard, and Lessa (2008) suggested that the cause of death of an infant was cranial modification; they found severe periosteal reaction on the occipital and parietals, and a perforated necrotic occipital. Guillén and colleagues (2008) proposed that cranial modification practices could have contributed to increased morbidity and mortality in non-adults when cranial modification was severe, or if there were any other pre-existing conditions affecting the infant. From a purely theoretical perspective, continuously applying pressure on different areas of the cranium could have led to a variety of behavioural and functional implications, but these hypotheses cannot be evaluated in the present (O'Brien et al., 2013). Additionally, considering the widespread nature and the significant cultural importance that cranial modification had in past communities, speculating about possible mental impairments or even mental health issues opens the door for decontextualized and potentially harmful interpretations of disabilities, which in the context of the pre-Hispanic Andes could include racist and colonial undertones.

In summary, cranial modification was a widespread practice that led to a visible marker of identity on the human body. The interpretations for cranial modification vary and in the pre-Hispanic Andes those include, but are not limited to, ethnic affiliation, kin groups, socioeconomic status, economic specialization, gender, social identity, and/or geographic origin. While the earliest studies focused on typologies, anthropologists have begun looking at the cultural and sociopolitical implications of head shaping practices. On the Peruvian Central Coast, the most common type of cranial modification was the tabular or fronto-occipital shape, produced by applying pressure on the anterior and posterior areas of the cranium. In general, cranial modification did not seem to negatively affect the people who were elected to modify their heads. However, there have been case studies that showed evidence of potentially harmful consequences of the practice, such as infections, or even death.

3.4 Methodological background II: Dental pathology

Teeth are some of the most robust and hard parts of the body, have a good rate of preservation in archaeological contexts, and can provide a wide range of information about the individuals they belonged to (Hillson, 2018; Roberts & Manchester, 2010). The study of teeth in bioarchaeology is commonly known as 'dental pathology' and has largely involved the study of oral microbial flora and diet (Hillson, 2005). Dental pathology's aim is to identify and interpret disease and anomalies in teeth – and surrounding bone – to provide information about oral hygiene, diet, cultural behaviour, occupation, etc. (Hillson, 2005, 2018; Lukacs, 2012; Rose & Burke, 2017).

The different diseases that affect teeth can be interconnected in their symptoms and aetiologies, and their relationships are complex, for instance, dental plaque is associated with dental caries, and both conditions can lead to periodontal disease (Hillson, 2018) (Figure 3.6). The range of diseases and genetic anomalies bioarchaeology can study through teeth is large, but for the purposes of this thesis I will focus on caries, abscesses, calculus, antemortem tooth loss, and dental wear.

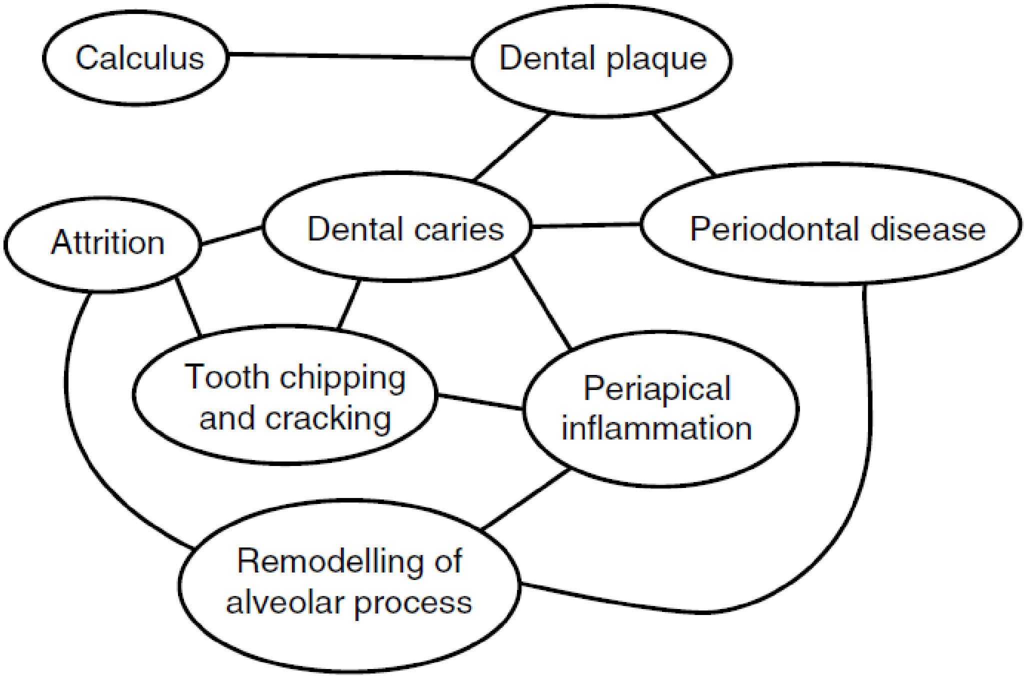

Figure 3.6 Interrelationships of different dental conditions (Hillson, 2018, fig. 9.1).

3.4.1 Dental caries

Tooth decay—also known as dental caries or cavities—is likely the most commonly reported dental pathology in the archaeological record, and it is described as a "*disease process* [emphasis in original] characterized by the focal demineralization of dental hard tissues” by organic acids produced by plaque bacteria (e.g., *Streptococcus mutans*) during the fermentation of carbohydrates (Hillson, 2005, 2018; Larsen, 1997, p. 65; Roberts & Manchester, 2010). Despite the strong association with oral bacteria, caries aetiology is multifactorial, and can include causes such as diet and nutrition, oral hygiene, trace elements in food and water, salivary glycoproteins, dental plaque, dental attrition, other underlying diseases, heredity, and tooth morphology (Hillson, 2018; Kinaston et al., 2019; Larsen, 1997; Roberts & Manchester, 2010). Untreated caries can provoke inflammatory responses in the tissue supporting the tooth (i.e., alveolar bone in the osteological record), but does not necessarily mean the loss of the infected tooth (Hillson, 2018).

Caries appear in a variety of stages, ranging from changes in enamel opacities to the complete loss of crowns and roots to the infection (Larsen, 1997). The cavities that are observable to the naked human eye are a late stage in tooth decay, as most of the demineralization occurs underneath the surface (Hillson, 2005). Dental caries mostly appear on surfaces that are exposed to the environment, which include the crown and sometimes the root (Hillson, 2018; Larsen, 1997; Roberts & Manchester, 2010). Crown caries can develop at any age on the grooves and pits of the occlusal surfaces (especially on the molars) or the interproximal spaces across all teeth (Hillson, 2001, 2005, 2018). Caries that develop on the root can start on the cemento-enamel junction, the portion of the tooth below the crown, or the cement of the root, both which can be exposed in older adults because of continuous eruption (due to severe dental wear, see below) or periodontal disease (Hillson, 2001, 2005, 2018; Suzuki et al., 2020). In general, the molars and premolars are more often affected by caries, while mandibular teeth are usually more affected than maxillary teeth, but there are no significant differences between right or left teeth (Hillson, 2001).

In our diets, simple sugars (e.g., sucrose, lactose, glucose, and fructose) are the primary factor in tooth decay because they are the sugar preferred by oral bacteria in the fermentation process, and they are also a substrate for the polysaccharides (complex sugars) that form the structure of dental plaque (Bradshaw & Lynch, 2013; Sheiham & James, 2015). The role of starches—also complex carbohydrates—is inconclusive and seems to be dependant on the cooking process, retention of food particles in the mouth, and the interactions with simple sugars, all which affect the bioavailability of sugars and their cariogenicity (Bradshaw & Lynch, 2013; Lingstrom et al., 2000). Starchy foods, such as maize and potatoes, are of particular interest in this thesis as they were some of the most common foods in the pre-Hispanic Andes.

3.4.2 Abscesses

Abscesses are alveolar lesions and an inflammatory response to the infection of the pulp chamber of the tooth (Forshaw, 2014; Hillson, 2001, 2018; Roberts & Manchester, 2010). Abscesses are sometimes called periapical cavities, but there can also be periodontal abscesses in the gums (Hillson, 2001, 2018). For abscesses to be detected with the naked eye in bioarchaeology, the infection needs to advance long enough to develop a hole in the bone to allow the escape of the accumulated pus, as bone and teeth are non-compressive tissues (Hillson, 2001; Roberts & Manchester, 2010). However, with X-rays and computed tomography, abscesses that have not broken through the cortical bone can be seen as “holes” inside the maxillae or mandibles. Dental infections that lead to abscesses can develop due to untreated dental caries, attrition, dental plaque, and/or trauma; they can be chronic or acute, but differentiating these based on the abscesses left on the bone is difficult (Kinaston et al., 2019; Roberts & Manchester, 2010). The infected tooth associated with an abscess can be lost antemortem, but the presence of the abscess itself (the hole) is a useful indicator of dental health (Forshaw, 2014). Before modern treatments, such as antibiotics, the presence of abscesses could have led to complications such as maxillary sinusitis, bad breath, pain, and even death due to the infectious nature of the condition (DeWitte & Bekvalac, 2009; Forshaw, 2014; Roberts & Manchester, 2010).

3.4.3 Dental calculus

Dental calculus is calcified (sometimes also referred as mineralized) dental plaque (Hillson, 2018; Roberts & Manchester, 2010). Plaque consists of an accumulation of microorganisms and an extracellular matrix that cover the surface of the tooth (Forshaw, 2014; Hillson, 2018; Roberts & Manchester, 2010). In humans, the bacteria in dental plaque can incorporate monosaccharides and amino acids from sugars, proteins, and fats, but they favor simple sugars, in particular sucrose (Hillson, 2005). The metabolism of sugars in dental plaque produces organic acids, while the incorporation of amino acids produces alkaline by-products (Hillson, 2005).

There are two types of calculus: supragingival calculus, the most common type, is found above the gums and is usually grey or brown in color; and subgingival calculus, generally green or black in color and found as thin layers on exposed roots under the gums (periodontal pocket) (Hillson, 2018; Roberts & Manchester, 2010). Calculus mostly develops on the tooth surfaces nearest the salivary glands—lingual side of the lower incisors and the buccal side of upper molars (Roberts & Manchester, 2010).

The accumulation of dental calculus between the gums and the teeth can lead to periodontal disease and the loss of periodontal bone (Clarke et al., 1986). The by-products of plaque bacteria include organic acids that could cause dental caries (Hillson, 2018). There is population-specific evidence that the presence of plaque could have a negative correlation to the development of caries (Manji et al., 1989), but the evidence is not conclusive (Dahlén et al., 2010).

3.4.4 Antemortem tooth loss

Antemortem tooth loss (AMTL), as the name suggests, refers to the loss of teeth during a person’s life before their death. In the archaeological record, AMTL can be identified by the healing of the edges of the alveolar bone and/or the filling of the alveolus with new bone (Roberts & Manchester, 2010). AMTL can occur ‘naturally’ due to various reasons, including alveolar abscesses and caries, periodontal bone loss, trauma, continuous eruption, etc. (Kinaston et al., 2019). Dental trauma can occur on the crown, root, or both, and it does not always affect the surrounding bone (Hillson, 2005). Small fractures, such as chipping, can be caused by hard inclusions, such as small stones in food, but larger dental trauma can be a result from events such as accidental falls or interpersonal violence (Lukacs, 2007).

In some studies, premolars and molars seem to be more affected by AMTL than any other type of tooth, which could be associated with their predisposition for caries and dental wear (Lukacs, 2007). Evidence suggests that AMTL can lead to the development of temporomandibular joint disorders (Barghi et al., 1987; Granados, 1979; Tallents et al., 2002).

3.4.5 Dental wear

Dental wear is the combined erosive result of mechanical masticatory forces and chemical components on the teeth and it usually occurs on the occlusal surfaces of the tooth crowns (Kinaston et al., 2019; Roberts & Manchester, 2010). Tooth wear is multifactorial in origin, as it includes dental attrition, which is caused by contact between teeth; dental abrasion, caused by contact with foreign objects such as food; and dental erosion, which is caused by chemical components, such as acids (Sperber, 2017). However, in archaeological contexts it could be complex to tease out sources of wear on teeth (Hillson, 2018). Food sources and their processing can affect dental wear, as the presence of small hard particles in food and water, such as sand from coastal areas or stone grit from a mortar, will accelerate dental wear (Chattah & Smith, 2006; Roberts & Manchester, 2010). The severity of dental wear can be age-progressive and aging methods for adults have been developed based on wear patterns (Brothwell, 1968; Lewis et al., 2021; Lovejoy, 1985). Interestingly, evidence suggests that severe dental wear can be compensated by “an equivalent slow eruption,” meaning teeth continue to erupt in adulthood (Levers & Darling, 1983, p. 405; Whittaker et al., 1985). This continuous eruption, plus the remodeling of the surrounding bone due to the mechanical forces acting on the jaws, made it so many past groups suffered from AMTL due to the lack of structural support (Hillson, 2018).

In summary, dental pathology, the study of disease in teeth and the surrounding tissues, has largely been used in bioarchaeology to assess diet, oral hygiene, cultural behaviour, occupation, genetic variation, etc. The relationships between the oral diseases studied in this area are complex, as they can be interconnected. In the context of this thesis, the relevant oral diseases are caries, abscesses, calculus, antemortem tooth loss, and dental wear. Dental caries is one of the most common variables in the study of dental health, and it refers to the demineralization of dental tissues caused by by-products of oral bacteria. Dental abscesses, particularly periapical cavities, are an inflammatory response to infection in the pulp cavity, and in the archaeological record they are generally observed as holes in the bone surrounding the tooth root. Dental calculus is mineralized dental plaque, which consists of a layer of microorganisms on the crown or root of the tooth that can lead to other dental diseases. Antemortem tooth loss refers to the loss of teeth previous to death, which can be caused by a number of conditions, such as dental wear or infection. Lastly, dental wear is the combination of dental attrition, abrasion, and erosion of the teeth's occlusive surfaces, generally due to masticatory forces.

Chapter 4

4 Sample and methods

This chapter is divided into two sections: the first will review the sample and the second will describe the methods used both for the skeletal remains and CT scan images of the fardos.

4.1 The sample

The sample analyzed in this thesis was recovered by the archaeological rescue project “Proyecto de Mejoramiento Integral del Servicio de Interpretación del Patrimonio Cultural Mediante la Construcción del Museo Nacional del Perú,” which took place in the Archaeological Sanctuary of Pachacamac before the construction of the new national museum, Museo Nacional del Perú or MUNA (Baldeos, 2015; García & Baldeos, 2020). The excavation site—Sector 3 of the archaeological complex—was approximately 300 meters northwest of the site’s museum, Museo Pachacamac, and included a pre-Hispanic cemetery composed of skeletonized remains and mummy bundles or fardos (Baldeos, 2015).

The main archaeological intervention took place between March 4th to May 31st, 2015, and additional smaller excavations were conducted in the periphery between 2016 and 2019 as the new museum was being built (Baldeos, 2015; García & Baldeos, 2020). The 2015 excavation team, led by archaeologist Jhon Baldeos, recovered 97 funerary contexts (*Entierros*) in 4 layers (Appendix 1), most of which were skeletonized remains (Baldeos, 2015). The total number of burials was higher (138) because many contexts included multiple burials. No mortuary structures were found, as the bodies were interred directly in pits in the sand (Baldeos, 2015).

The 2015 team reported that all the recovered material from the uppermost layer (*Capa 1, Nivel 1*) was disturbed, lacked any mortuary context, and were secondary burials (Baldeos, 2015). The 2016-2019 interventions recovered 31 funerary contexts (*Hallazgos fortuitos*), most of them heavily disarticulated and disturbed, with no evidence of mortuary structures.

Both the 2015 and 2016-2019 human remains were found associated with mostly Ychsma archaeological material, although it is possible that some Ychsma-Inca material was present (Baldeos, 2015; García & Baldeos, 2020). Based on this evidence, the archaeological team concluded that the cemetery had been in use during the last two time periods before the Spanish Conquest, the LIP and the LH (1100 – 1532 CE) (Baldeos, 2015). These archaeological associations were further supported by radiocarbon dating, which dated the remains to the LIP and possibly the early LH (A. Nelson, personal communication, June 14th, 2023).

Based on stratigraphy, Baldeos (2015) concluded that the last layer used during pre-Hispanic times was *Capa 1, Nivel 2*, their second excavation layer (Appendix 1). Given the archaeological similarities between the 2015 and 2016-2019 contexts, it is highly likely that they belonged to the same burial site (Baldeos, 2015; García & Baldeos, 2020). Baldeos and García (2015; 2020) concluded that the disturbances in this cemetery were likely the result of illegal sand mining activities that took place in the second half of the 1900s. Another potential contributing factor to the alteration of the burial site is heavy urbanization of the area. Local residents have built houses around the walls of the archaeological complex and used the surrounding areas as walking roads for commuting (Baldeos, 2015; García & Baldeos, 2020).

The primary archaeological difference between the skeletal material and the fardos was the preservation of the contexts. The skeletonized remains were heavily disturbed and disarticulated, thus it was not possible to individualise the remains of each burial (Baldeos, 2015). Additionally, the archaeological material associated with the burials was not well preserved either (Baldeos, 2015), and direct connections with each individual could not be made. In contrast, the fardos were relatively well preserved and their internal contents were not mixed between one another, thus the archaeological materials inside were directly associated with the individual from the fardo (Baldeos, 2015). These major differences in preservation could be explained by purely taphonomic factors (e.g., sand mining), or could be a reflection of different cultural practices in the past.

Due to the high number of skeletonized remains and the commingled nature of the contexts, the skeletal subsample examined for this thesis was limited to most of the 2015 remains and some additional crania from the 2016-2019 material for cranial modification analysis. The fardo subsample included the excavated remains from the 2015 and 2016-2019 interventions. Figure 4.1 shows the distribution of the material that was analyzed. It is important to note that not all the remains from the MUNA collection were examined, see next section for the selection process. In all, Ashley Ward and I examined 103 contexts for this study: 70 skeletal remains contexts[10] and 32 fardos (See Appendix 2 for the full list of individuals analyzed in this thesis). In total, I examined 85 crania: 62 from the skeletal subsample and 23 from the fardo subsample.

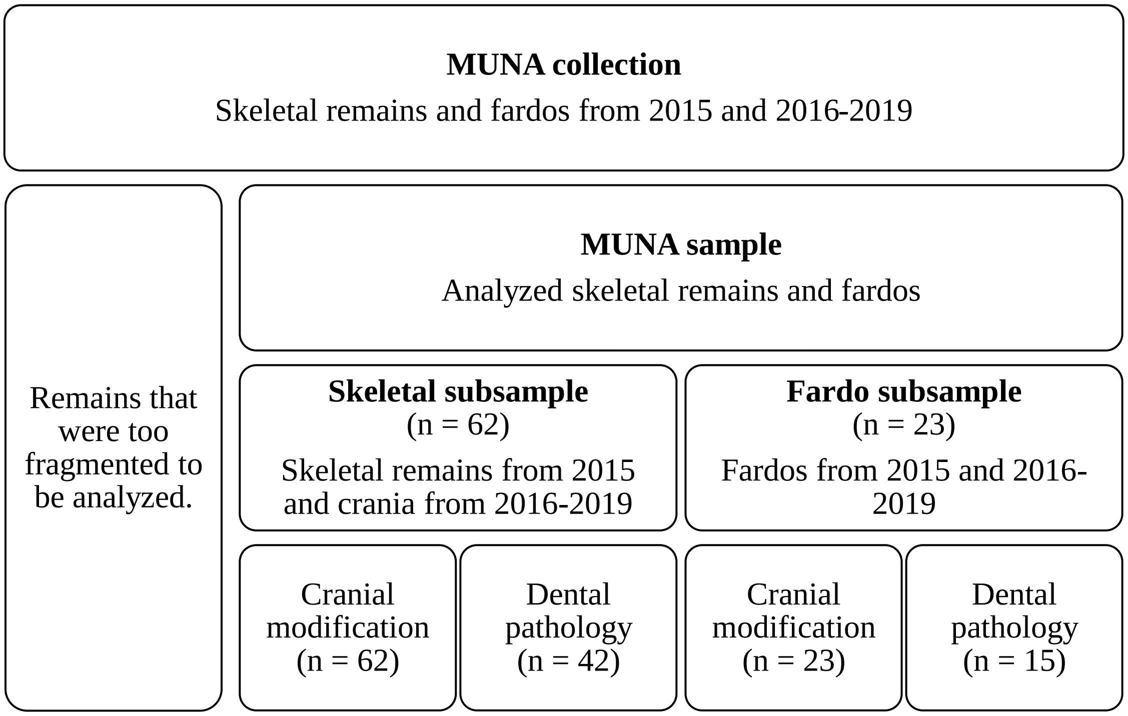

Figure 4.1 Distribution of human remains analyzed in this thesis.

The cranial modification analysis included 85 individuals—62 skeletonized crania and 23 crania from CT scans of fardos (Table 4.1). Notably, the youngest non-adult cohort, infant was not represented by complete and articulated crania. The infant cohort was

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[10] The 2015 contexts were analyzed in their entirety. The contexts from 2016-2019 were not, in these contexts, only the crania were analyzed for cranial modification.

present in the larger MUNA collection and represented by post-cranial skeleton and disarticulated cranial bones. The dental pathology section included a total of 57 maxillae and mandibles: 42 from the skeletal subsample and 15 fardos (Table 4.2). Non-adults were excluded from the dental pathology section to simplify the analysis and because deciduous teeth were not well preserved in this sample.

Table 4.1 Distribution of individuals per cohort included in the cranial modification analysis (cohorts based on Buikstra & Ubelaker, 1994).

Cohort	Skeletal subsample	Fardo subsample	Total
Infant (birth-1 year)	0	0	0
Child (2-11 years)	6	7	13
Adolescent (12-20 years)	8	1	9
Young adults (21-35 years) (F/M/I)	14 (6/7/1)	11 (3/7/1)	25 (9/14/2)
Middle adults (36-50 years) (F/M/I)	23 (6/14/3)	4 (3/1/0)	27 (9/15/3)
Old adults (51+ years) (F/M/I)	1 (0/1/0)	0	1 (0/1/0)
Adults no cohort (F/M/I)	10 (4/5/1)	0	10 (4/5/1)
Total	62	23	85

F: female; M: male; I: indeterminate

Table 4.2 Distribution of individuals per cohort included in the dental pathology analysis (cohorts based on Buikstra & Ubelaker, 1994).

Cohort	Skeletal subsample	Fardo subsample	Total
Young adults (21-35 years) (F/M/I)	12 (3/5/4)	11 (3/7/1)	23 (6/12/5)
Middle adults (36-50 years) (F/M/I)	19 (4/9/6)	4 (3/1/0)	23 (7/10/6)
Old adults (51+ years)	1 (0/1/0)	0	1 (0/1/0)
Adults no cohort (21+ years) (F/M/I)	10 (2/4/4)	0	10 (2/4/4)
Total	42	15	57

F: female; M: male; I: indeterminate

4.2 Methods

The bioarchaeological analysis of the skeletal subsample took place in June 2022 at Museo Pachacamac (see Appendix 12 for recording sheets). The fardo subsample was indirectly analyzed primarily through 3D renderings and 2D slices of CT scans using the Dragonfly (version 2022.2) and ORS Visual^{SI} software (www.theobjects.com) at the Department of Anthropology of Western University during the months of February to April 2023. Additionally, digital X-ray images were used when necessary.

Ashley Ward and I conducted most of the analyses presented in this research. As this thesis focuses on the cranium, I analyzed most of the crania, while Ward focused more on the post-cranial skeleton. However, we both worked on both cranial and post-cranial bones throughout the weeks of analyses. We also collaborated closely with Sarita Fuentes and Denise Pozzi-Escot from Museo Pachacamac.

All the crania analyzed in this thesis were X-rayed using a portable X-ray machine by the ‘Mummies as Microcosms’ team in June 2022. The cranium from the individual E67 was also CT scanned because it had trepanations. The fardos were CT scanned at Resocentro in Lima between 2019 and 2022, and X-rays were also taken for most of them during the same time (see Appendix 3 for the X-ray and CT scan details).

Given the large number of skeletal remains, the limited timeframe, and the focus on cranial modifications, the analysis of the 2015 skeletal remains began by selecting contexts that had crania. Following this initial selection, we continued to narrow down the contexts by choosing those with crania that had enough facial and cranial vault bones to correctly position them with the Frankfort Horizontal for the cranial modification analysis. When adult mandibles were present and were relatively well preserved, those contexts were included in the dental pathology section. Skeletal contexts without crania that included mostly long bones and os coxae were also selected for the biological profile analysis. Due to the limited number of fardos, the selection process for this subsample also included skeletons that were > 75% complete and well preserved but were missing the cranium. We used these fardos to increase our population-level data for the biological profile and mortuary practices variables, and for the comparisons between the skeletal and fardo subsamples. In both subsamples, we excluded contexts with crania that were relatively complete, but were too fragmented to be studied.

Given the time constraints, the 2016-2019 skeletal material could not be analyzed in detail, but some contexts with crania were briefly examined by Andrew Nelson and Kate Woodley in June 2022. I have included 17 of these crania in the cranial modification analysis part of this thesis. Nelson and Woodley analyzed biological profile variables, paleopathology, dental health, and cranial modification. Additionally, they took detailed photographs of the crania and teeth. I have used both their notes and photographs in my analyses of cranial modification, age-at-death estimation, and skeletal sex determination.

To address the research questions of this thesis, for each context we analyzed the minimum number of individuals (MNI), biological profile (skeletal sex, age-at-death, and stature), cranial modification, dental pathology, and mortuary practices of the selected contexts. All the methods used were macroscopic and/or non-destructive (Table 4.3). For both subsamples we used similar methodologies with some minor changes due to the better preservation and individualized nature of the fardos, and the differences between direct analysis of bone and indirect analysis through digital images. After the examinations, the individuals were sorted into cohorts (Table 4.4) based on age and skeletal sex (Table 4.5). If an individual's final age range spanned more than one cohort, they were sorted into the cohort that included most of their age range. Most of the individuals that had minimal presence of teeth (less than 3 teeth) were sorted into the 'Adults (no cohort)' age group given that I could not establish an accurate age range for them. The edentulous individuals were sorted into the old adult cohort.

Table 4.3 Bioarchaeological methods used in this project.

Variable	Methods
Skeletal sex: adults only	Cranium (Walker, 2008), pelvis (Buikstra & Ubelaker, 1994; Klales et al., 2012), and humeral and femoral head diameters (Zamora et al., 2022).
Age-at-death for adults	Pubic symphysis (Brooks & Suchey, 1990), the sternal end of the fourth rib (Işcan, 1991; Muñoz et al., 2018), and dental wear (Lovejoy, 1985).
Age-at-death for non-adults	Dental development (Buikstra 1989 in Buikstra & Ubelaker, 1994; Gaither, 2004) and skeletal development (Gaither, 2004; Schaefer et al., 2009).
Stature: adults only	Predictive equations presented in del Angel & Cisneros (2004), which were based on Genovés (1967).

Table 4.4 Cohorts and age ranges used in this thesis (based on Buikstra & Ubelaker, 1994).

	Cohort	**Age range**
Non-adults	Infant	Birth to 1 year
	Child	2 to 11 years
	Adolescent	12 to 20 years
Adults	Female/male/indeterminate young adult	21 to 35 years
	Female/male/indeterminate middle adult	36 to 50 years
	Female/male/indeterminate old adult	51+ years
	Adults (no cohort)	21+ years

Table 4.5 Skeletal sex groups and probabilities.

Skeletal sex group	**Probability**
Male/female	90-100%
Probable male/probable female	75-94.99%
Indeterminate	<74.99%

4.2.1 Skeletal sex

For the skeletal subsample, the scoring of the cranial and pelvic morphological traits was done through direct, close observation. The femoral and humeral head diameters were measured using a digital sliding caliper. For the fardos, we used the 3D renderings of the scans in ORS Visual^{SI} and Dragonfly for the cranial and pelvic traits. The femoral and humeral head diameters were measured using the 2D slices and the Ruler Tool. To best visualize the morphological traits, we cropped the 3D model using the Clip Tool to isolate the os coxae or cranium, then we changed the color spectrum, light source, and window leveling settings for each fardo.

In most cases, the skeletal sex of the skeletal subsample was estimated through the cranial method because the remains were commingled, and it was not possible to associate pelvises and crania. Unfortunately, sex estimation through cranial traits is not as reliable as with pelvic traits—particularly in modified crania—and sexual dimorphism of the cranial traits varies between populations (Garvin et al., 2014). Walker's (2008) population-specific discriminant functions were based on American/English and archaeological Native North American groups, and although we used the latter in this project, they are not specific for pre-Hispanic Andean samples. Additionally, in my experience, sexual dimorphism of cranial traits in Andean people is not as marked as in other groups. To assess the reliability of the skeletal sex results in this osteological subsample, we compared the results of the two methods—cranium and pelvis—in the fardo subsample, as the fardos were individualized remains and in most cases, we had both, pelvic and cranial, methods for one individual.

4.2.2 Age-at-death

Similar to the skeletal sex analysis, the age-at-death estimation in the skeletal subsample was done through direct observation and measurement of the bones and teeth. Dental wear in adults was recorded by coloring the amount of wear of the teeth's enamel from occlusal, buccal, and lingual views using a diagram of permanent dentition (Appendix 12). The dental diagrams were printed out as part of the recording sheets and colored in with pencils. After and during recording, the completed dental diagrams were scored based on Lovejoy's method (1985). Long bone maximum lengths in non-adults were measured using digital sliding calipers and a metal measuring tape adapted to be a portable osteometric tape. For the most part, dental development in non-adults was analyzed through simple observation, but in some cases the X-rays of the mandibles or maxillae were used as well to determine the degree of development of some teeth that had not erupted yet, such as the third molars in late adolescents.

For the CT scans of adult individuals, we cropped the 3D model to isolate the pubic symphysis and changed the light source, window leveling, and color spectrum settings accordingly for each CT scan. Additionally, we used the 2D slice views to better visualize the furrows and contours of the pubic symphysis for more accurate scoring and description. For the analysis of the sternal end of the 4th rib in the CT scans we only used the 2D slice views, as the 3D renderings did not offer enough detail for accurate results. It was not always possible to accurately locate the 4th right rib, thus we decided to use any rib—from the 3rd to the 10th—that was not pathological. We positioned the sternal ends by moving the axes in the 2D views. Dental wear in the CT scans was analyzed through the 2D slice views, as the 3D models did not offer enough detail. To correctly visualize the degree of wear in the enamel, the window leveling settings were changed accordingly to provide enough contrast between the enamel and dentin. Dental wear was recorded using the same dental diagrams as for the skeletal subsample, but they were digitally viewed and edited on a Samsung Galaxy Tab S6 Lite using the Samsung Notes app. After the dental diagrams were complete, they were scored based on Lovejoy’s methodology (1985). For the non-adults, dental and skeletal development were visualized in the 2D views, as they provided better image quality; long bone measurements were taken using the Ruler Tool in the 2D slices as well.

4.2.3 Stature

Adult stature was estimated through maximum long bone measurements by using the predictive equations presented in del Angel & Cisneros (2004), which were based on Genovés (1967). This method was developed using Mesoamerican individuals, and although it is not population-specific for the Andes, it is a method that has been used in Andean studies before, and it is the method used in the larger “Mummies as Microcosms” project. In the skeletal remains, long bones were measured using the same portable osteometric tape mentioned above and the standard positions and landmarks (Buikstra & Ubelaker, 1994). For CT scans, the process was not as straightforward because a) there is not a widely used standard for measuring long bones, b) the software used did not have an accurate tool to measure distances in the 3D models, c) there was a lack of consistency in the position of the long bones inside the fardos, and d) the standard landmarks used for measuring long bones were not always on the same three-dimensional plane, thus they were not always on the same 2D slice and the Ruler Tool could not be used.

Considering these factors, we decided to record the measurements of the long bones by using the Points Tool in the 2D views in Dragonfly. First, we positioned the bone to have an anterior-posterior view to simulate the standard position we used in the analysis of the skeletal remains. Then, we placed individual points in the standard landmarks, which gave us x, y, and z coordinates. Lastly, we input the coordinates into an equation to measure the distance between 2 points in three dimensions (Figure 4.2).

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

Figure 4.2 Mathematical equation to calculate the distance between two points in three dimensions (Furey, n.d.).

4.2.4 Cranial modification

To record cranial modification in both subsamples I described the crania in detail to include which parts were modified, posterior asymmetry, and potential pathological conditions associated with the modification process, such as porosities and periosteal new bone formation on the cranial vault. The descriptions were written on a blank piece of paper and did not follow any particular published method, rather I focused on the morphology of the crania and which landmarks/areas were modified and affected. For a detailed description of the cranial modification types in the MUNA sample see Chapter 5. For comparisons between the MUNA sample and other Central Coast samples and the interpretation of the cranial modifications in the MUNA sample, I used Pedro Weiss' typology and descriptions of modifying appliances (Weiss, 1961, 1962).

The recording of the modification included identifying which bones were modified, how they were modified (e.g., flattened), and the severity of modification (mild, moderate, or severe). The severity was subjectively assessed by comparing the modified morphology to photos and diagrams of unmodified crania. Mild severity was a slight modification of a small section of the modified bone; moderate severity was a more pronounced modification of less than 50% of the modified bone; and severe severity was an even more pronounced modification that generally affected more than 50% of the modified bone.

Asymmetry was recorded on a presence/absence basis, which side was more modified (left or right), and the severity of the asymmetry. Similar to the severity of the modification, the severity of asymmetry was assessed by comparing the asymmetric morphology to a symmetric cranium. Mild asymmetry was a slight difference between left and right sides of the posterior portion of the cranial vault, but the less modified side did not bulge out; moderate asymmetry involved a more pronounced difference between the right and left sides with the less modified side bulging out slightly; severe asymmetry was a very pronounced difference between the right and left sides, with the less modified side bulging out more significantly.

There have been other studies that have found an association between the cranial lesions described in this chapter and cranial modification in the Andes (Guillén et al., 2008; Holliday, 1993; Mendonça de Souza et al., 2008; Stewart, 1976; Weiss, 1958, 1961) (for more details see section 3.3). For this reason, I looked for potential pathological lesions on the cranial vaults of the MUNA sample. The three pathological lesions analyzed in this thesis were cranial vault porosities, periosteal reaction on the nuchal crest, and a suprainiac lesion. The recording of these lesions was only possible in skeletal subsample. It was done through a description of the pathology, which bones were affected, the severity, and the stage of healing (active, healing, or healed).

For the porosities, the severity and healing stages were assessed by following Rinaldo and colleagues' (2019) descriptions and photos. The full methodology could not be followed due to time constraints, as the evaluation form by Rinaldo et al. included subdividing each cranial vault bone into quarters and the frequency of pits in 1 cm^2 in addition to recording the severity, healing stage, and size of the area affected in each bone. The severity of the periosteal reaction on the nuchal crest and suprainiac lesions was assessed by the size of the affected area. The stage of healing for the periosteal reaction on the nuchal crest was assessed by observing how much bone remodelling had occurred. The stage of healing for the suprainiac lesions was assessed by whether the porosities on and around it had evidence of closure and dull or rounded edges.

In addition to the descriptive analysis, for the 2015 skeletal subsample I took the 24 standard craniofacial measurements following Buikstra and Ubekaler (1994) (Appendix 12). For the 2016-2019 crania, I took four measurements (cranial height, cranial breadth, cranial length, and frontal chord) as these measurements can capture the dimensions of the cranium as a whole (O'Brien & Stanley, 2013). These measurements were taken using a digital sliding caliper and a manual spreading caliper.

For the examination of CT scans, I used ORS Visual^{SI} for the descriptive analysis of the cranium through the 3D model and Dragonfly to record the craniofacial measurements in the 2D slices. This separation was due to the fact that the 3D models in ORS Visual^{SI} were clearer than in Dragonfly, but the 2D slices and Ruler Tool were easier to manipulate in Dragonfly. For the descriptive part, I cropped the 3D rendering to isolate the cranium, then I changed the light source and window leveling accordingly, and lastly, I followed the same descriptive steps as with the skeletal remains. For the measurements, I oriented the cranium in the 2D slices following the sagittal and coronal planes of the body to correctly identify the standard landmarks needed for the craniofacial measurements. After identifying the landmarks, I used the Ruler Tool to measure the distance between the points.

For each craniofacial measurement in the CT scans, I took two distances from the two observable planes and calculated an average for more accuracy. For example, to measure cranial height, I measured the distance from basion to bregma from the sagittal and coronal planes, or lateral and anterior-posterior views (Appendix 4). If the measurements were different by more than 1mm, I re-positioned the cranium and took the two measurements again. For the fardos subsample, I took six measurements (cranial height, cranial breadth, cranial length, and the frontal, parietal, and occipital chords) to obtain a more complete assessment of the cranium.

4.2.5 Dental pathology

The dentition of the skeletal subsample was analyzed directly through close observation and sometimes a magnifying glass. Whenever teeth were loose and not in their alveoli, I sorted them accordingly based on morphology and fit within the available alveoli. In some cases, it was not possible to associate teeth to an individual and these were recorded separately as “assorted teeth.”

For the CT scans, the dental analysis was performed both in ORS Visual^{SI} and Dragonfly. The initial inventory of the dentition and preliminary morphological analysis of the abscesses and AMTL was done in the 3D model of ORS Visual^{SI} because of the better quality of the model. The corroboration of the inventory and subsequent analysis of caries, AMTL, abscesses, and dental wear was done in the 2D slices in Dragonfly because of the better quality of the images, easier manipulation of the orientation and window leveling, and more accessible tools. Initially, dental calculus was also going to be recorded in the fardos, but the quality and resolution of the CT scans did not allow an accurate recording of the variable. The teeth that were loose inside the fardo were marked using the Point Tool and identified based on morphological differences. Due to the quality and resolution of the clinical CT scans and the degree of dental wear, it was not always possible to give an accurate identification of every tooth, thus they were sorted into single root teeth (incisors, canines, and premolars) or molars. When permanent and deciduous dentition were present, the teeth were also sorted into these two categories as accurately as possible. However, given the poor preservation of deciduous teeth, the comparisons and statistical analyses were performed only using the adult dentition data.

The analysis of the dentition included inventory and examination of dental caries, antemortem tooth loss (AMTL), abscesses, dental wear, and dental calculus. Initially, the analysis was going to include periosteal bone loss as well, but that variable could not be recorded accurately throughout the subsamples due to preservation and visualization issues. The methods were adapted from the Standards by Buikstra and Ubelaker (1994) to suit the sample. After recording the dental pathology variables, markers of coca leaf chewing were taken into consideration in the interpretation of the results following Indriati and Buikstra (2001). Unfortunately, one of the most relevant indicators, severe exposure of the molar roots, could not be examined.

Caries were recorded based on the number of lesions, which teeth were affected, the position of the lesion (occlusal, interproximal, or others), and the severity (small, moderate, or severe) (Table 4.6). Dental calculus was recorded on a presence/absence on the teeth affected and by the severity (mild, moderate, or severe) (Table 4.7). For AMTL, I registered which tooth was lost and the degree of bone resorption (incomplete or complete resorption). For the abscesses I recorded which tooth was affected, the severity based on relative size (small, moderate, or severe), and the healing stage based on bone remodelling (incomplete or complete healing). For dental wear, I used the same method as for the age-at-death estimation above. These variables were recorded on the same dental diagrams as dental wear. Caries were recorded using red, dental wear was recorded using grey, calculus was recorded using green, and abscesses were recorded using purple or highlighters. Although all these variables were recorded, the results of this thesis only present the prevalence of carious teeth, AMTL, abscesses, and dental calculus. Dental wear is presented by severity.

Table 4.6 Descriptions used to record dental caries based on Buikstra & Ubelaker (1994).

Severity	Description
Small	The caries is a dot of maximum 1 mm.
Moderate	The caries is affecting <50% of the neck/crown
Severe	The caries is affecting >51% of the neck/crown.

Table 4.7 Descriptions used to record dental calculus based on Buikstra & Ubelaker (1994).

Severity	Description
Mild	Dots or non-continuous short lines, thin layers, usually along the neck of the tooth.
Moderate	Continuous lines and spots covering <50% of the crown/neck.
Severe	>51% of the crown/neck area is covered in calculus.

4.2.6 Mortuary practices

The indirect analysis of the mortuary practices in the skeletal subsample was done by reading the final excavation report from 2015, which had descriptions and photographs of the archaeological items associated with the burials (Baldeos, 2015). The examination of the mortuary practices in the fardos was done in ORS Visual^{SI} and Dragonfly. This included detailed written descriptions and tabulated records of the fardos (Appendix 5).

In ORS Visual^{SI} we did a preliminary examination of the fardo using the 3D rendering as it was clearer than the 3D model from Dragonfly, and the manipulation of the window leveling was easier. During this step we recorded rough shapes and components in the fardo, such as the presence and/or number of cane sticks, rope, or mats. In Dragonfly, we used the 2D views to more accurately record the presence and/or number of the items in the fardos, especially the internal components, such as cotton fill, gourds, metals, pottery, cane sticks, and tools. Given the time constraints and large number of components in the fardos, we did not record the preservation of each item, rather we assessed the preservation of the fardo as a whole.

For comparison purposes between the subsamples, given that the lack of direct association in the skeletal material (Baldeos, 2015), the comparison was made based on the general number of types of archaeological items found in each subsample.

4.2.7 Statistical analysis

One of the main aims of this research was to compare the skeletal and fardo subsamples using the variables mentioned above. Fisher’s exact tests are recommended for the comparison of categorical data in small sample sizes when the observations per cell are <5 or the expected values are <1. When dividing the individuals in cohorts and the analyzed variables (e.g., modified vs non-modified crania), some of observed values were below 5 and some of the expected values were below 1. Accordingly, Fisher’s exact tests were performed to examine the differences between the categorical variables in the qualitative analysis of cranial modifications and the dental pathology sections.

In the quantitative section of the cranial modification analyses (i.e., cranial measurements), I tested for normal distribution using descriptive plots and the Shapiro-Wilk normality test given that the sample size for the Fardo subsample was relatively small. After this, I tested if the variances between the compared subgroups were different using F-tests. Lastly, I tested if the means of the compared subgroups were different by using a Student's T-test. These statistical analyses were done in the statistical package R using RStudio, and the statistical significance threshold was set to 0.05.

For the comparison of stature means in Chapter 6, I used one-way ANOVAs with Tukey *post-hoc* tests. The tests were performed for four sites using the following website: https://statpages.info/anova1sm.html.

Chapter 5

5 Results

This chapter is divided in two sections. Section 5.1 summarizes the comparison between the skeletal and fardo subsamples and determines if they are similar or different. Having concluded that they were likely part of the same community, the second part includes other relevant comparisons of cranial modification and dental pathology within the complete sample (e.g., females vs males), and a description of cranial vault pathological lesions potentially associated with cranial modification processes within the skeletal subsample (i.e., cranial vault porosities, suprainiac lesions, and periosteal reaction). To simplify the analyses, all probable female individuals have been grouped with the female individuals. The same has been done with the probable male and male individuals.

5.1 Demographic information

To assess the reliability of our skeletal sex and age-at-death in adults results in the skeletal subsample, we compared the results of different standard methods for pelvic and cranial traits in 13 individualized remains—12 fardos and 1 skeletonized individual. For the skeletal sex determination, we compared pelvic (Klales et al., 2012) and cranial (Walker, 2008) methods; while for the age-at-death estimation we compared the pubic symphysis (Brooks & Suchey, 1990) and dental wear (Lovejoy, 1985) methods. For detailed descriptions and analysis, see Appendix 6. Below is a summary of the conclusions.

In the skeletal sex comparisons, the male individuals showed more consistent results between the two methods than the female individuals, but in general, the results between methods did not differ greatly. In the age-at-death comparisons, for most individuals, the dental wear method consistently provided younger age ranges than the pubic symphysis method. Overall, the two age-at-death estimation methods provided results that were consistent with the cohort system used in this thesis (following Buikstra & Ubelaker, 1994). In sum, the use of cranial (Walker, 2008) and dental (Lovejoy, 1985) traits for skeletal sex and age-at-death estimation, respectively, were appropriate for this sample, as their results were consistent with each other.

5.2 Skeletal vs fardo subsamples comparisons

The stature data in this section included contexts with and without crania. Overall, based on the predictive equations from del Angel and Cisneros (2004) using maximum femoral length, female individuals were generally shorter than their male counterparts (Table 5.1 and Figure 5.1). However, there was no significant difference between skeletal and fardo subsamples (t-test: $t = 2.02$, $df = 46$, $p = 0.63$).

Table 5.1 Stature (cm) per subsample based on the predictive equations from del Angel and Cisneros (2004) using maximum femoral length.

Subsample	Skeletal sex group	n	Min. stature	Max. stature	Mean		Standard deviation
Skeletal	F	9	139.25	148.70	144.36	152.05	3.87
	M	13	150.41	170.20	158.55		4.92
Fardo	F	8	135.04	152.70	143.98	150.89	5.59
	M	10	150.34	163.44	155.83		4.85
MUNA sample (skeletal + fardo)	F	17	135.04	152.70	144.18	151.53	4.61
	M	23	150.34	170.20	157.37		4.97

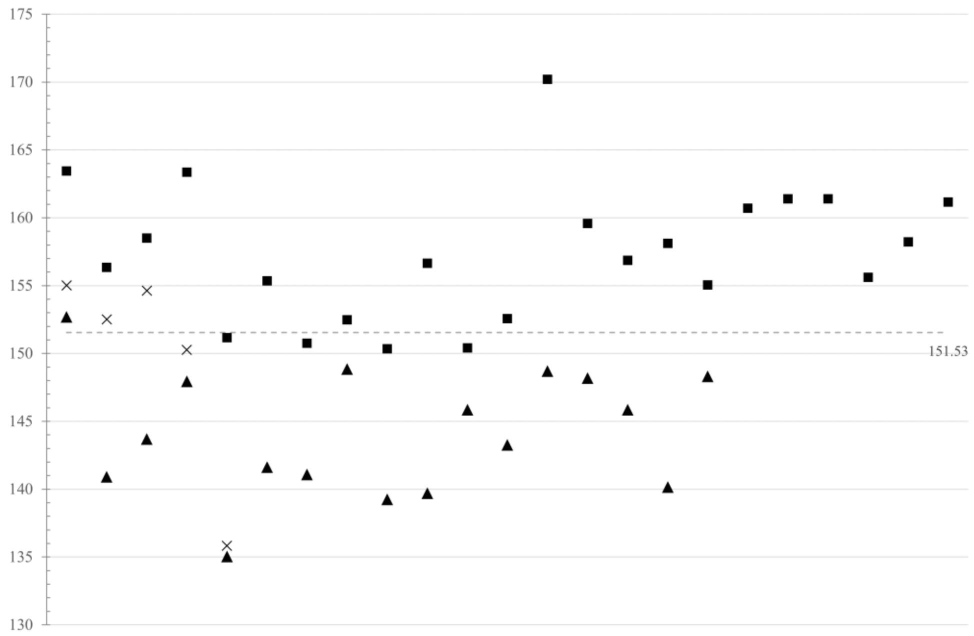

Figure 5.1 Statures (cm) based on the predictive equations from del Angel and Cisneros (2004) using maximum femoral length for female (▲), male (■), and indeterminate (×) adults; dashed line indicates combined sample stature mean. Y axis indicates stature values in centimeters.

Given the length of the comparisons and the limited page length for a master’s thesis, the complete comparisons of cranial modification, dental pathology, and mortuary rituals between the skeletal and fardo subsamples can be found in Appendix 7, below is a summary of the results.

The *qualitative* cranial modification analysis showed that the only type of modification found in the MUNA sample was the fronto-occipital or coastal type (Table 5.2). Within this type, however, there was variation in terms of subtypes, the severity of the modifications (mild, moderate, and severe), the prevalence and severity of posterior asymmetry, and the prevalence of a depression along the coronal suture. Examples of the MUNA cranial modifications can be seen in Appendix 7.

Table 5.2 Subtypes of fronto-occipital cranial modification found in the MUNA sample.

Subtype[11]	**Description**
Not modified	- The cranial vault is not modified.
Frontal	- Only anterior modification; there is no posterior modification. - There can be a depression along the coronal suture.
Occipital	- Only posterior modification, it affects the occipital and sometimes the posterior end of the parietals; there is no anterior modification. - The posterior modification can be asymmetric. - The flattened area can be around obelion/lambda or the occipital squama. - There can be a small, oval or circular depression in the center of the flattened area. - There can be a depression along the coronal suture.
Fronto-occipital	- Anterior and posterior modification. - The posterior modification affects the occipital and sometimes the posterior end of the parietals. - The posterior modification can be on obelion/lambda or on the occipital squama. - There can be a small, oval or circular depression in the center of the posterior modification. - The posterior modification can be asymmetric. - There can be a depression along the coronal suture.

In both subsamples, the most common subtype of cranial modification was the Fronto-occipital, then the Occipital, and lastly the Frontal. The comparisons between subsamples in terms of posterior modification and asymmetry showed no statistically significant differences, but both variables showed intra-sample variability. The only statistically significant differences between subsamples were found in the prevalence of anterior

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[11] In this thesis, I have used the terms ‘Frontal’, ‘Occipital’, and ‘Fronto-occipital’ (capitalized) for the subtypes of cranial modification. For the areas of the cranial vault that have been modified, I have used the terms ‘anterior’ and ‘posterior’ (no capitalization).

modification and in the prevalence of the coronal depression. But, in neither case was there a significant difference in the prevalence of each severity. Furthermore, there was no association between the prevalence of anterior modification and the coronal depression, as might be expected if the coronal depression was caused by the anterior modification.

The *quantitative* analysis of the cranial index showed that the subsamples were not significantly different, which was consistent with the qualitative results. In sum, despite showing some variability in the expression of cranial modification traits, there were no major differences between the skeletal and fardo subsamples.

The comparison of dental pathology variables (i.e., caries, abscesses, AMTL, and dental wear) between the subsamples did not yield any significant differences between the skeletal and fardo subsamples. This supported the hypothesis that the subsamples were likely parts of the same sample.

Both subsamples had a wide range of types of archaeological items associated with the human remains. In general, there were no observable differences in the presence of different types of archaeological items between subsamples. However, the *Spondylus* shells were only recorded in the fardos (12 halves). Similarly, metal pieces were more common in the fardos than in the skeletal subsample, despite the larger number of skeletonized remains. The lack of *Spondylus* shells and lower amount of metal pieces in the skeletal subsample was more likely associated with modern looting and other activities that disturbed the contexts, rather than differential mortuary treatments between the subsamples. Evidence that supports this hypothesis includes that there were no other significant differences in the variables examined in this study, the disturbed nature of the upper level of the site, and because metal and *Spondylus* shells are perhaps two of the most eye-catching archaeological items in this cemetery, and thus likely looted more often than pottery sherds or plain cotton textiles. During our bioarchaeological analysis of both subsamples, the maximum minimum number of individuals (MNI) for the skeletal material was 13, while for the fardos it was three individuals in a single fardo. Although this may have seemed like a difference in burial patterns, this was likely due to the disturbances the skeletal sample suffered, not due to different mortuary treatments.

5.2.1 Summary

The biological profile, cranial modification, dental pathology, and mortuary treatment analyses provided evidence that the two subsamples did not differ significantly from each other in skeletal sex and age distribution; stature; posterior modification and asymmetry; prevalence of caries, abscesses, AMTL, and dental wear; and the presence/absence of different types of archaeological items. Thus, they were likely part of the same sample, and will be treated as such for the remainder of this thesis.

5.3 MUNA sample

After establishing that the two subsamples likely belonged to the same overall sample (which I refer to as the ‘MUNA sample’), below I present the comparison between other subdivisions of the overall sample (i.e., female vs male individuals and young vs middle adults) and the results of analyses that were done only with the skeletal subsample, but that can be loosely extrapolated to the complete sample given the lack of substantial differences between the subsamples.

5.3.1 Stature

When comparing all females to all males combined, there was a significant difference in stature (t-test: $t = 2.03$, $df = 36$, $p < 0.001$) (Table 5.1). This was consistent with other Central Andes sites (Mackey & Nelson, 2020; Pechenkina et al., 2007; Watson, 2016).

5.3.2 Cranial modification

Fisher’s exact tests for anterior modification ($p = 0.76$), posterior modification ($p = 1$), posterior asymmetry ($p = 1$), and the coronal depression ($p = 0.18$) showed no association between skeletal sex and the prevalence of these modifications. Similarly, there was no significant difference in the number of individuals per subtype of cranial modification between skeletal sex groups (Fisher’s exact test: $p = 0.38$). Broadly, this indicated that cranial modification practices were likely not meant to mark a distinction between female and male individuals (and tentatively women and men, but the data collected in this thesis is not enough to make that conclusion about gender in the MUNA cemetery).

In contrast, the Student's t-tests of the cranial index values between skeletal sex groups (Table 5.3) and Occipital vs Fronto-occipital subtypes (Table 5.4) showed significant differences between male and female adults ($p < 0.001$) and both subtypes ($p < 0.001$) (Table 5.5; see Appendix 7 for normality and variance tests). Despite the statistical significance, the boxplots in Figure 5.2 show overlap between the compared subgroups.

Table 5.3 Minimum, maximum, and mean cranial index (CI) values per skeletal sex group in the MUNA sample (mm).

	Female (n = 21)	Male (n = 34)
Minimum CI	79.88	75.14
Maximum CI	106.80	101.24
Mean	93.80	86.48
Standard deviation	7.44	6.57

Table 5.4 Cranial index minimum, maximum, and mean values per cranial modification subtype in the MUNA sample (mm).

	Fronto-occipital (n = 56)	Occipital (n = 21)	Frontal (n = 2)
Minimum CI	76.97	75.14	80.24
Maximum CI	110.68	98.66	90.34
Mean	92.23	85.97	85.29
Standard deviation	7.36	6.65	7.14

Table 5.5 Student’s T-tests for the cranial index values in the MUNA sample.

Comparison	*t*	*df*	Means	*p*
Female vs Male*	3.81	53	93.80 vs 86.48	0.0003583
Fronto-occipital vs Occipital*	3.41	75	92.23 vs 85.98	0.0007316

* $p < 0.001$

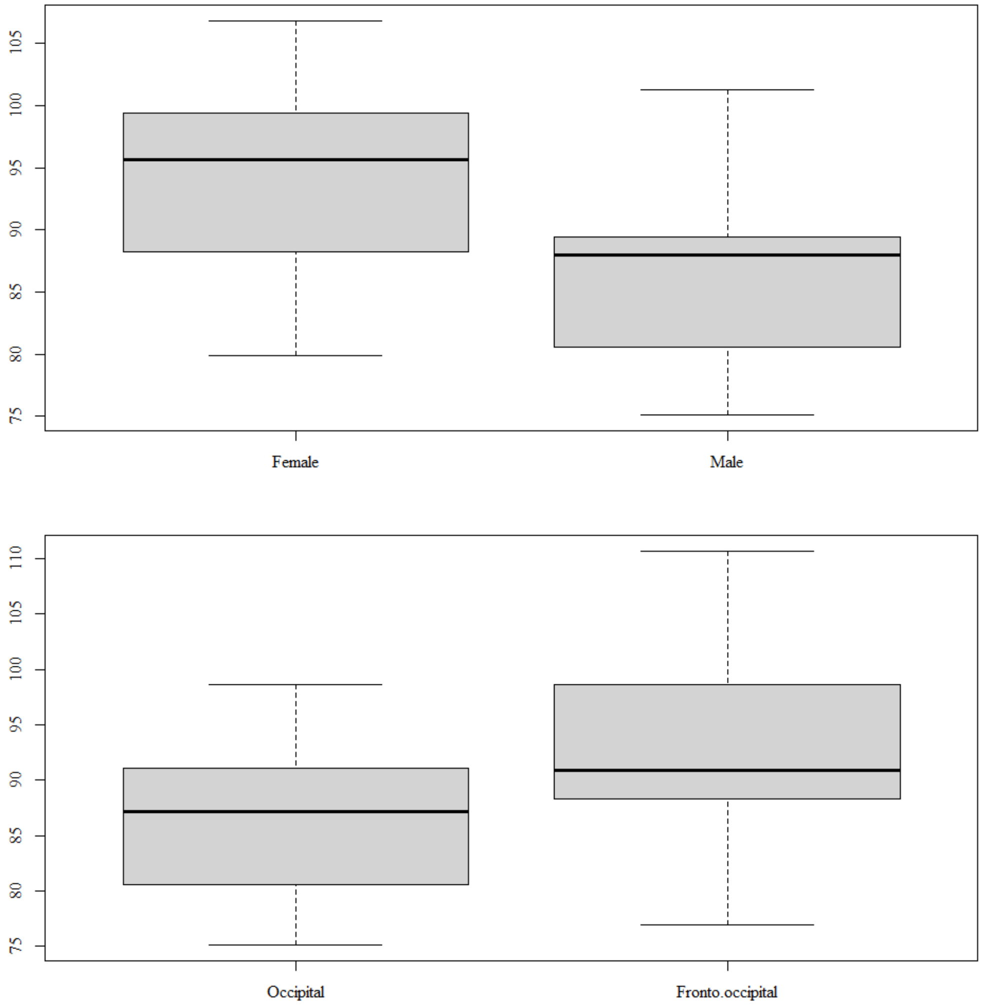


Figure 5.2 Boxplots of cranial index measurements comparing female vs male groups (top) and Occipital vs Fronto-occipital subtypes (bottom). X axis indicates subgroup; Y axis indicates cranial index values.

5.3.3 Pathological lesions: Cranial vault porosities, suprainiac lesions, and periosteal reaction on the nuchal crest.

This section of the analysis only includes results from the skeletal subsample, as the variables could not be accurately recorded through the CT scans of the fardos. See Table 5.6 for full descriptions of the pathological lesions.

Table 5.6 Pathological lesions potentially associated with cranial modification practices.

Pathological lesions	Description
Pattern of porosities (Figure 5.3)	- On the frontal bone, they formed a "U" shape around bregma. - The porosities continued along the sagittal suture on the parietals inside the temporal lines. - Lastly, porosities were present around the parietal-occipital sutures and on the occipital squama above the nuchal crest.
Suprainiac lesion (Figure 5.4)	- Oval depression around the nuchal planum, above the nuchal crest, that had evidence of porosities and proliferative periosteal reaction.
Periosteal reaction on the nuchal crest (Figure 5.3 and Figure 5.5)	- Generally localized on the edge of the nuchal crest. - Mostly proliferative but could potentially be lytic as well.

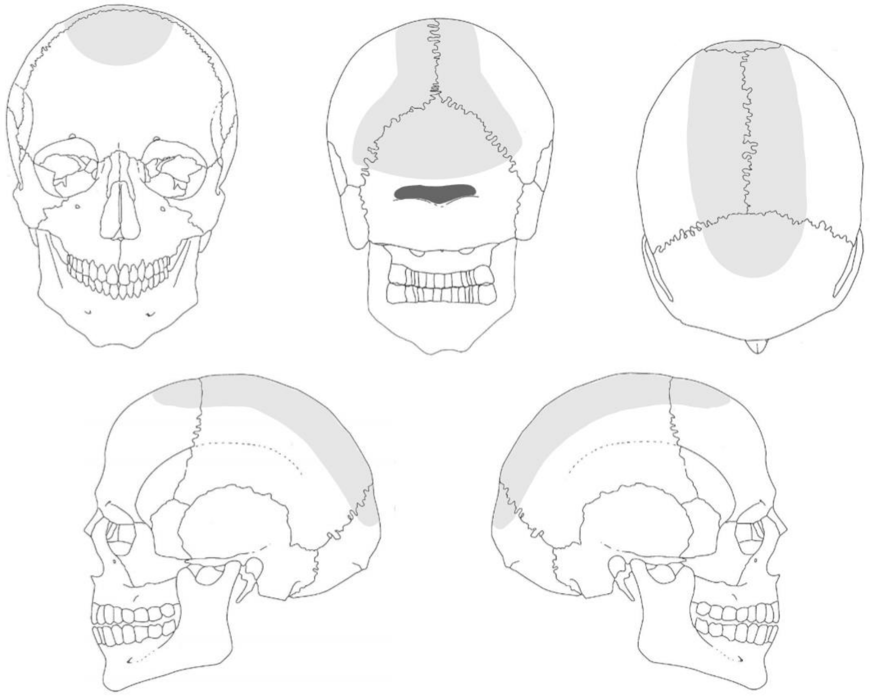


Figure 5.3 Pathological lesions on the cranial vault of some crania of the MUNA sample; light gray: porosities (aggregate pattern based on multiple crania from the MUNA sample), dark gray: periosteal reaction (adapted from Buikstra & Ubelaker, 1994).

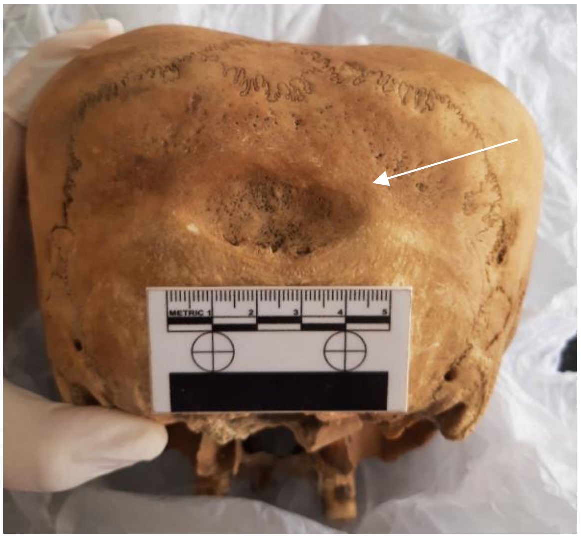


Figure 5.4 Suprainiac lesion on the occipital of B15.

Figure 5.5 Periosteal reaction around the nuchal crest of E17.

Although 62 skeletonized adult and non-adult crania were analyzed in this thesis, only 60 or 61 were included in the pathological lesions section because two of them had hair or textiles still attached to the cranial vault and I was unable to examine them in detail. The cranial vault porosities were analyzed in 60 crania, and the suprainiac lesion and periosteal reactions in 61 crania.

Out of the 60 crania analyzed, 37% (n = 22) did not have cranial vault porosities in the pattern described above. The rest of the crania had porosities in the complete pattern or in parts of it. From those, 8% (n = 5) had mild porosities, 47% (n = 28) had moderate porosities, and 8% (n = 5) had severe porosities (Figure 5.6). In terms of healing stages, which were recorded based on whether the porosities had evidence of closure and non-sharp edges, there were no crania with active porosities, 43% (n = 26) had healing porosities, and 20% (n = 12) had healed porosities. There was no association between the prevalence of cranial vault porosities and skeletal sex (Fisher's exact test: $p = 1$) or age (adults vs non-adults, Table 4.4) (Fisher's exact test: $p = 1$). Similarly, there were no differences between adults and non-adults in the number of individuals per degree of severity (Fisher's exact test $p = 0.82$) or healing stage (Fisher's exact test: $p = 1$). When subdividing the non-adults into cohorts (children and adolescents), there were no significant differences in the number of individuals per healing stage (Fisher's exact test: $p = 0.11$).

Of the 61 crania, only four (7%) had a suprainiac lesion (Figure 5.7) and only eight individuals (13%) had periosteal reactions around the nuchal crest (Figure 5.8). There were no differences in the prevalence of the suprainiac lesion (Fisher's exact test: $p = 1$) or periosteal reactions around the nuchal crest (Fisher's exact test: $p = 0.39$) between sex groups. The lack of association between the prevalence of these three types of lesions and skeletal sex follows the same trend as the other cranial modification variables analyzed.

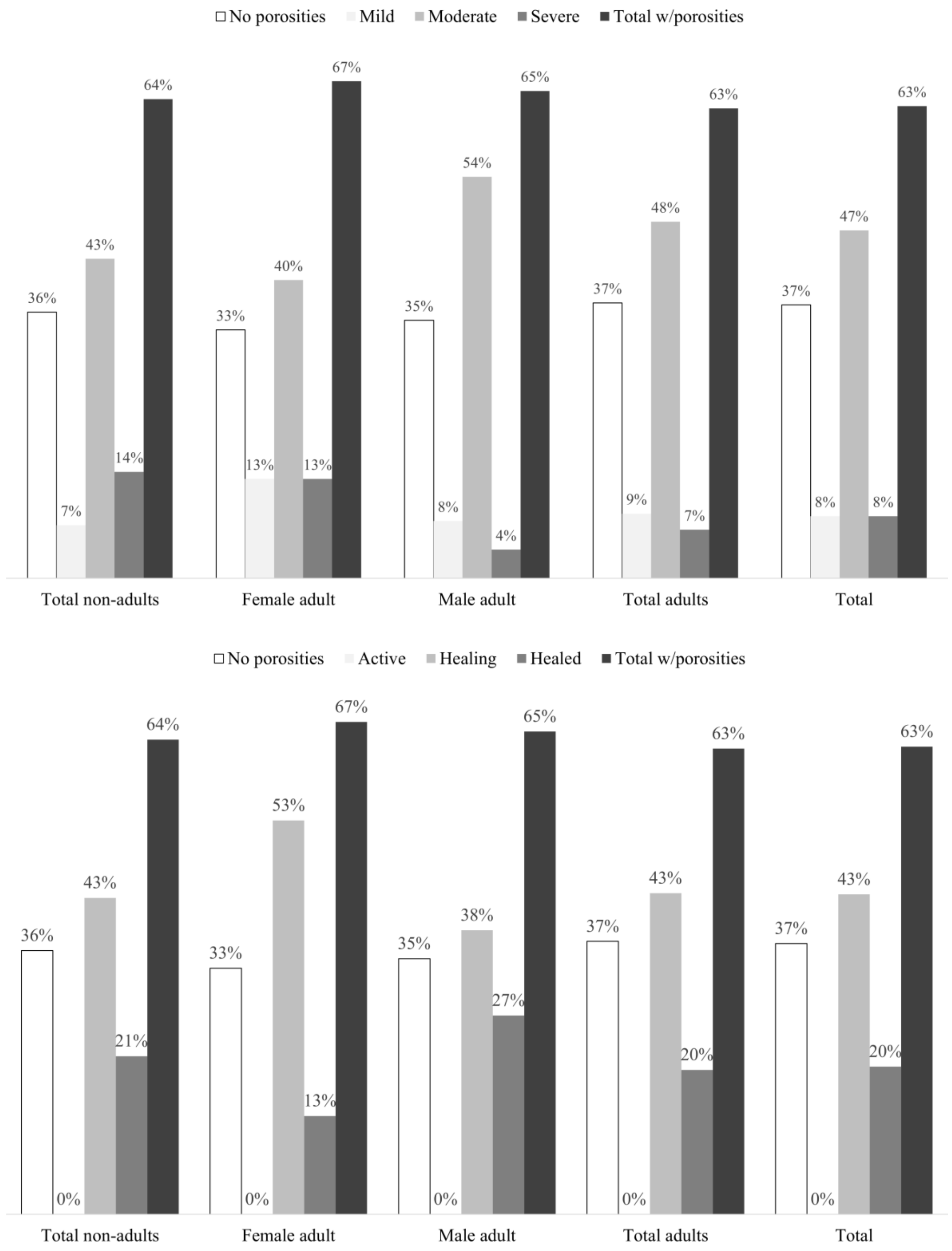


Figure 5.6 Distribution of porosities on the cranial vault in the skeletal subsample; shades of gray indicate severity (top) and healing stage (bottom). X axis indicates cohorts; Y axis indicates prevalence.

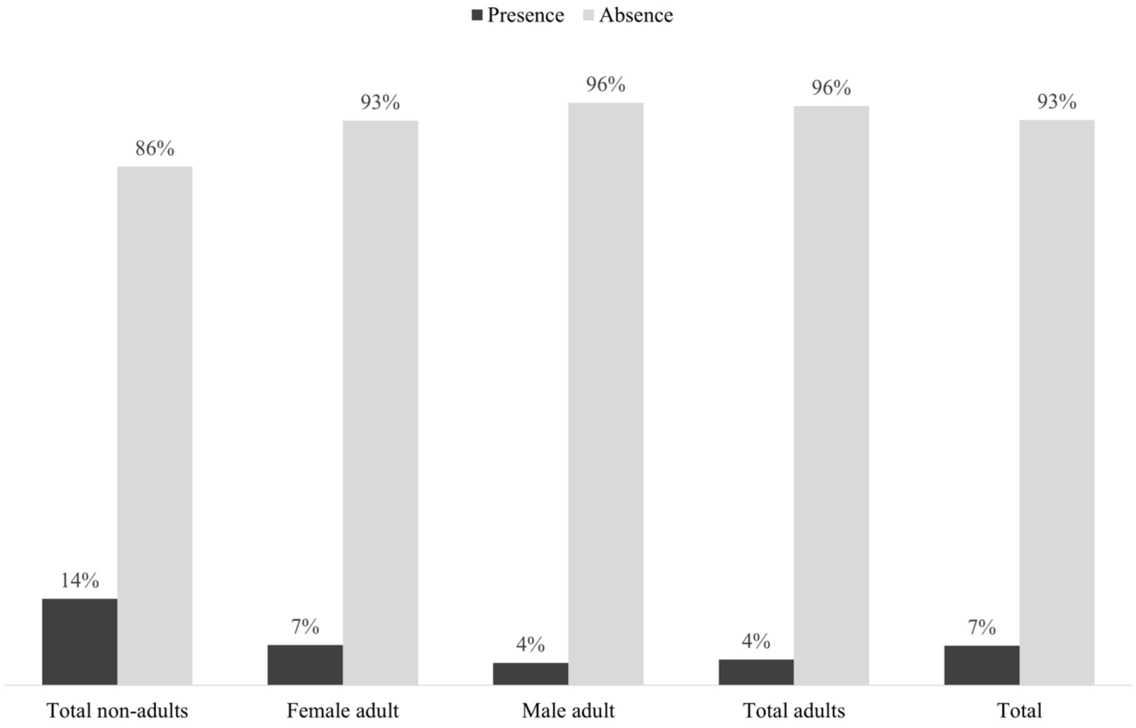


Figure 5.7 Distribution of suprainiac lesions in the skeletal subsample; shades of gray indicate presence and absence. X axis indicates cohorts; Y axis indicates prevalence.

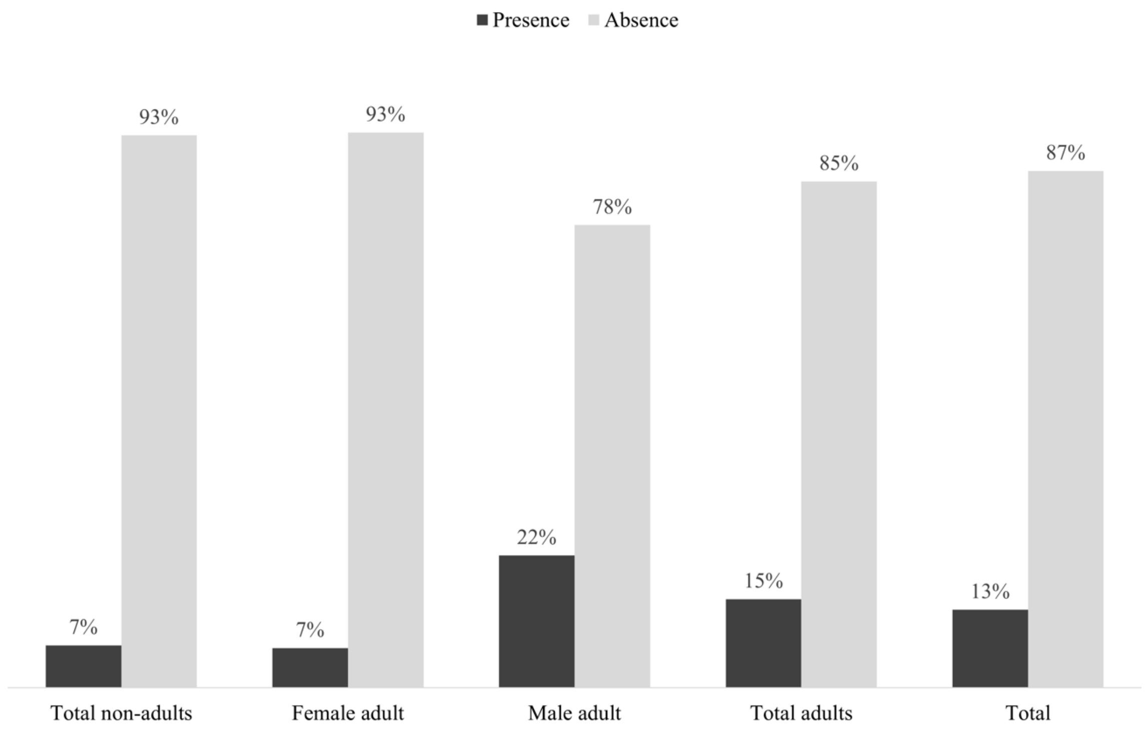


Figure 5.8 Distribution of periosteal reaction on the nuchal crest in the skeletal subsample; shades of gray indicate presence and absence. X axis indicates cohorts; Y axis indicates prevalence.

The cranial vault porosities (Fisher's exact test: $p = 0.61$), the suprainiac lesion (Fisher's exact test: $p = 1$), and the periosteal reaction on the nuchal crest (Fisher's exact test: $p = 0.70$) were not significantly associated with the subtypes of cranial modification (Table 5.7). It is important to note that the non-modified cranium also showed evidence of porosities (but not the periosteal reaction on the nuchal crest or the suprainiac lesion), particularly on the occipital squama, which indicated that cranial modification practices, if associated with the porosities, were not the sole reason for their presence.

Furthermore, the three pathological lesions were found in crania with mild, moderate, and severe cranial modification. This shows that these conditions, if they were a consequence of cranial modification practices, were not exclusively associated with severe forms as one might expect. Furthermore, in the case of the porosities, they seem to have been widespread among the individuals from this cemetery, as over half of the analyzed crania had them to some degree.

Table 5.7 Distribution of pathological lesions on the cranial vault by subtype of cranial modification.

Pathological lesions	Not modified (N = 1)	Frontal (N = 2)	Occipital (N = 21)	Fronto-occipital (N = 38)
Cranial vault porosities	1 (100%)	2 (100%)	11 (52%)	24 (63%)
Suprainiac lesion	0	0	1 (5%)	3 (8%)
Periosteal reaction on the nuchal crest	0	0	2 (10%)	6 (16%)

These pathological lesions, along with the cranial modification subtypes within the MUNA sample, become more relevant in the discussion of the possible devices or appliances people could have used in the past to modify their infants' heads. It is worth noting that the lesions that affected the posterior portion of the cranial vault were found almost exclusively in the Occipital and Fronto-occipital subtypes. It is accepted by various researchers that the fronto-occipital modification in the Peruvian coast was likely achieved using cradle-boarding techniques (Mendonça de Souza et al., 2008; Stewart, 1976; Weiss, 1961) (for more detail see section 3.3). However, some of the variants seen in the MUNA sample (and elsewhere in the Central Coast, such as at Ancón) suggested that other types of devices could have been used along with, or instead of, a cradleboard, as certain head shapes could not have been achieved with such a device (see Chapter 6 for more discussion).

5.3.4 Dental pathology

The prevalence of carious teeth (Table 5.8 and Figure 5.9) was significantly lower in young adults than in middle adults (skeletal sex groups combined; no old adults were present in the analysis of caries) (20.4% vs 28.1%) (Fisher's exact test: $p = 0.04$), but based on the odds ratio value, this difference was small (Table 5.9). In contrast, there was no significant difference in the prevalence of carious teeth between male and female adults (Fisher's exact test: $p = 0.74$). This indicated that the prevalence of carious teeth was positively associated with age, but not skeletal sex. The analysis of caries did not yield any conclusive results for coca leaf chewing (e.g., severe cervical root caries on the buccal surface of the molars (Indriati & Buikstra, 2001)).

Table 5.8 Distribution of carious teeth by cohort in the combined MUNA sample; N: total number of observable teeth, n: number of carious teeth.

Cohort	**MUNA sample**		
	N	**n**	**%**
Female young adults	103	21	20.4%
Male young adults	215	44	20.5%
Indeterminate young adults	49	10	20.4%
Total young adults (skeletal sex groups combined)	367	75	20.4%
Female middle adults	74	17	23.0%
Male middle adults	97	29	29.9%
Indeterminate middle adults	64	20	31.3%
Total middle adults (skeletal sex groups combined)	235	66	28.1%
Total female adults (cohorts combined)	177	38	21.5%
Total male adults (cohorts combined)	315	73	23.2%
Total indeterminate adults (cohorts combined)	129	36	27.9%
Total adults	621	147	23.7%

Table 5.9 Fisher's exact test values for the prevalence of carious teeth between subgroups in the MUNA sample.

Prevalence of caries between:	***p***	**Odds ratio**	**95% CI**
Young vs middle adults*	0.04	0.66	0.44-0.98
Female vs male adults	0.74	0.91	0.56-1.44
Male: young vs middle adults	0.08	0.60	0.33-1.09
Female: young vs middle adults	0.71	0.86	0.39-1.90

* $p < 0.05$

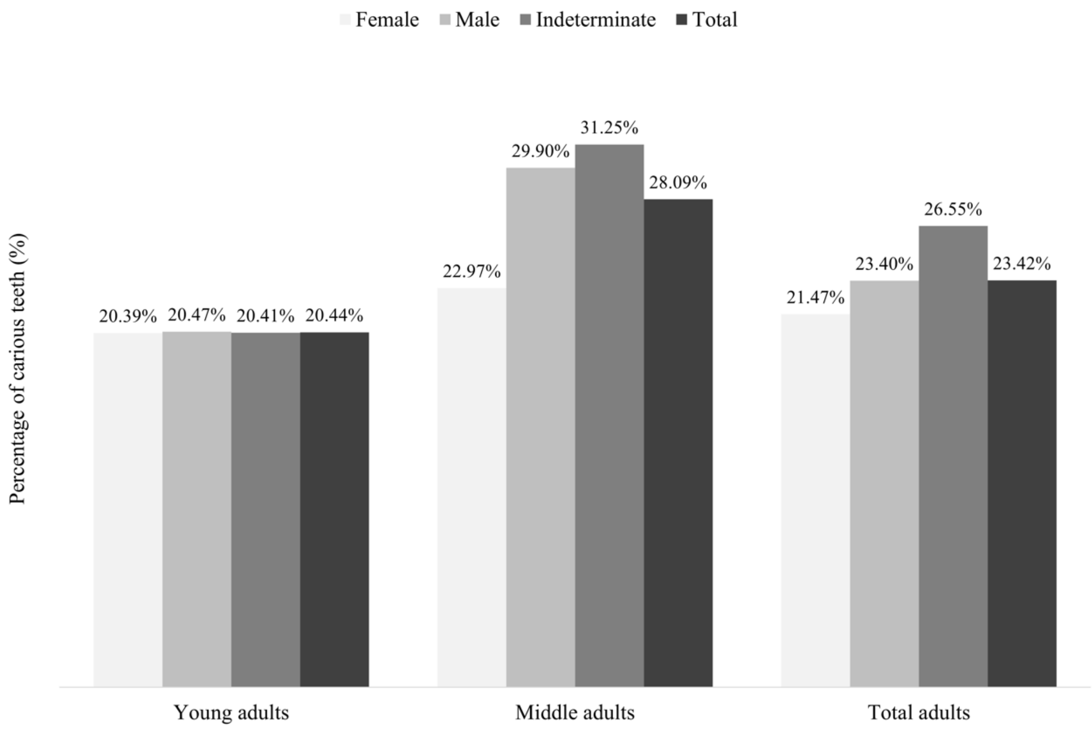


Figure 5.9 Prevalence of carious teeth by cohort in the MUNA sample; shades of grey indicate skeletal sex group. X axis indicates cohorts; Y axis indicates prevalence.

The prevalence of abscesses (Table 5.10 and Figure 5.10) in young adults was 2%, while the prevalence in middle adults was 5.2%; this difference was significant

(Fisher's exact test: *p* < 0.01). The prevalence of abscesses in males (5.1%) was significantly higher than in females (2.3%) (Fisher's exact test: *p* = 0.04). This could suggest differences in cultural or dietary practices between skeletal sex groups. Both odds ratios were relatively small, which indicated a small difference between the groups (

Table 5.11). In all, there was a small positive association between the prevalence of abscesses and age and skeletal sex group.

Table 5.10 Distribution of abscesses by cohort in the combined MUNA sample.

Cohort	MUNA sample		
	N	n	%
Female young adults	192	0	0.0%
Male young adults	384	12	3.1%
Indeterminate young adults	160	3	1.9%
Total young adults (skeletal sex groups combined)	736	15	2.0%
Female middle adults	224	9	4.0%
Male middle adults	320	24	7.5%
Indeterminate middle adults	192	5	2.6%
Total middle adults (skeletal sex groups combined)	736	38	5.2%
Total female adults (cohorts combined)	480	9	1.9%
Total male adults (cohorts combined)	864	36	4.2%
Total indeterminate adults (cohorts combined)	480	8	1.7%
Total adults	1824	53	2.9%

Table 5.11 Fisher's exact test values for the prevalence of abscesses between subgroups in the MUNA sample.

Prevalence of abscesses between:	***p***	**Odds ratio**	**95% CI**
Young vs middle adults**	0.0019	2.53	1.35-5.00
Female vs male adults*	0.04	2.22	1.04-5.29

** p < 0.05, ** p < 0.01*

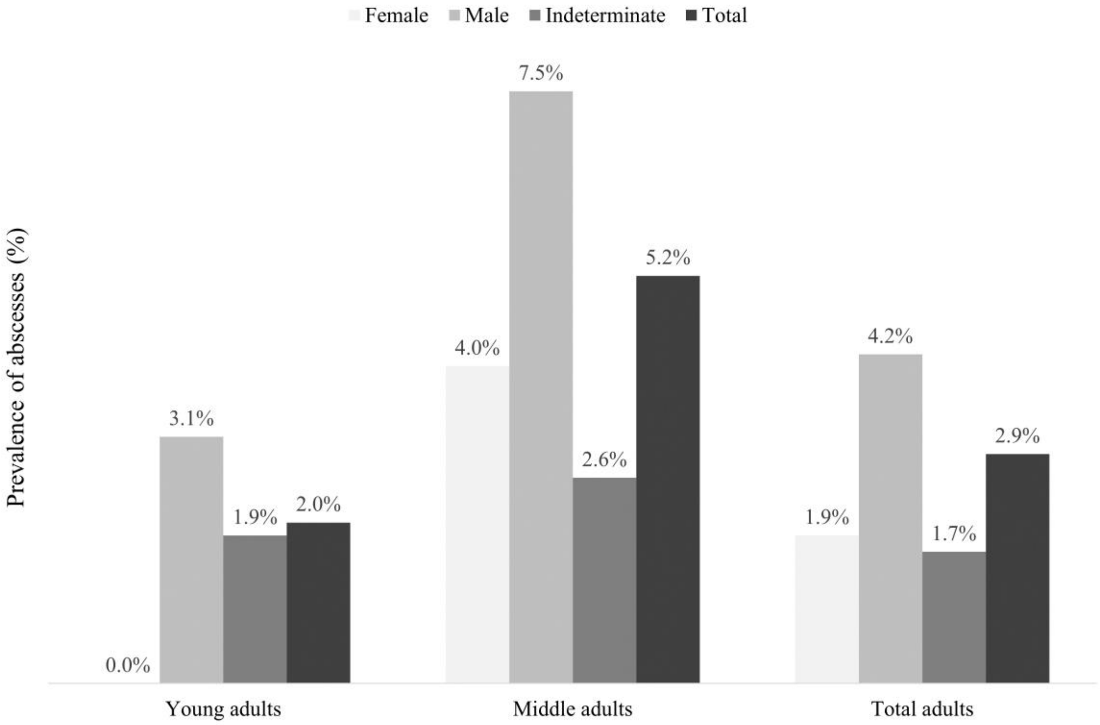


Figure 5.10 Prevalence of abscesses by cohort in the MUNA sample; shades of grey indicate skeletal sex group. X axis indicates cohorts; Y axis indicates prevalence.

There was a significant difference in the prevalence of AMTL between young adults (6.8%) and middle adults (11.5%) (Table 5.12 and Figure 5.11) (Fisher's exact test: $p < 0.01$). When comparing between skeletal sex groups (young and middle adults combined), the prevalence of AMTL in female individuals (11.9%) was significantly lower than in male individuals (18.0%) (Fisher's exact test: $p < 0.01$). The prevalence of

AMTL in female young adults was significantly lower than in female middle adults (6.3% and 13.4%, respectively) (Fisher's exact test: *p* = 0.03). This trend was similar in the male group (young adults: 8.9% vs middle adults: 13.8%), but it was not significant (Fisher's exact test: *p* = 0.07). In all, the prevalence of AMTL was positively associated with age and skeletal sex group (Table 5.13). The results of this variable suggest that coca chewing may have been a practice, as there was evidence of AMTL of molars (which is a marker for the practice, as per Indriati and Buikstra (2001)). However, the evidence is not conclusive.

Table 5.12 Distribution of AMTL by cohort in the MUNA sample; N: total number of observable alveoli, n: number of AMTL.

Cohort	**MUNA sample**		
	N	**n**	**%**
Female young adults	192	12	6.3%
Male young adults	384	34	8.9%
Indeterminate young adults	160	4	2.5%
Total young adults (skeletal sex groups combined)	736	50	6.8%
Female middle adults	224	30	13.4%
Male middle adults	320	44	13.8%
Indeterminate middle adults	192	11	5.7%
Total middle adults (skeletal sex groups combined)	736	85	11.5%
Female old adults	-	-	-
Male old adults	32	32	100%
Indeterminate old adults	-	-	-
Total old adults (skeletal sex groups combined)	32	32	100%
Total female adults (cohorts combined)	480	57	11.9%
Total male adults (cohorts combined)	896	161	18.0%

Total indeterminate adults (cohorts combined)	480	30	6.3%
Total adults	1856	248	13.4%

Table 5.13 Fisher's exact test values for the prevalence of AMTL between subgroups in the MUNA sample.

Prevalence of AMTL between:	*p*	Odds ratio	95% CI
Young vs middle adults**	0.004	1.70	1.16-2.29
Female vs male adults**	0.003	1.63	0.89-1.78
Male: young adults vs middle adults	0.07	1.55	0.94-2.57
Female: young vs middle adults*	0.03	2.1	1.03-4.72

* $p < 0.05$, ** $p < 0.01$

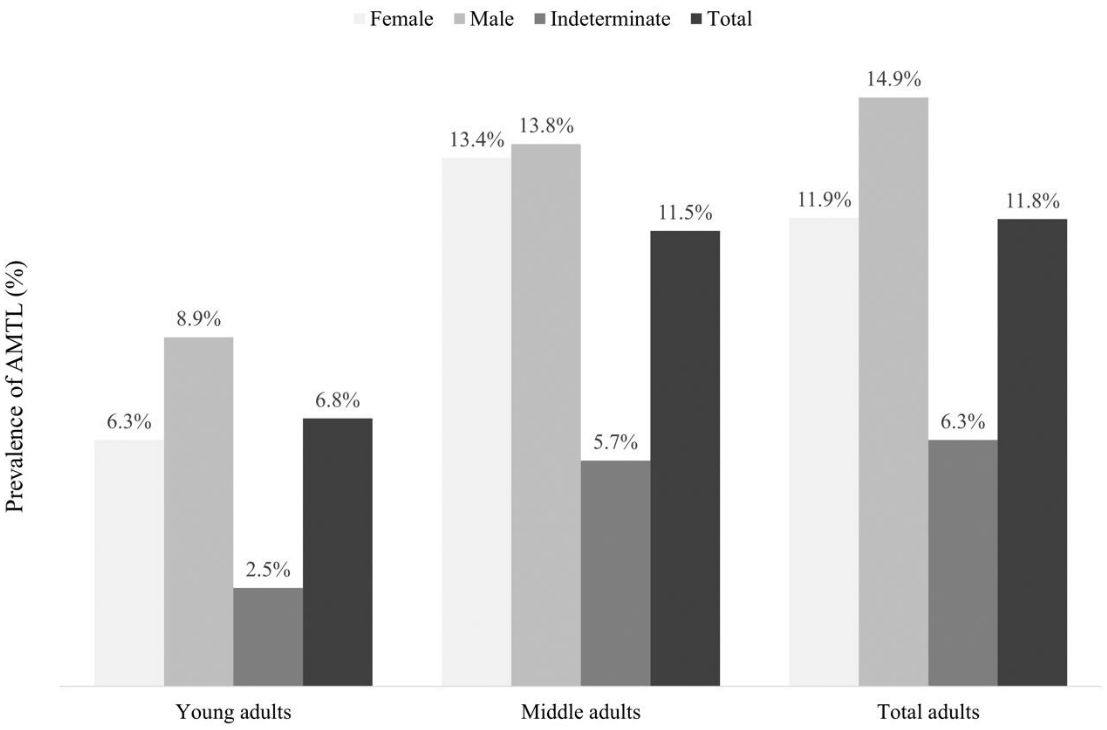


Figure 5.11 Prevalence of AMTL by cohort in the MUNA sample; shades of grey indicate skeletal sex group. X axis indicates cohorts; Y axis indicates prevalence.

Out of 35 observable individuals, 28 (80%) presented dental calculus (Figure 5.12). There was no association between the prevalence of dental calculus and skeletal sex (Fisher's exact test: *p* = 0.13) or age (Fisher's exact test: *p* = 0.66).

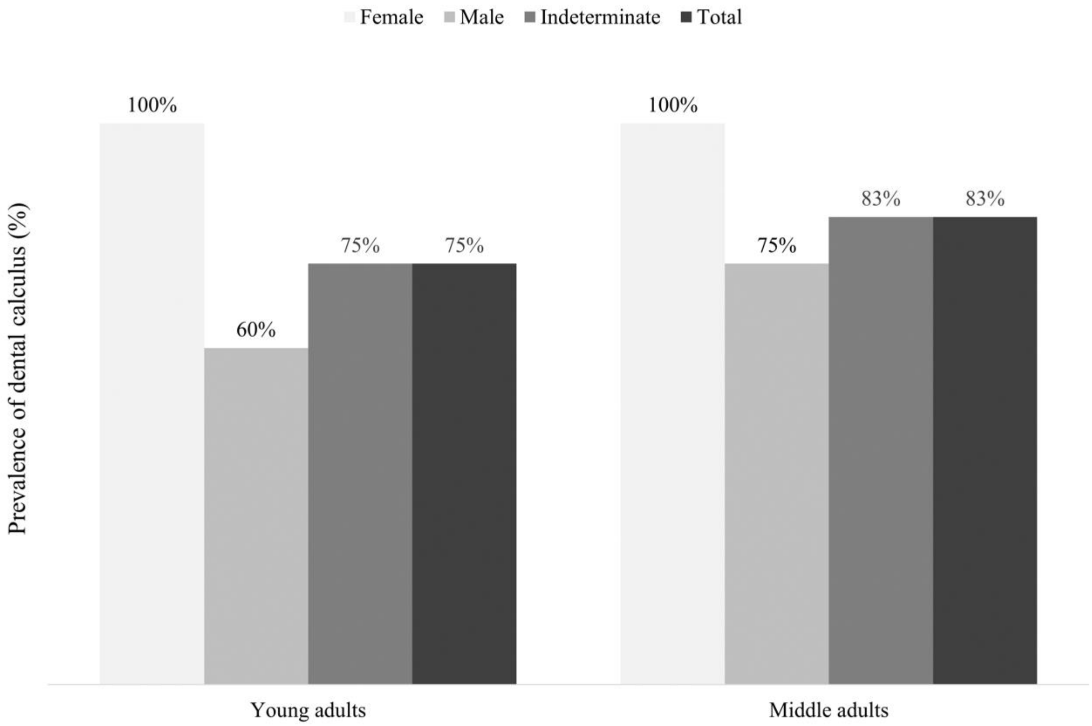


Figure 5.12 Prevalence of dental calculus (%) by cohort in the skeletal subsample; shades of grey indicate skeletal sex group. X axis indicates cohorts; Y axis indicates prevalence.

5.3.5 Mortuary treatment

In the MUNA fardos, we found that female individuals were generally associated with weaving tools (e.g., spindles, yarn balls, needles). Baldeos and his team found that some contexts with male individuals were associated with possible agricultural tools, such as wooden sticks (Baldeos, 2015). Thus, there seemed to be a broad trend in the MUNA sample in which female individuals were buried with weaving tools, while males were buried with agricultural tools.

5.3.6 Summary

The *qualitative* analysis of cranial modification showed no differences in the prevalence of anterior and posterior modification, posterior asymmetry, or the coronal depression between female and male individuals. The *quantitative* analysis showed slight significant differences in the cranial index means between skeletal sex groups and between the Occipital and Fronto-occipital subtypes. Both differences indicated that, despite the relatively homogeneity of cranial modification in the MUNA sample, slight variations in morphology are present and should be taken into account in the interpretation of this practice. Additionally, the difference between female and male adults suggested that, to a degree, cranial modification could have been influenced by the gender assigned to the infant at birth.

The pathological lesions potentially associated with cranial modification practices were porosities on the cranial vault, suprainiac lesions, and periosteal reaction around the nuchal crest. Out of the three, the porotic lesions were present in over half of the skeletonized crania, while the other two were present in 7% and 13% of individuals, respectively. The three pathological lesions were present in mild, moderate, and severe cases of cranial modification. This suggests that the severity of the modification was not necessarily associated with the prevalence of these lesions on the cranial vault. On the other hand, the lesions on the occipital (periosteal reaction on the nuchal crest and suprainiac lesions) were only seen in the crania with posterior modification.

The dental pathology results showed a small, but significant, positive association between the prevalence of carious teeth, abscesses, and AMTL with age, which is to be expected. However, this positive association was not found between dental calculus and age. Additionally, there was a small association between the prevalence of abscesses and skeletal sex group in which male adults had a higher prevalence of abscesses and AMTL than female adults. However, this was not observed in the prevalence of carious teeth. This could suggest different cultural or dietary practices between skeletal sex groups that increased the abscesses in male adults, such as chicha consumption or preparation.

Chapter 6

6 Discussion

Given the lack of significant differences between the skeletal and fardo subsamples, the discussion of the results will be focused on the larger MUNA sample within the context of the Central Coast during the LIP and early LH. It will explore the role of cranial modification and dental pathology in the social organization within the cemetery, and in the wider context of the Central Coast. Additionally, it will discuss the ways in which people in the past could have achieved the head shapes seen in the MUNA sample, and the potential factors (e.g., modifying appliances) involved in the intra-sample variability. I will also discuss differential diagnoses for the pathological lesions possibly associated with cranial modification. Lastly, I will discuss the connection between the people interred in this cemetery and the larger site of Pachacamac.

6.1 Demographic distribution

Although this thesis, which focused on crania and teeth, did not include infants (birth to 1 year) and only had one old adult, the larger MUNA sample we analyzed included 15 infants and 10 old adults out of over 250 individuals. The low representation of these cohorts in the cranial modification and dental pathology samples could be explained by sampling bias, taphonomic reasons, or biocultural behaviors for infants and old adults (e.g., different burial spaces for these two cohorts, weaning practices, life expectancy for adults).

Although we did not analyze the entirety of the MUNA collection, we did examine most of the contexts. From the 2015 skeletal material, we analyzed all the contexts with complete (or relatively complete) crania, and contexts without crania with well preserved post-cranial skeleton. The only contexts that were excluded were the ones that were too fragmented for biological profile or cranial modification analyses. From the 31 2016-2019 contexts, only 19 included disarticulated human remains (García & Baldeos, 2020), and although we did not examine those in their entirety, 17 crania were analyzed and included in the cranial modification analysis. From the fardos, which included the 2015 and 2016-2019 materials, we only excluded the ones that were too poorly preserved to be analyzed for biological profile and/or cranial modification. So, although we did not examine *all* the MUNA contexts, we analyzed *most* of the remains, and it is unlikely that sampling bias was greatly impacting the representation of infants and old adults.

The 15 infants in the larger MUNA sample were mostly represented by post-cranial bones and some disarticulated cranial bones. The generally regular preservation and completeness of some of the infants remains make it unlikely that taphonomic damage played a major role in the lack of infants in the cranial modification analysis. It is more likely that the lack of articulation in cranial bones in the MUNA infants was a determining factor in the unintentional exclusion from this thesis.

Due to the generally poor preservation of the skeletal remains, not all the individuals were analyzed for biological profile, as some were only represented by a single bone. The 10 old adults were represented by fragmented os coxae and one cranium. The relatively good preservation of the crania contrasted with the poor preservation of the ox coxae and was an indicator that taphonomy was not the sole factor in the low representation of old adults in the cranial modification sample. From a comparative standpoint, the low representation of old adults in the MUNA sample followed a similar trend that has been found in other Central Coast sites across time periods (Boza, 2010; Murphy & Boza, 2009; Pezo-Lanfranco & Eggers, 2016; Vega, 2016; Watson, 2016). This could be explained by a multitude of factors, such as adults not surviving middle adulthood in pre-Hispanic times, but these factors cannot be explored in full in this thesis.

Looking at cultural practices and how they might impact the demographic profile, if the MUNA people were pilgrims, it is possible that for the most part, the youngest and oldest of the group (and potentially the frailest) did not make the journey to Pachacamac. It is also possible that if they did travel to Pachacamac, they were buried separately for cultural reasons that are out of the scope of this thesis. An ethnohistoric account by José de Arriaga indicated that pre-Hispanic people kept the bodies of young babies who died in pots (Arriaga, 2002 [1621]). This was perhaps to store the deceased newborns or stillbirths until they were buried later with an adult or as a different kind of offering.

Additional factors could include a lower mortality rate for infants due to breastfeeding practices during this age, and a low percentage of adults who lived beyond the 50 years of age.

6.2 Stature

The analysis of stature compared the MUNA sample with two other Central Coast sites (Ancón and Huaca Huallamarca) and a North Coast site (Farfán). The ANOVA results comparing the statures in the MUNA, Ancón (Watson, 2016), Huaca Huallamarca (Pechenkina et al., 2007), and Farfán (Mackey & Nelson, 2020) samples showed that at least one site was different from the others for both skeletal sex groups (Table 6.1 and Table 6.2, Figure 6.1). The Tukey *post-hoc* tests for the female adults (Table 6.3) showed significant differences between the MUNA sample and Ancón and Huaca Huallamarca, but not with Farfán. The Tukey *post-hoc* tests for the male adults (Table 6.3) showed no significant differences between the MUNA sample and Ancón, Huaca Huallamarca, and Farfán, but there was a difference between Ancón and Farfán.

It is notable that the stature mean for the female MUNA group was significantly smaller than the two Central Coast sites (Ancón and Huaca Huallamarca), but not different from the North Coast site of Farfán. This suggests that female adults may have had different cultural practices or different access to resources between Central Coast valleys than their male counterparts. However, there were no significant differences between the stature means of the female adults between Ancón and Huaca Huallamarca. The difference between Ancón and Farfán stature means could be explained by differences in diet or a differentiated access to resources that made the Ancón individuals significantly taller. Isotopic analysis to assess dietary differences would provide further evidence to explore these stature patterns.

Table 6.1 Stature (cm) per subsample based on the predictive equations from del Angel and Cisneros (2004) using maximum femoral length; n: number of femora measured.

Subsample	Skeletal sex group	n	Mean	Standard deviation
MUNA (Central Coast)	F	17	144.2	4.61
	M	23	157.4	4.97
Ancón (Central Coast)	F	12	150.4	4.57
	M	14	161.2	2.98
Huaca Huallamarca (Central Coast)	F	14	152.8*	5.81*
	M	20	159.2*	5.24*
Farfán (North Coast)	F	18	144.0	3.42
	M	6	154.4	2.12

** Values were calculated based on maximum femoral length means and standard error values from the article.*

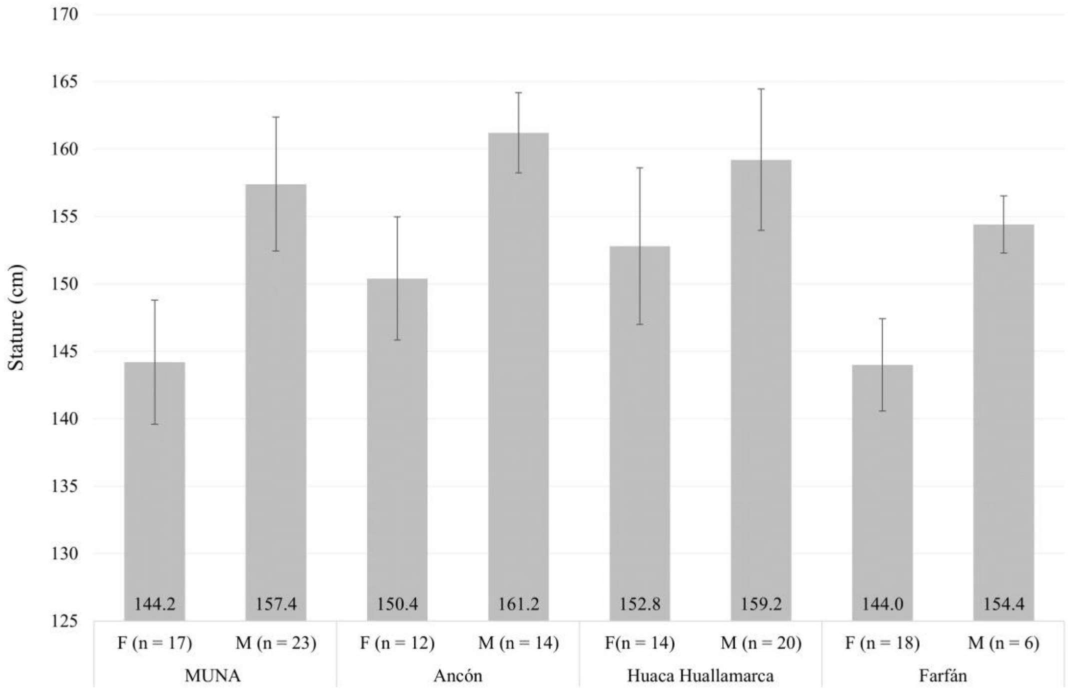


Figure 6.1 Stature means with standard deviation values by skeletal sex group for the MUNA sample, Ancón, Huaca Huallamarca, and Farfán. X axis indicates the samples; Y axis indicates stature values in cm.

Table 6.2 One-way ANOVA for the comparison of adult stature means between the MUNA, Ancón, Huaca Huallamarca, and Farfán samples.

		Sum of squares	*df*	Variance	F	*p*
Female adults	Between groups	898.1	3	299.4	14.1	< 0.001
	Within groups	1207.4	57	21.2		
	Total	2105.6	60			
Male adults	Between groups	240.5	3	80.2	3.9	0.0126
	Within groups	1203.0	59	20.4		
	Total	1443.5	62			

Significance level of 0.05.

Table 6.3 Tukey *post-hoc* tests for the comparison of the adult stature means between the MUNA, Ancón, Huaca Huallamarca (HH), and Farfán samples.

	Comparison	Mean diff.	95% CI	p
Female adults	MUNA vs Ancón*	6.2	1.6 – 10.8	0.004
	MUNA vs HH*	8.6	4.2 – 13.0	< 0.0001
	MUNA vs Farfán	-0.2	4.3 – 3.9	0.9992
	Ancón vs HH	2.4	-2.4 – 7.2	0.5508
	Ancón vs Farfán*	-6.4	-10.9 – -1.9	0.0024
	HH vs Farfán*	-8.8	-13.1 – -4.5	< 0.0001
Male adults	MUNA vs Ancón	3.8	-0.3 – 7.8	0.0732
	MUNA vs HH	1.8	-1.9 – 5.5	0.5642
	MUNA vs Farfán	-3.0	-8.5 – 2.5	0.4743
	Ancón vs HH	-2.0	-6.2 – 2.2	0.5848
	Ancón vs Farfán*	-6.8	-12.6 – -1	0.0159
	HH vs Farfán	-4.8	-10.4 – 0.8	0.1135

* $p < 0.05$

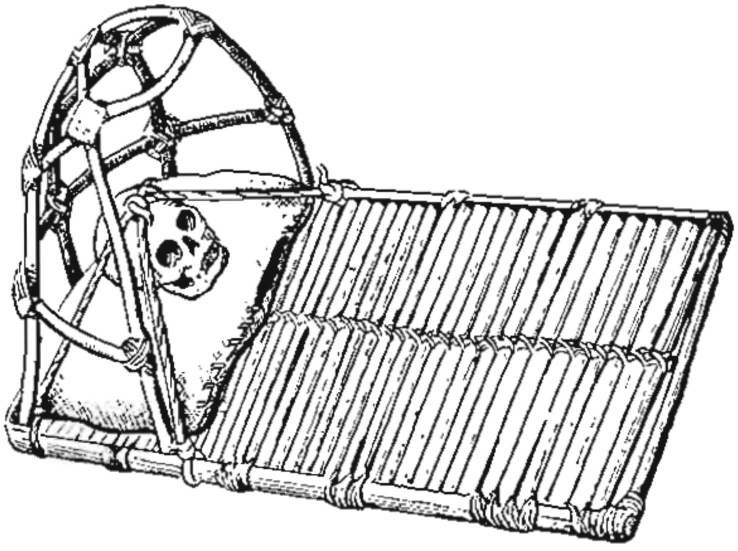
6.3 Cranial modification

6.3.1 Cranial modification at MUNA

Given that cranial modification practices took place in infancy when the cranial bones were still malleable (from birth to until around 3 years of age) head shaping was a form of irreversible assigned identity, not status a person achieved in their lifetime (Gowland & Thompson, 2013; Tiesler, 2014). Under this framework, cranial modification within the MUNA sample could be, very broadly speaking, ascribed ethnicity and/or socio-economic status.

Using the cranial modification results, the MUNA cemetery could be interpreted under three different models: 1) the people were *local* to Pachacamac or the Lurín Valley; 2) the people were *regional pilgrims* from elsewhere on the Central Coast; or 3) the people were *pan-Andean pilgrims* from across the Andes. In the first model, the expected cranial modification styles would be relatively uniform at MUNA and different from other Central Coast sites. In this scenario, cranial modification could have been a marker to differentiate themselves from other Central Coast communities. In the second model, it would be expected to find intra-site variability in cranial modification styles, but similarities with other Central Coast sites. In the third model, cranial modification styles would be expected to be more variable than in the second model (e.g., include the annular type, which is representative of highland cultures), and it would also be expected to find archaeological material from other areas of the Andes.

The MUNA crania can be generally classified within 2 types from Pedro Weiss' typology: 1) 'Fronto Occipital Costeño' and 2) 'Occipital Costeño-Inca Costeño' (previously called 'Fronto Occipital-Inca Costeño') (Weiss, 1961, 1962). In Weiss' typology, the two types were associated with cradle-boarding techniques (Figure 6.2) (Weiss, 1961, 1962). Variability in shapes within the two fronto-occipital types was not uncommon (e.g., some had the frontal modified and others did not), and posterior asymmetry was often found in crania with this type of modification (Weiss, 1961, 1962). Weiss also associated the prevalence of suprainiac lesions (which he called suprainiac *trepanations*) with the fronto-occipital types (Weiss, 1961, 1962). These characteristics, plus the general description of the fronto-occipital cranial modification, were present in the MUNA sample, which suggests that cradle-boarding techniques were likely used in this community.



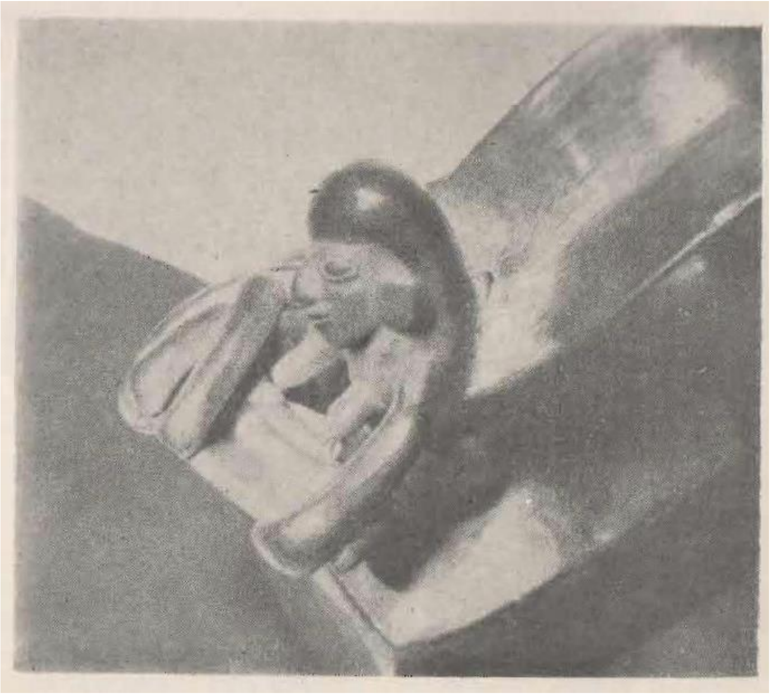


Figure 6.2 *Top:* Cradle-boarding drawing based on a Chimú (North Coast) example (Weiss, 1961, Fig 6). *Bottom:* Chimú huaco (pottery figurine) depicting a woman breastfeeding a baby using a cradleboard or crib (Weiss, 1961, Fig 4).

Although most of the shapes found in the MUNA Cemetery can be explained by cradle-boarding techniques, there are certain modifications that could have needed different appliances to achieve the desired shape. For instance, individual B15, a young female adult, presented a moderate bilobate shape on the posterior portion of the cranial vault (Figure 6.3). The anterior modification was severe, while the posterior modification was moderate, and presented mild posterior asymmetry with the left side more flattened than the right. Additionally, B15 had a moderate coronal depression and a mild obelionic depression. Although it was likely that cradle-boarding was done with different materials and techniques to shape the infants' heads into different variants (e.g., different pillow fillings or wider cloth bands instead of ropes), the bilobate shape from B15 does not entirely fit the morphology expected for a cradleboard.

Figure 6.3 Anterior, posterior, superior, and lateral views of the cranium of B15; lines and arrows indicate the modifications.

The cranial morphology from B15 resembled Weiss' Huaura type (Figure 6.4), which was described as a cranium compressed "*de arriba a abajo*" (from top to bottom) and anteroposteriorly to a lesser degree, with pronounced parietal-occipital lobes, posterior bilobate shape, and variable frontal modification (Weiss, 1962, p. 24). The Huaura appliance from Figure 6.4, like the cradleboard, put pressure on the cranial vault from top to bottom and anteriorposteriorly, and likely on the sagittal plane as well, and thus could have produced a similar shape to the fronto-occipital type, but with a bilobate shape on the posterior side.

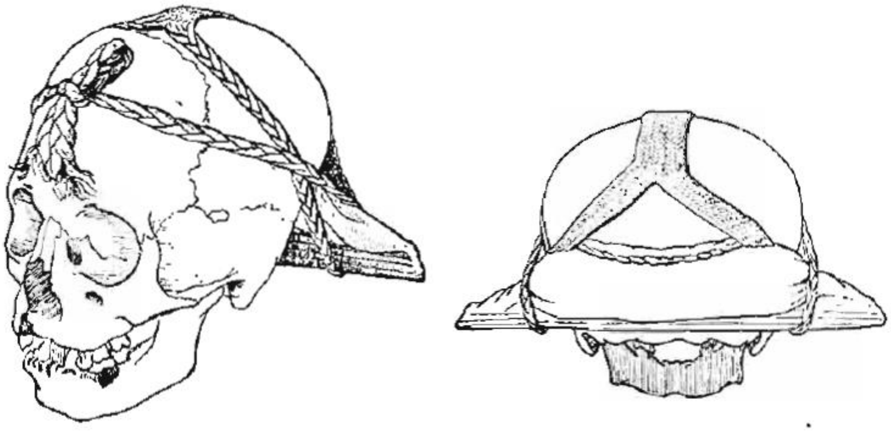


Figure 6.4 *Top:* Examples of Weiss' Huaura type from Cerro de Oro and Ancón, and a Chancay pottery figurine which resembled the bilobate shape, according to Weiss (Weiss,

1962, Lámina XXVIII). *Bottom:* Drawing of a modifying appliance associated with the Huaura type (Weiss, 1961, Lámina III).

The severity of the modifications could also be an indicator as to how the modifying appliances were built and applied. Although not many devices associated with cranial modification have been found in the coastal region of Perú, it is generally understood that pre-Hispanic people used cloth strips, chords, pads, and/or harder materials such as wooden boards or cradles (Allison et al., 1981; Gowland & Thompson, 2013; Weiss, 1961). Thus, it is possible that people used harder surfaces or materials (e.g., wooden boards or a sheet of sticks, see Figure 6.5) to achieve flatter areas, as softer materials, such as cloth pillows, would have left less pronounced impressions on the bone. In this sense, the posterior flattening found at MUNA was likely achieved using less flexible materials, such as wooden boards. Meanwhile, the anterior flattening and coronal depression were likely done with softer materials, such as chords or cloth bands (something similar to the chords in the drawing in Figure 6.2 and Figure 6.4), as the flattening is not as pronounced. Similarly, the obelionic depression could have been achieved by placing a small, round pillow over the wooden boards that went over the flattened area.

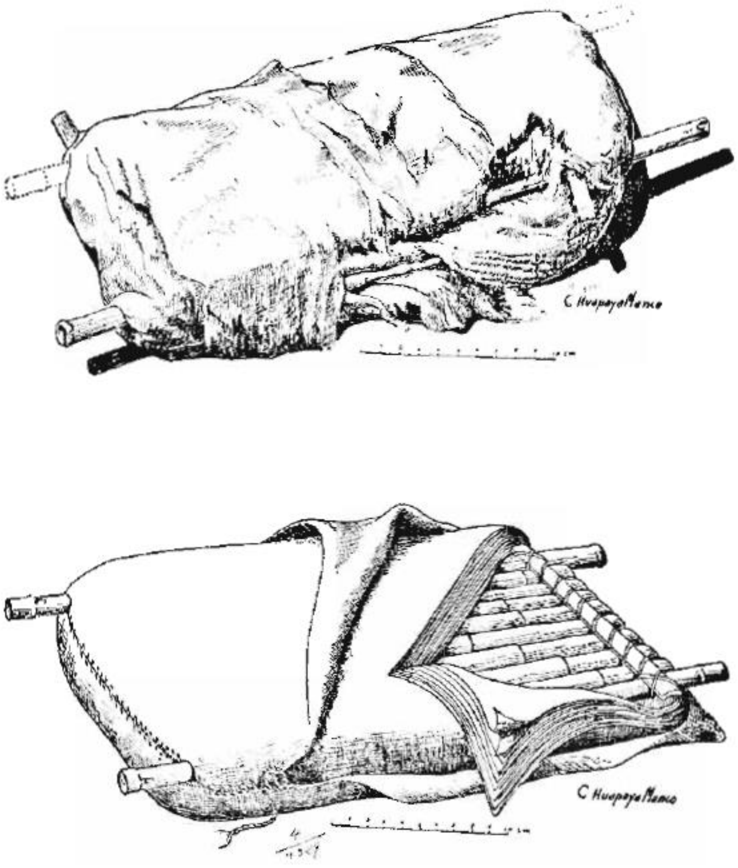


Figure 6.5 Drawings of two examples of artifacts, which according to Weiss, given their dimensions, they could not have been used for anything else but pillows to modify infants' heads. He associated these pillows with the Fronto Occipital-Inca Costeño type (Weiss, 1961, Lámina VI).

The high prevalence of posterior asymmetry in the MUNA sample and the lack of major differences between the tested subgroups suggested that asymmetry was perhaps non-intentional in this sample, or that it was a marker for a subdivision that was not detected in this thesis. If the asymmetry was non-intentional, it could also suggest a "lack of skill" from the caretakers of the infants who practiced cranial modification, or that symmetry—or lack thereof—was not a key morphological characteristic in the cranial modification types of the MUNA people. It is also reasonable to understand how complicated it would have been to tie an infant's head in a specific way for an extended period without the infant moving or the appliance shifting places on the head unintentionally.

It is important to note that cranial modification was part of childcare, and thus caretakers would have practiced cranial modification in ways that avoided any side effects (Tiesler, 2014), such as asymmetry, if it was unwanted. Father José de Arriaga, in his book about the extirpation of idolatry in Perú, described how cribs were huacas—broadly meaning a sacred object or place (Arriaga, 2002 [1621]). They were made by 'officials' who, while building the cribs, drank chicha and asked out loud for the child's wellbeing (Arriaga, 2002 [1621]). Cranial modification continued well after the Spanish invasion despite the Inquisition's efforts to prohibit the practice, which could have included burning over 300 cribs, as they were seen as associated with sorcery (Arriaga, 2002 [1621]; Weiss, 1961). The sentences above demonstrate the social and cultural importance cranial modification and its practices had in pre-Hispanic communities, and perhaps it had particular relevance in the dynamic between caretakers and infants.

Given the importance of cranial modification, it seems unlikely that caretakers "lacked skills" to achieve the cranial forms they wanted their infants to have. So, in the case of the MUNA people, the reasons behind the widespread nature of asymmetry could be more about symmetry not playing an important role in the social dynamics that cranial modification was part of, or perhaps their hair styles and head dresses "masked" potential asymmetry, so it was not an issue.

There were only two significant differences between the skeletal and fardo subsamples in the qualitative analysis, one of which was the prevalence of anterior modification. Although the Fardo subsample had a higher prevalence of anterior modification than the skeletal subsample, in both cases the number of crania with anterior modification was higher than the number of crania without it. Furthermore, in both subsamples the most common degrees of severity were mild and moderate. This pattern was found across all represented cohorts. This suggests that the statistical difference could have been due to a reduced fardo sample size, as the number of skeletonized crania was approximately triple the amount than the number of the fardos.

The second qualitative variable with statistical differences between subsamples was the prevalence of the coronal depression. In the skeletal subsample, the number of crania without the coronal depression was higher than the number of crania with it, and this pattern was the opposite in the Fardo subsample. This was a marginal statistical difference ($p = 0.05$), which, again, could be explained by a smaller sample size in the Fardo subsample.

It is worth noting that there was no statistical association found between the prevalence of anterior modification and the coronal depression. However, given that both the anterior modification and coronal depression are modifications affecting the same area of the cranial vault, it is possible that other factors (e.g., the type of modifying appliance used, the materials, or the amount of pressure put on the forehead) could have contributed to the patterns of prevalence seen in both traits.

There were two significant differences in the quantitative cranial modification analysis: one between female and male adults, and the other between the Fronto-occipital and Occipital subtypes. In the MUNA sample, the comparison of the cranial index values between female and male adults yielded a small, but significant difference ($p < 0.001$). This difference could be explained by a smaller sample size for the female group (20 vs 34 individuals, respectively). A factor that could be contributing to the higher cranial index mean (and thus shorter crania) among female individuals is the severity[12] of the anterior and posterior modifications. Female individuals, despite having a smaller sample size, had four cases of severe anterior and posterior modification (two of each), while the male subgroup only had one severe case of anterior modification. Additionally, in the female subgroup, the number of crania with moderate cranial modifications was higher than the number of crania with mild modifications. This trend was not the same in the male subgroup, where the number of crania with mild modification was higher than the number of crania with moderate modification. Although these qualitative differences in severity were not statistically significant, along the quantitative results, they showed a pattern in which female individuals, on average, had a higher cranial index than males—

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[12] To remind the reader, severity of anterior and posterior modification was assessed subjectively by comparing the modified crania to an unmodified cranium.

and thus, “shorter” heads—which could have been associated with more pronounced cranial modification shapes in female individuals.

This pattern in cranial modification suggested that, to a degree, this practice could have been influenced by the gender the infant was assigned at birth. Furthermore, in the MUNA sample, very broadly speaking, some male adults were found associated with possible agricultural tools (e.g., large sticks possibly for digging), and female adults were found associated with weaving tools (e.g., spindles, yarn, needles). These two pieces of evidence could suggest differentiated cultural practices for male and female individuals.

In a comparative study, Díaz (2015) found that at Armatambo and other Ychsma sites female adults were generally buried with weaving tools, while male adults were buried with slings and/or tweezers. At Huaca 20 (Maranga Complex) and Ancón, males were associated with fishing tools, while the females were associated with weaving tools (Prieto, 2014; Watson, 2016). So, it seems possible that on the Central Coast, mortuary rituals were partially differentiated by skeletal sex (potentially gender), by labor specialization, or both simultaneously. In this scenario, female individuals were buried with weaving tools (e.g., needles, spindles, etc.) and males were buried with agricultural or fishing tools, such as digging sticks or paddles. In the MUNA sample we found a similar trend, where female fardos were associated with weaving tools (e.g., spindles, yarn balls, needles), while some skeletonized contexts with male individuals were associated with large wooden sticks, which the final report interpreted as possible agricultural tools (Baldeos, 2015).

I would like to clarify that the difference in cranial modification between female and male individuals was likely influenced by the gender the newborn was assigned at birth, not by their gender identity or the role they had in society in adulthood. On the other hand, the difference in associated archaeological items between female and male adults was most likely based on their gender identity or the role they had in their society, rather than the gender they were assigned at birth. While it is likely that for most people in the past, just like in modern times, the gender they were assigned at birth coincided with their gender identity, it is also likely that for some people this was not the case. This should be taken into consideration when trying to make a connection between cranial modification, gender, and associated archaeological items[13].

The Fronto-occipital subtype had a statistically significantly higher cranial index mean than the Occipital subtype ($p < 0.001$). This meant that the crania with Fronto-occipital modification were, on average, "shorter" than their Occipital counterparts. While the mean for the Fronto-occipital crania was higher, some crania with the Fronto-occipital subtype had cranial index values below the Occipital subtype mean. This meant that some crania within the Fronto-occipital subtype were "longer" than some crania with the Occipital subtype, which was an unexpected result, as a cranium with anterior and posterior flattening was expected to be "shorter" than one with only posterior flattening.

This inconsistency could be explained by analyzing the modified area on the occipital and frontal, and the two landmarks used to measure cranial length: opistocranion and glabella, respectively. In some of the Fronto-occipital individuals with lower CI values (high 70s to low 80s), the modification on the posterior portion was around obelion and did not flatten opistocranion as much. It is also possible that such modification could have pushed opistocranion outwardly, increasing the cranial length instead of decreasing it. Similarly, in most of the sample, the modification on the anterior side flattened the posterior half of the frontal bone, thus glabella was not greatly affected.

This variant of the Fronto-occipital modification could have been subdivided to produce another subtype to capture the obelion flattening, but unfortunately, due to time constraints and the complexity of the task, it could not be done in this thesis. It is recommended that future lines of research on cranial shape variability for the MUNA collection take this variable into account, along with posterior asymmetry, as in multiple crania, when viewed from one side appeared to be modified around obelion, while when viewed from the other side appeared to be modified at a lower point on the occipital

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[13] Díaz (2015) cited a 1983 study by María Mendoza who unwrapped a LH fardo from Huaca Granados (Rímac Valley) with a male individual who had been buried with a loom, yarn balls, spindles, and cotton thread.

bone. Initially, this project intended to include an analysis using 3D landmarks, but time and practicality prevented it. Hence, additional recommendations include using an approach that uses 3D landmarks to better understand cranial modifications in the MUNA collection.

These two particularities in the cranial modification in the MUNA people could not only account for the decreased cranial index in some crania but they are more pieces of evidence to suggest that cradle-boarding was not the only modifying appliance used on individuals buried in the MUNA cemetery, as the flattening of obelion—or the larger lambda area—at an angle less of 90° with the Frankfort Horizontal, would be complicated to achieve using a cradleboard and pillows.

Regardless of modifying appliance, the ways in which the head of the infant would have been wrapped and boarded may have been a contributing factor in the presence of the pathological lesions described for the skeletal material in the previous chapter. Vera Tiesler indicated that although cranial modification was likely performed in ways that avoided side effects, “some nuisances may have been accepted” to achieve the cranial shapes that would have benefitted the individual in their lifetime (Tiesler, 2014, p. 55). In this context, “some nuisances” could have been some non-life-threatening pathological lesions that caretakers were able to care for during the period in which cranial modification practices took place.

For instance, Weiss (1961) found doughnut-shaped pillows from Paracas (South Coast) with ‘grime’ and short hairs stuck on the fabric, which he interpreted as a consequence of the pillows being in contact with the infants’ skin. This finding could be evidence of some lack of hygiene that could have resulted in soft tissue infections or pathological lesions, which in turn could have led to bone lesions. Although the pathological lesions on the cranial vault (i.e., the porosities pattern, periosteal reaction on the nuchal crest, and suprainiac lesions) could be associated with cranial modification practices, some differential diagnoses will be discussed here.

The porosities on the cranial vault and periosteal reaction on the nuchal crest could be indicators of metabolic illnesses, such as rickets, scurvy, or anemias (Brickley & Mays, 2019; Klaus, 2020; Ortner, 2003). The examination of the cranial and post-cranial skeleton showed no evidence of rickets in the MUNA sample (A. Ward, personal communication, August 19th, 2023). Émy Roberge's master's thesis examining an aclla cemetery from Farfán found no evidence of rickets in the post-cranial skeleton, but she did note the presence of interglobular dentin in the teeth, which indicated the presence of vitamin D deficiency in the female individuals (Roberge, 2022).

On the other hand, there were five non-adults with a lesion distribution consistent with subadult scurvy, as per Brickley and Mays (2019), which included porosities on the external surface of greater wings of the sphenoid and on the posterior surface of the maxillae (Brickley & Mays, 2019; Klaus, 2020; A. Ward, personal communication, August 19th, 2023). Additionally, three individuals showed the expansion of the diploe on the cranial vault (Klaus, 2020; Ortner, 2003), and two showed porotic hyperostosis on areas outside of those described for the pattern of porosities described (A. Ward, personal communication, August 19th, 2023). These lesions were consistent with those caused by anemia.

Although it is likely that the cases mentioned above were evidence of metabolic disease in the MUNA sample, the pattern of porosities found on the cranial vaults in the MUNA sample seemed to have been more consistent with cranial modification practices because of 1) the relatively consistency of the pattern across the sample, which is not necessarily found associated with the diseases mentioned (especially on the occipital); 2) the areas that had the porosities were often the site of direct interaction with the modification appliances; and 3) the lack of active cases of porosities.

The lack of modification along the sagittal suture, but presence of porosities on the area, could be explained by the shape of the modifying appliance. If the cradleboard or Weiss' Huaura appliance were compressing the infants' heads anteroposteriorly, it is possible that a band or chord was tied along the sagittal suture on the top of the head (see Figure 6.2 and Figure 6.4). Even though direct compression of the sagittal suture was likely lacking, fabric or other materials constantly rubbing against the infants' scalp and hair could have led to potential bacterial, fungal, or parasitic infections that led to bone reactions. Guillén and colleagues also associated potential biological effects, such as porosities, bone necrosis, and neurovascular changes in response to cranial modification practices (Guillén et al., 2008). The lack of active cases in the porosities pattern found at MUNA is consistent with the understanding that cranial modification practices occurred in infancy (until around 3 years of age). Since no infants were included in the cranial modification analysis, it is not surprising that all the porosities found within the described pattern were healing or had healed prior to death. In contrast, out of the five scurvy cases mentioned above, two were active and were found on children (2 to 11 years).

The periosteal reaction on the nuchal crest found on the MUNA sample was localized to that particular region on the occipital. It was not found widespread on the rest of the cranial vault. The localized nature of this (mostly proliferative) periosteal reaction suggested that the factors contributing to its presence were also localized, which is consistent with compression of the occipital region to achieve a posterior flattening, whether with the use of a cradleboard or any other appliance.

Weiss (1961, 1962) associated his fronto-occipital type with suprainiac lesions by suggesting that these lesions were trepanations made alongside the modifications, not as pathological consequences of the compression of the occipital bone. On the other hand, Stewart interpreted these lesions as a consequence of cranial modification practices, and suggested that pressure on the occipital could have led to “local anemia of the scalp tissue” and “this may have led to necrosis, ulceration, and eventually involvement of the underlying bone” (Stewart, 1976, p. 429). Stewart hypothesized that if an infant survived this temporary condition, the only evidence left behind would have been soft tissue scarring and remodeled bone underneath (Stewart, 1976). Holliday (1993) also concluded that the suprainiac lesions were a potential side effect from cradle-boards use based on the localized nature of lesions and the lack of active cases in non-adults over the age of 1 year. They suggested that the pressure and friction of an infant’s head on the cradleboard may have contributed to ischemic ulcers and favorable conditions for infections (Holliday, 1993). Weiss found possible evidence of scarring on the occipital on some Peruvian crania, which he associated with his suprainiac trepanations, but unfortunately the quality of the photographs is too low to make any conclusive remarks (Weiss, 1958).

When thinking about these three pathological lesions in the context of childcare, it is likely that caretakers knew how to care for potential injuries that could have occurred during the years that cranial modification took place (e.g., skin infections, sweat-related irritation, etc.). The widespread nature of cranial modification in the MUNA sample and the lack of active cases of the three lesions described in this thesis are two pieces of evidence to suggest that although “some nuisances” happened (per Tiesler, 2014), they were more often than not taken care of and did not negatively affect the health of the infants in a life-threatening way and not enough to discontinue the practice.

It is recommended that future research on this topic should include microscopic or more detailed evaluations of the porosities and periosteal reactions on the external and internal tables of the cranial vault. Additionally, I would recommend a more systematic approach to the recording of the suprainiac lesion and periosteal reaction on the nuchal crest, such as taking multiple measurements of the lesion and the distances from cranial landmarks.

6.3.2 Cranial modification at MUNA and other Pachacamac samples

Most bioarchaeological research from Pachacamac has focused on the human remains found within the Sacred Precinct. This section will describe cranial modification examples from other areas at Pachacamac and compare them to the MUNA results.

In their bioarchaeology of care study, Palma and Makowski (2019) analyzed an Ychsma female individual from Pachacamac associated with Early Ychsma pottery. Although cranial modification was not the focus of their study, the authors concluded they had occipital modification (Palma & Makowski, 2019). In addition, the authors briefly mentioned that a young male adult who had the same type of modification (Palma & Makowski, 2019). Even though they do not make any conclusions about the significance of cranial modification for the burial, they suggested that it was more likely that it was a marker for group identity rather than socio-economic status. Based on the photos of the female cranium, the shape resembled the Occipital subtype found at MUNA.

Valerie O’Loughlin (2004) analyzed a sample of 127 crania, 41 of which were Peruvian from coastal and highland sites. In their typology, they described six types, four of which were fronto-occipital variants and one was an annular type (O'Loughlin, 2004). The four types of fronto-occipital cranial modifications were the occipital (vertical flattening of the nuchal area), lambdoid (flattening around lambda), fronto-vertico-occipital (vertical flattening of the occipital and oblique flattening of the frontal), and the parallelo-fronto-occipital (occipital and frontal with oblique flattening) types (O'Loughlin, 2004). Three types of the fronto-occipital modification (except the lambdoid) were found their sample from Pachacamac and the larger Central Coast region, while the annular type was mostly found in crania from the South Coast (the archaeological context of some crania was unknown) (O'Loughlin, 2004). This exclusive presence of the fronto-occipital variants at Pachacamac and the Central Coast was consistent with the MUNA results.

In their PhD dissertation, Anne Tiballi examined the remains and associated archaeological grave goods of 25 individuals from the Cemetery of the Sacrificed Women, a Late Horizon sample from the Temple of the Sun within Pachacamac (Tiballi, 2010). Of the 20 crania, 16 presented cranial modification, three could not be analyzed for this variable, and one was unmodified (Tiballi, 2010). Of the 16 modified crania, seven showed annular modification, while nine showed tabular modification (Tiballi, 2010). Of these nine, two had "fronto-occipital" modification, three had "parallelo-fronto-occipital" modification, and four had "lambdoid variations" (Tiballi, 2010, p. 203). Unfortunately, Tiballi does not define or describe these three fronto-occipital types, thus a direct comparison with the MUNA subtypes cannot be made. However, the broad fronto-occipital type could have potentially resembled the shapes found at MUNA, and the lambdoid shape was possibly similar to the lambdoid by O'Laughlin (2004). In this sample, there was a combination of annular and fronto-occipital cranial modifications, which was contrasting with the exclusive presence of fronto-occipital shapes in the MUNA sample. This was likely because the individuals from the Cemetery of the Sacrificed Women were both locals to the coast and migrants from the highlands, while the MUNA people were likely a coastal community. Additionally, this sample was from the LH, a period when pilgrimage and migration have been proposed to be higher (Owens & Eeckhout, 2015).

Takigami and colleagues (2014) conducted an osteological analysis of 11 Ychsma burials excavated near the Painted Temple. In their brief mention of cranial modification, they described that several of the analyzed crania had occipital flattening, often asymmetrical (with the right side more flattened), and that the severity and extent of the modification varied between individuals (Takigami et al., 2014). They concluded that the cranial shapes were more consistent with unintentional modification by cradling or swaddling, rather than intentional cranial modification, thus they did not discuss the meaning behind cranial modification in this sample (Takigami et al., 2014). The broadly described morphology present in this Ychsma sample (i.e., occipital flattening and posterior asymmetry) was relatively consistent with that of the MUNA sample.

In their 2013 master's thesis, Jessica Han analyzed 586 crania from Pachacamac from the Hrdlička collection at the Smithsonian (28 non-adults, and 235 females, 293 males, and 30 indeterminate adults). Although the crania were from Pachacamac, further temporal or spatial provenance is lacking from this collection. Han determined that most crania from the sample were modified and classified them as tabular erect or tabular oblique (Han, 2013). They concluded that 31.7% of crania were unintentionally modified by cradle-boarding practices, and 49.8% were intentionally modified (Han, 2013). Most crania presented the tabular erect type of modification, and there were no annular crania in the sample (Han, 2013). Additionally, asymmetry was present in about 30% of crania (Han, 2013). The broad homogeneity (i.e., exclusive prevalence of the fronto-occipital or tabular modification and lack of annular types), presence of fronto-occipital variants, and prevalence of asymmetry was consistent with what was found in the MUNA sample.

The comparisons between the MUNA sample and other Pachacamac samples broadly suggested that the individuals mostly had fronto-occipital cranial modification (except for the aclla sample). Due to the lack of detailed descriptions, it is not possible to assess more similarities or differences between the samples. However, it was observed that the other Pachacamac samples generally had intra-sample variability of the fronto-occipital shapes consistent with the intra-sample variability of the MUNA sample.

6.3.3 Cranial modification at MUNA and other Central Coast sites

The fronto-occipital cranial modification type has been found on the North, Central, and South Coasts of Perú (Tomasto-Cagigao, 2020; Verano & Lombardi, 1999; Weiss, 1961, 1962). However, this does not necessarily mean that the MUNA people had direct connections or influence from the North or South Coasts, nor that they came from those regions. The fronto-occipital type is, morphologically, a very broad shape. It was achieved by compressing the infant’s head anteriorposteriorly, and there are a limited number of ways in which this can be done. Thus, it should not be surprising to find overlap in the cranial morphology of people from different regions that compressed the front and/or back of their heads. The cranial shapes found at Farfán, a site on the North Coast, although were broadly classified as fronto-occipital, they were morphologically different from the MUNA crania (Mackey & Nelson, 2020). Similarly, modified crania from the Nasca have been broadly described as fronto-occipital, but the cranial morphology is different from that of the MUNA sample (Tomasto-Cagigao, 2020).

To avoid conflating drastically different regions and communities based solely on a very broad cranial modification shape, I will focus this section of the discussion on the Central Coast, as no direct archaeological evidence from the North or South Coast has been found at MUNA. Furthermore, it is generally understood that during the LIP, the pilgrimage was likely limited regionally or locally, and only became a pan-Andean phenomenon after the arrival of the Inca (Owens & Eeckhout, 2015). Another hypothesis is that Pachacamac was not an important pilgrimage center until the arrival of the Inca, who drastically rebuilt and reorganized the site (Makowski, 2022).

In the collection from the Necropolis of Miramar at Ancón, Watson (2016) analyzed fardos from the MH and LIP. The latter were associated with Chancay artifacts. She found that 90% of the individuals at Ancón had cranial modification, and that the 10% of crania that were not modified belonged to neonates (close to birth), an age range in which cranial modification practices had not taken place yet, or if they had, they most likely would not have left permanent evidence on the cranial bones (Watson, 2016). The crania from Ancón had fronto-occipital modifications, specifically Weiss’ Fronto Occipital Costeño and Huaura types (Watson, 2016), a classification consistent with the one described for the MUNA sample. Weiss' Huaura type has been found associated with Chancay archaeological material in other sites in the northern half of the Central Coast (Watson, 2016; Weiss, 1961, 1962).

In addition to the similarities in general cranial morphology, the Ancón fardos also presented suprainiac lesions (L, Watson, personal communication, August 19th, 2023) and coronal depressions (A, Nelson, personal communication, August 21st, 2023). Unfortunately, these observations are anecdotical, as they were not published with the other results.

The general lack of observable differences in cranial modification between the MUNA remains and the fardos from Ancón suggested that the people from the two sites could have shared some cultural practices. This could support the hypothesis that perhaps the cranial modification techniques and appliances were shared across valleys in the Central Coast. Given that Weiss' Huaura type has been found associated with Chancay archaeological material, it is also possible that the presence of this shape at MUNA was evidence of cultural influence from the northern edge of the Central Coast (Huaura and Chancay Valleys) in the Lurín Valley, the southern edge (or the other way around).

The intra-sample variability and inter-sample lack of differences would support the first and second models. In the first scenario, the people from MUNA (Ychsma) could be locals to Pachacamac/the Lurín Valley and they shared cultural practices with the Chancay people from Ancón. In the latter scenario, Chancay pilgrims with Huaura cranial modifications could have traveled to Pachacamac (a site traditionally associated with the Ychsma) and were buried at the MUNA cemetery after death.

In their 2011 PhD dissertation, Ellen Salter-Pedersen mentioned that the prevalence of cranial modification was low at the Late Horizon site of Rinconada Alta, in the Rímac Valley. The most common cranial modification within this sample was a form of mild occipital flattening, which they attributed to unintentional modification (Salter-Pedersen, 2011). Only eight out of 69 crania were determined to have intentional cranial modification, and they were described as tabular erect with modification of the frontal and occipital bones (Salter-Pedersen, 2011). A case study from a single fardo from the same site of Rinconada Alta determined that the individual had tabular erect modification (Sutherland, 2019). These two general descriptions of the Rinconada Alta material were broadly consistent with what was found in the MUNA sample, and the lower prevalence of cranial modification could be a temporal difference, since the Rinconada Alta remains were LH and the MUNA sample was mostly LIP. This would be consistent with Weiss' hypothesis that cranial modification in the coast became less pronounced with the Inca arrival (LH) in comparison with the previous period (LIP) (Weiss, 1961, 1962). Less pronounced fronto-occipital shapes, especially if they only affected the posterior portion of the cranial vault, could be interpreted as unintentional flattening by cradle-boarding, even if they were not. Although not much can be compared, the photos of two examples of modified crania show evidence of posterior asymmetry and possibly a coronal depression and bilobate shape (Salter-Pedersen, 2011, Figures 3.2 and 3.4).

Mercedes Okumura (2014) analyzed 78 adult crania from Pasamayo, a Chancay cemetery located near the Chancay Valley, north of Ancón. In this study, Okumura mostly used O'Loughlin's typology and found that the Pasamayo crania presented the occipital and lambdoid types (Okumura, 2014). A third modification type, the fronto-lambdoid, was included in Okumura's typology (2014), and although this one was not described, we can assume that it referred to a modification that included O'Loughlin's lambdoid modification with frontal flattening. The intra-site variability in fronto-occipital subtypes, including one that specifically refers to the flattening of the area around lambda, was consistent with the variability found in the MUNA sample.

The similarities between the MUNA sample and other Central Coast sites can also be seen in the lesions potentially associated with cranial modification. In 2008, Mendonça de Souza and colleagues published a case study of a four to six months old infant from the Chillón Valley in the Central Coast (probably Inca) in which they concluded that the infant had possibly died from pathological lesions because of cranial modification practices. There were four pathological lesions described in the article: 1) porous lesions along the coronal suture on the upper frontal and right parietal; 2) proliferative periosteal reaction on the outer table of the occipital (near the lambdoid suture) and the parietals (on the parietal eminence, and lambdoid and sagittal sutures); 3) a perimortem destructive lesion on the left occipital squama that affected the outer table more than the inner table; and 4) an oblong-shaped proliferative endosteal reaction in the inner table of the occipital between lambda and the internal occipital protuberance (Mendonça de Souza et al., 2008). Two modifications of cranial shape were described: 1) a flattened area on the occipital squama; and 2) a "depressed transverse sulcus," which crossed the right parietal bone, posterior and parallel to the coronal suture (Mendonça de Souza et al., 2008). The destructive lesion on the occipital squama was associated with the flattened area on the same bone because the latter encircled the former, and the transverse sulcus on the right parietal was associated to the porous lesions on the upper frontal and right parietal because they were parallel to each other (Mendonça de Souza et al., 2008).

The pattern of porosities found in some of the crania from the MUNA sample was reminiscent of the pattern of periosteal reaction and porosities described on the cranial vault of the Chillón infant. Similarly, the suprainiac lesion and periosteal reaction around the nuchal crest found in some MUNA crania could have been less severe examples of the destructive lesion on the left occipital squama found on the Chillón infant. Additionally, the description and photograph of the "depressed transverse sulcus" from the 2008 article was reminiscent of the coronal depression described in this thesis. The pathological and morphological similarities between the Chillón infant and the MUNA crania, and the Central Coast association of both cases, reinforces the hypothesis that the pathological lesions found on some of the skeletonized crania at MUNA were side effects of cranial modification practices that were shared with nearby sites.

The cranial modification comparisons between the MUNA sample and the other Central Coast sites suggest relative homogeneity in and across all sites, as they only showed the general fronto-occipital type, but with the presence of different variants. This was consistent with the intra-sample variability of the form and structures of the fardos found at MUNA (and other Ychsma sites), in which case, intra-culture variability in cultural practices could be a key characteristic of the Ychsma (Nelson et al., 2021). This supported the idea that cranial modification shapes and modifying appliances were potentially shared across valleys. This, in turn, supported the idea that the people buried at MUNA were likely locals to the Central Coast, but not necessarily local specifically to

Pachacamac or the Lurín Valley. The topic of regional pilgrimage, unfortunately, cannot be answered (nor eliminated) with cranial modification variables given that different sites in the Central Coast, including MUNA, have similar patterns of cranial modification.

6.4 Dental Pathology

The study of dental pathology aims to identify and interpret disease and anomalies in teeth—and the surrounding bone—to explore questions about diet, oral hygiene, cultural practices, etc. (Hillson, 2005, 2018; Lukacs, 2012; Rose & Burke, 2017). Thus, the results of this thesis can provide information to explore some cultural and social practices within the society buried at the MUNA cemetery.

From a methodological standpoint, the dental analyses of the skeletonized remains were more detailed than that of the CT scans of the fardos due to the reduced ability to make fine detailed observations in the latter. In the direct analysis of teeth, I was able to observe smaller caries (< 1mm), which was not possible in the CT scans of the fardos. Similarly, when only the root of the tooth was present in the CT scans, it was impossible to differentiate those that had the entire crown worn down from those that had severe caries that affected the complete crown. This differentiation was possible in the skeletonized remains. Furthermore, the analysis of abscesses and AMTL in the skeletonized remains was more detailed as well, as I could observe and assess the resorption and healing of the bone surrounding the lesion, something that was possible, but more limited, in the CT scans. Lastly, the recording of dental wear in the skeletonized remains was also more detailed than in the CT scans of the fardos. All these limitations in the CT scans of the fardos could have affected the results, especially the statistical significance of some comparisons.

The intensification of agricultural crops and their introduction into the diets of LIP coastal people likely affected their dental health, especially as cariogenic foods such as maize and potatoes were common in the LIP. Additionally, ethnohistoric sources highlight the relevance of maize, chicha, and coca leaf chewing in the diets of late pre-Hispanic communities (Pezo-Lanfranco et al., 2017; Rostworowski, 2004). The overall dental pathology results of the prevalence of carious teeth, AMTL, abscesses, and dental wear were consistent with that of a carbohydrate-rich, and cariogenic diet with the presence of abrasive elements.

The lower prevalence of carious teeth, abscesses, and AMTL in young adults than in middle adults was expected, as the older one person is, the more dental lesions they can accumulate during their lifetime. The only old adult was edentulous, thus caries were not observable.

Evidence of sex differences in oral pathological conditions is still not conclusive, although some studies have shown a female bias in the prevalence of caries due to biological (e.g., flows of estrogen) and cultural factors (Lukacs & Largaespada, 2006). The higher prevalence of abscesses and AMTL in male adults than in female adults suggested that, although biological factors were relevant, cultural practices (e.g., coca chewing, chicha drinking) may have been contributing more to the prevalence of these conditions in the MUNA sample than biological ones. This further supported the idea that there may have been differentiated cultural practices between female and male individuals.

In a study with prehistoric Canary Islanders, Lukacs (2007) found a higher rate of AMTL of anterior maxillary in males than in females. They proposed that this pattern could have been explained by accidental falls due to the uneven topography of the land or traumatic injury due to traditional forms of interpersonal combat among male individuals (Lukacs, 2007). Thus, the higher prevalence of AMTL in male individuals in the MUNA sample could also be explained by higher prevalence of interpersonal violence among male individuals. However, the analysis of this variable was out of the scope of this tethis.

The association between the prevalence of abscesses and skeletal sex, but the lack of association between the prevalence of carious teeth and skeletal sex, could be explained by preservation and methodological errors. The preservation of teeth, especially in the skeletal material was not ideal, as many teeth were lost postmortem, thus were unavailable for analysis. In contrast, the preservation of the mandibles and maxillae in the skeletal material and fardos was better, and this perhaps allowed for a more accurate recording of abscesses than of caries. Furthermore, while the preservation of teeth in the fardos was better, there were limitations in the analysis through the CT scans (e.g., lack of resolution would not allow for the visualization of small caries). These limitations did not affect the recording of abscesses as much, as the resolution of the CT scans allowed for the visualization of small, moderate, and severe abscesses. Additionally, the higher prevalence of AMTL in males could also be contributing to the recording of carious teeth.

In a comparative study between late pre-Hispanic coastal and highland sites, Pezo-Lanfranco and colleagues (2017) found that the two coastal samples (both from the Central Coast) had more severe dental wear than their highland counterparts. This was explained by the differences in food types and food processing techniques, both of which could have left more abrasive particles in the diets of coastal people (i.e., sand). The prevalence of dental wear across the coastal sites was consistent with the prevalence of dental wear across all adults in the MUNA sample.

Coca leaf chewing is a contributing factor in dental pathology in the Central Andes due to the changes it produces in the oral environment (Indriati & Buikstra, 2001). Indriati and Buikstra (2001) built a technique to identify coca leaf chewing based on dental pathology. In this technique, strong markers for coca leaf chewing included cervical-root caries on the buccal surface of molars, severe root exposure of molars, the presence of molar roots only, and the AMTL of molars (Indriati & Buikstra, 2001).

A dental pathology study from the Pinos cemetery in the Huaura Valley (Chancay Culture) indicated that all individuals across socioeconomic statuses were consuming a relatively homogenous cariogenic diet, but that the consumption of chicha and coca leaf chewing may have been partially reserved for individuals of higher statuses (Pezo-Lanfranco & Eggers, 2016). In contrast, the results of the dental analysis of the MUNA sample did not show evidence of coca leaf chewing in the MUNA sample based on the strong markers defined by Indriati and Buikstra (2001).

Future research on the dental pathology of the MUNA sample should include a more systematic approach to the analysis of caries, in particular a more detailed description of the area of the tooth affected by the caries. Additionally, a more detailed comparison of abscesses and AMTL that includes healing stage and severity would be recommended. Similarly, the recording of periodontal bone loss, which unfortunately was not possible for this thesis, would be recommended, especially for the diagnosis of coca leaf chewing. The inclusion of non-adults in the analysis of dental pathology could also enrich our understanding of cultural and social changes that could have happened at critical life stages, such as the weaning process and the introduction of adult cultural practices in adolescence (e.g., coca leaf chewing). Lastly, a more systematic approach to dental wear and dental calculus would be recommended, especially if it includes more detailed approaches to severity. In terms of the recording of dental pathology in CT scans, it would be recommended to create a comparative matrix in which detailed descriptions and images of dental pathology are made by direct analysis and indirect analysis through CT scans to assess the accuracy/limitations of the latter.

6.5 Summary

The results from the biological profile, cranial modification, dental pathology, and mortuary practices analyses suggested that the two subsamples were likely part of a single sample, the MUNA sample. The lack of infants and low representation of old adults in the group analyzed for cranial modification could be explained by taphonomy, sampling bias, methodological biases, differentiated burial patterns, and/or biocultural factors (such as weaning age and low percentage of adults who lived beyond 50 years of age).

Taphonomic damage, although present in the MUNA sample, cannot fully explain the lack of representation of crania of infants and the low number of old adults in the group analyzed for cranial modification, as post-cranial bones were recorded for both, some of which were in good condition. Lack of articulation of the cranial vault of infants played an important role in their exclusion from the cranial modification analysis, as it is necessary to have a complete and articulated cranial vault.

Even though we did not analyze all the contexts excavated from the MUNA cemetery, we examined most of them and only excluded the ones that were too poorly preserved for biological profile and/or cranial modification analyses. Thus, it is unlikely that sampling bias was a key factor in the low representation of infants and old adults in this thesis. Methodological errors could partially explain the lack of old adults in the cranial modification and dental pathology sections, as Lovejoy's method (1985) relied on dental wear alone, but not other factors, such as AMTL.

Different social or cultural behaviors could also potentially explain the low representation of infants and old adults in the MUNA collection. If the MUNA people were pilgrims, it is possible that these two cohorts did not make the journey to Pachacamac. Additionally, it is also possible that infants and old adults were buried elsewhere and not with the other cohorts. It is also important to consider biocultural factors, such as the age the weaning process occurred or the life expectancy of adults in the MUNA sample, as those variables would be impacting the representation of infants and old adults in the cemetery.

Based on the morphology of the modified crania, it is likely that the people from the MUNA cemetery used, among different things, a form of cradle-boarding technique to flatten the heads of their infants. The variability within the fronto-occipital shape, the relatively high prevalence of posterior asymmetry, and the presence of suprainiac lesions were characteristics of the coastal fronto-occipital type developed by Pedro Weiss (Weiss, 1961, 1962). Some of the crania at MUNA did not necessarily fit the expected shapes from a cradleboard as they had a bilobate morphology on the posterior end of the parietals. This shape could have been achieved by a modifying appliance similar to Weiss' Huaura type (associated with Chancay material), in which a wooden board is tied on the posterior side of the head, while chords or cloth bands tie around the anterior side on the forehead. The modification on obelion/lambda would also likely require a different modifying appliance, as the angle of the modification would be complicated to achieve with a cradleboard.

The significant difference in the cranial index values between female and male adults could suggest differences in cranial modification practices (although the qualitative variables did not yield any differences). Broadly speaking, female adults had "shorter" heads than their male counterparts, which could suggest more pronounced shapes in female individuals. Evidence of gender-specific archaeological items with individuals from the two skeletal sex groups supported the idea that there were gender-specific cultural practices, some of which could have included cranial modification. In general, in the Central Coast the female individuals have been found buried with weaving tools (e.g., spindles, looms, yarn), while the male individuals have been found buried with tools associated to fishing, hunting, or agriculture (e.g., large wooden sticks, mazes, tweezers, slings) (Díaz, 2015; Prieto, 2014; Watson, 2016). We must be careful with generalizations and the conflating sex and gender in the past, but future research on the topic would be enriching and fruitful.

On average, the cranial index of the Fronto-occipital subtype was higher than the cranial index of the Occipital subtype. This indicated that the Fronto-occipital crania were “shorter” than their Occipital counterparts. However, some Fronto-occipital crania had indexes below the Occipital subtype mean, which meant they were “longer.” This was not expected, as a head compressed anteroposteriorly is expected to be “shorter” than one that is only compressed posteriorly. This inconsistency could be explained by the way the occipital and frontal bones were modified in relation to the cranial landmarks used to measure cranial length (opistocranion and glabella, respectively). In some of the Fronto-occipital crania with low cranial indexes (high 70s-low 80s), the modification on the occipital was affecting the area around obelion and lambda, thus not flattening the opistocranion. Similarly, most of the anterior modification in the MUNA sample was focused on flattening the posterior end of the frontal bone, thus not greatly affecting the glabella.

Because there was a significant difference in the cranial index values between the Occipital and Fronto-occipital subtypes, it would have been ideal to further subdivide the Fronto-occipital subtype taking into consideration where on the occipital the flattening occurred (e.g., obelion). However, given time constraints and the complexity of the analysis, this analysis could not be made for this thesis. It is recommended that these variables, along with posterior asymmetry, are taken into consideration for future research.

Although the general fronto-occipital shape has been found in the North, Central, and South Coasts of Perú, it would be imprudent to make direct connections between the MUNA sample and the North or South Coast, as no direct archaeological connection between the MUNA cemetery and those regions has been made. For the North Coast, the cranial shapes from Farfán, although classified as fronto-occipital, were different from those found at MUNA. In the South Coast the cranial modification landscape is different to the one found at MUNA (and arguably the Central Coast), as sites in this region have presented greater variation of cranial shapes across time and space.

Furthermore, the fronto-occipital type is a broad umbrella term used to describe the cranial modification that resulted from anteroposterior compression of the cranial vault. This type of compression can be done in a limited number of ways, and thus it should be expected to find overlap in the cranial morphology of different communities that modified their heads anteroposteriorly, regardless of their connections. Although, different appliances could lead to subtle variability in shapes.

The widespread nature of the fronto-occipital shape within the sample and its intra-sample variation, the lack of highland types of cranial modification, and the closeness of the MUNA cemetery to Pachacamac all supported the hypothesis that the MUNA people were likely local to the Central Coast. In this sense, the third model of pan-Andean pilgrimage can be discarded, as there were no highland cranial modifications or archaeological material associated with this region (in contrast with the aclla sample). This conclusion will be tested in a future stable isotope study of hair samples.

The first and second models cannot be discarded because it is possible that the MUNA people were locals to Pachacamac/the Lurín Valley or that they were regional pilgrims. If we assume that the fronto-occipital subtypes (and appliances) were present across all the Central Coast regardless of valley, it is likely that the MUNA people were in fact local to the Lurín Valley and/or Pachacamac. On the other hand, if we assume that the fronto-occipital subtypes and appliances were unique to each valley and exchanged culturally or by migration or pilgrimage, then the intra-sample variability would be explained by regional pilgrimage. Unfortunately, it is not possible to make that distinction with the current cranial modification analysis.

The overall dental pathology results for the MUNA sample were consistent with that of a carbohydrate-rich diet with the presence of abrasive elements, like sand. The positive association between the prevalence of carious teeth, abscesses, and AMTL was an expected result, as the older a person is, the more time they have to accumulate dental lesions. The higher prevalence of abscesses and AMTL in male adults than their female counterparts could be linked to differentiated diets or cultural practices, such as chicha consumption and coca leaf chewing. Coca leaf chewing was likely a contributing factor in dental pathology in the Central Andes, but the results of this current thesis did not show evidence of this practice at MUNA. The lack of association between caries and skeletal sex could be explained by methodological and/or recording errors. Additionally, a higher prevalence of AMTL could be masking a higher prevalence of caries in male adults as well.

In all, the MUNA sample was likely a group of Central Coast people who lived and died in the region, as the cranial modification and dental pathology results do not show drastic differences with other Central Coast samples. In the current thesis is impossible to say if they were local to Pachacamac/the Lurín Valley or if they were regional pilgrims. Fortunately, samples for stable isotope analyses were taken and hopefully those results will answer this question more concretely. Additional research with this sample should focus on a more systematic approach to cranial modification, possible pathological conditions associated with cranial modification practices, and dental pathology.

Chapter 7

7 Conclusions

The Archaeological Sanctuary of Pachacamac was one of the most important pre-Hispanic sites in the Central Coast. It sits in the Lurín Valley, approximately 25 km south of the Lima Metropolitan Area, and it overlooks the mouth of the Lurín River, the Pacific Ocean, and the remains of the Urpi Kocha lagoon (Museo Pachacamac, n.d.-b; Winsborough et al., 2012). Pachacamac has archaeological evidence of monumental architecture from the end of the Early Horizon (900-200 BCE) to the Late Horizon (1470-1532 CE) (Makowski, 2017; Makowski et al., 2020; Museo Pachacamac, n.d.-b).

Given its prominent status as an oracle and administrative center, Pachacamac had a long history with pilgrimage (Eeckhout, 2004; Rostworowski, 2002). It is thought by some researchers that pilgrimage to Pachacamac was fairly regional during pre-Inca times, and that it only became a pan-Andean oracle during the Late Horizon (Owens & Eeckhout, 2015). A contrasting hypothesis suggested that pilgrimage to Pachacamac did not start until the arrival of the Inca, who reorganized the monumental landscape of the site and integrated the center into the Qhapaq Ñan, or Inca Road System (Makowski et al., 2020).

During the Late Intermediate Period (600-1100 CE), the Lurín Valley was occupied by the Ychsma, a coastal pre-Inca culture. Researchers have suggested that the Ychsma were a stratified society socially and politically organized as a chiefdom (señorío), which was subdivided into smaller groups (curacazgos) arranged along the valleys of the Lurín and Rímac rivers, with the main chief established at Pachacamac (Eeckhout, 2004; Espinoza Soriano, 2015; Rostworowski, 2002).

Given the hypothesis for the Ychsma social organization, it is likely that cranial modifications in this community were associated with a social code to differentiate social status or kinship groups (although this thesis showed some possible evidence of gender differentiation as well). If there was differential access to resources, such as food, within the social organization of the Ychsma, it would also be expected to find differences in dental pathology.

The human remains that were examined for this thesis were part of the MUNA collection, an Ychsma (and Ychsma-Inca) group that was excavated from the MUNA cemetery, which laid on the outskirts of the Sacred Precinct of Pachacamac. The main excavation was in 2015, although additional smaller interventions occurred between 2016 and 2019 (Baldeos, 2015; García & Baldeos, 2020). The final excavation report indicated that the upper most layer of the cemetery was comprised of disturbed and disarticulated human remains, while the deeper layers had mostly well preserved fardos funerarios (funerary bundles) (Baldeos, 2015). Jhon Baldeos (2015), the lead archaeologist, proposed that the observed disturbance was due to modern anthropogenic factors, such as illegal sand mining in the 60s.

Nonetheless, it is not completely understood if the drastic differences in preservation (skeletonized remains vs fardos) was solely due to modern disturbances, or if there were differences in mortuary practices. Furthermore, the connection between this cemetery and the site of Pachacamac has yet to be determined, as it is not clear if the individuals are locals to Pachacamac/the Lurín Valley or pilgrims. Therefore, the relationship between the skeletal and funerary bundles subsamples, and their connection to Pachacamac all remained unclear.

This thesis looked to explore three main research questions using bioarchaeological, archaeological, and ethnohistorical information: 1) were the skeletal and fardo subsamples part of a single sample or were they culturally distinct? 2) what was the role of cranial modification in the social dynamics of the people buried at the MUNA cemetery? And 3) what was the connection between the people interred in this cemetery and Pachacamac?

All the questions were explored through the analysis of cranial modification and dental pathology. Cranial modifications were a form of irreversible assigned identity, not achieved status, and in the Central Andes the practice has been associated with socioeconomic status and/or ethnicity (Torres-Rouff, 2020). Dental pathology aims to study and interpret disease and anomalies in teeth and the surrounding tissues to answer questions about diet, cultural practices, occupation, among other themes (Lukacs, 2012).

Thus, these two sets of variables are suitable to explore the social dynamics of the MUNA cemetery and its connection to Pachacamac and larger Central Coast region.

Given the location of the MUNA cemetery and Pachacamac's history with pilgrimage, there were three models to interpret the community buried at MUNA: 1) they were *locals* to Pachacamac or the Lurín Valley; 2) they were *regional pilgrims* from the Central Coast; or 3) they were *pan-Andean pilgrims* from across the Andes. In the first model, it would be expected to find relatively uniform cranial modification styles that were different from other Central Coast sites. In this sense, cranial modification would have been a marker to differentiate themselves from other communities. In the second model, it would be expected to find intra-site variability in cranial modification styles, but similarities with other Central Coast sites. In the final model, cranial modification shapes would be expected to be significantly more variable than in the second model (e.g., a combination of coastal and highland styles), and it would be expected to find other archaeological connections with other Andean regions, such as pottery or textiles.

7.1 Thesis findings

7.1.1 Cranial modification

The cranial modification section included 85 individuals—62 skeletonized crania and 23 crania from fardos. Infants were not part of this sample, although they were part of the larger MUNA sample. The overall comparison of qualitative and quantitative variables between the skeletonized remains and fardos showed no significant differences. This suggested that the two subsamples were likely part of a single sample, the MUNA sample.

Under Pedro Weiss' typology, the MUNA crania were generally classified within the 2 fronto-occipital types, which have been associated with cradle-boarding techniques (Weiss, 1961, 1962). Some MUNA crania presented a posterior bilobate shape, which would have not been possible with an appliance like the cradleboard. These crania were consistent with Weiss' Huaura type—and the associated appliance (Weiss, 1961, 1962). This type has been found associated with Chancay material in the Central Coast (Watson, 2016; Weiss, 1961, 1962). A third fronto-occipital shape in the MUNA sample included the flattening of the area around obelion/lambda. This shape was not consistent with a cradleboard, and a different appliance would have been needed. Thus, although the MUNA sample exclusively had the fronto-occipital or coastal type of modification, there was intra-sample variability of shapes.

Although there has not been much archaeological evidence of these modifying appliances in the coast of Perú, it is broadly understood that people in the past used cloth strips, chords, pads, and/or wooden boards to make these appliances. The severity of the modifications in the MUNA sample could provide evidence about the materials this community could have used. For instance, to achieve the flatter, more pronounced posterior modifications, the MUNA people could have used harder materials like wooden boards. On the other hand, for the less pronounced modifications (e.g., anterior modification, coronal depression, and obelionic depression), they could have used softer materials, such as cloth bands or chords.

There were two significant differences in the qualitative analysis of the MUNA sample: between female and male adults, and between the Occipital and Fronto-occipital subtypes. The higher cranial index means (thus “shorter” crania) in female adults vs their male counterparts could be explained by a smaller female sample size and/or by more severe cranial modifications in female adults. Female adults, despite having a smaller sample size, had more cases of severe anterior and posterior modification than their male counterparts. Although the qualitative comparisons between female and male individuals did not yield significant differences, when combined with the significant difference in cranial index means, they show a pattern in which female individuals could have been associated with more pronounced cranial modifications.

Other bioarchaeological studies from the Central Coast have found that female adults were generally buried with weaving tools (e.g., needles, yarn, spindles), while male adults were often found buried with agricultural or fishing tools (e.g., digging sticks, paddles) (Díaz, 2015; Prieto, 2014; Watson, 2016). A similar trend was found in the MUNA sample. These differences evidenced that Central Coast communities could have had gender-specific cultural practices, which could have included cranial modification.

More research is needed in the bioarchaeology of sex and gender, and we should be careful about conflating the two.

The second significant difference was found between the cranial index values of the Occipital and Fronto-occipital subtypes. On average, the Fronto-occipital crania were "shorter" than the Occipital crania, which was expected. However, some Fronto-occipital crania had lower cranial index values than the Occipital mean, which indicated that these were "longer." This inconsistency could be explained by analyzing the modified area on the occipital and frontal, and the two landmarks used to measure cranial length: opistocranion and glabella. In the Fronto-occipital crania with lower index values, the modification on the occipital was around obelion and in a < 90° with the Frankfort Horizontal, thus it was not flattening opistocranion. It is also possible that it was pushing this landmark outwardly. The flattening on the frontal was generally on the posterior half, which meant glabella was not flattened either.

Regardless of the subtype of modification, the ways in which the infants' heads would have been wrapped and boarded could have been a contributing factor in the presence of pathological lesions on the cranial vault. Three types of lesions were found in the MUNA sample: a pattern of porosities on the frontal, parietals, and occipital; suprainiac lesions; and periosteal reactions on the nuchal crest. Within the context of childcare, it is likely that caretakers accepted "some nuisances" to achieve the cranial modifications that would have benefitted the infant in their lifetime (Tiesler, 2014, p. 55). In that context, these three pathological lesions could have been non-life-threatening side effects from cranial modification practices that the caretakers were able to care for in infancy.

Differential diagnoses for these lesions include metabolic disorders, such as rickets, scurvy, and anemias (Brickley & Mays, 2019; Klaus, 2020; Ortner, 2003). No evidence of rickets was found in the MUNA sample. However, evidence of scurvy and anemias was found in shape of porosities on the anterior portion of the cranium and expansion of the diploe of the cranial vault, respectively (A. Ward, personal communication, August 19th, 2023). While these cases indicated that these two metabolic diseases were possibly present at MUNA, the pathological lesions in this thesis (i.e., pattern of porosities, suprainiac lesions, and periosteal reaction on the nuchal crest) did not fit the description for those metabolic diseases. Furthermore, other authors have associated potential biological side effects, such as porosities, bone necrosis, and neurovascular changes in response to compression to cranial modification practices (Guillén et al., 2008; Holliday, 1993; Mendonça de Souza et al., 2008; Stewart, 1976; Weiss, 1961, 1962).

The comparisons of the MUNA sample with other Pachacamac and Central Coast samples evidenced relative homogeneity in and across all sites with the prevalence of the fronto-occipital type, but with intra-sample variability of shapes. The only sample that had a mix of fronto-occipital and annular (highland type) modifications was the Pachacamac aclla sample, which was composed of locals and highland migrants who were brought together for this important Inca institution (Tiballi, 2010). In this sense, the results supported the idea that cranial modification shapes and appliances were potentially shared across valleys in the Central Coast. This would mean that the people buried at MUNA were likely locals to the Central Coast, but not necessarily Pachacamac or the Lurín Valley. These results were consistent with the first and second interpretative models, but unfortunately, the question of regional pilgrimage cannot be answered or eliminated with the results of this thesis.

7.1.2 Dental pathology

The dental pathology section included a total of 57 adult maxillae and mandibles, 42 from the skeletal subsample and 15 of the fardo subsample. Non-adults were excluded to simplify the analysis. The overall results of prevalence of carious teeth, AMTL, abscesses, and dental wear were consistent with a carbohydrate-rich and cariogenic diet with the presence of abrasive elements, such as sand.

The lower prevalence of carious teeth, abscesses, and AMTL in young adults than in middle adults was expected, as the older one person is, the more time they have had to accumulate dental lesions. The higher prevalence of carious teeth and AMTL in male adults than their female counterparts supported the hypothesis that there were differentiated cultural practices between female and male adults. In this case, cultural practices may have included coca leaf chewing, chicha drinking, and dietary behaviours.

The association between the prevalence of abscesses and skeletal sex, but the lack of association between the prevalence of carious teeth and skeletal sex could be explained by preservation or methodological errors. Many teeth in the skeletal material were lost postmortem, thus were unavailable for analysis. In contrast, the preservation of maxillae and mandibles in the MUNA cemetery was better, and this perhaps allowed for a better recording of abscesses. Furthermore, the resolution of the CT scans of the fardos did not allow for detailed observations.

Taken together, the cranial modification and dental pathology results provided new evidence of the social dynamics and organization of the community represented in this cemetery. Overall, there seemed to be a certain degree of homogeneity in the lifeways of the MUNA people, as shown in the widespread nature of the fronto-occipital cranial modification and the evidence of a generally carbohydrate-rich diet. However, the small, but significant, differences between subgroups in the MUNA cemetery suggested that people likely had different life experiences and behaviours that started at birth and continued after their deaths.

7.2 Future directions

Further differentiation within the Fronto-occipital subtype would be recommended to further understand the variability found in the MUNA sample, especially in the differentiation of the crania with flattening on obelion. It would also be recommended that future research on this topic includes microscopic or more detailed examinations of porosities and periosteal reactions on the external and internal tables of the cranial vault. Additionally, it would be recommended to take measurements of the affected areas, and distances from the lesions to cranial landmarks, in particular for the suprainiac lesions.

Future research on the dental pathology of the MUNA people should include a more systematic approach to the analysis of caries, in particular for the diagnosis of coca leaf chewing. Additionally, a more detailed comparison of abscesses and AMTL that includes healing stage and severity would be recommended. With a longer fieldwork timeline, the addition of periodontal bone loss to the analysis would also be recommended, as it was not possible for this thesis. The inclusion of non-adults would enrich our understanding of cultural and social changes that happened at critical stages, such as the weaning process and the introduction of adult practices in adolescence (e.g., coca chewing). Lastly, in terms of the recording of dental pathology, it would be recommended to create a comparative matrix in which detailed descriptions and images of dental pathology are made by direct analysis and indirect analysis through CT scans to assess the accuracy and limitations of the latter.

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Appendices

Appendix 1 Distribution of the 2015 contexts by layer of excavation.

Unidad	I			II	III
Área	A	B	C	-	-
Capa 1, Nivel 1 (~15 cm)	26 contexts (E01-E26)	41 contexts (E27-E67)	-	1 context (E90)	5 contexts (E91-E95)
Capa 1, Nivel 2 (~50 cm)	7 contexts (E68-E74)	-	-	-	-
Capa 2 (~1 m)	7 contexts (E75-E81)	5 contexts (E82-E86)	-	-	-
Capa 3 (~1.5 m)	2 contexts (E87-E88)	-	1 context (E89)	-	2 contexts (E96-E97)

Appendix 2 Individuals analyzed in this thesis.

Subsample	**Entierro**	**Unidad**	**Área**	**Capa**	**Nivel**	**MNI**	**# adults**	**# non-adults**
Skeletal	E05	I	A	1	1	3	2	1
Skeletal	E13	I	A	1	1	8	3	5
Skeletal	E16	I	A	1	1	9	4	5
Skeletal	E16A	I	A	1	1	2	2	0
Skeletal	E17	I	A	1	1	1	1	0
Skeletal	E17A	I	A	1	1	1	1	0
Skeletal	E18	I	A	1	1	3	2	1
Skeletal	E19	I	A	1	1	1	1	0
Skeletal	E20	I	A	1	1	4	1	4
Skeletal	E21A-21B	I	A	1	1	4	2	2
Skeletal	E25	I	A	1	1	3	1	2
Skeletal	E28	I	B	1		4	2	2
Skeletal	E32	I	B	1		1	1	0
Skeletal	E33	I	B	1		4	3	1
Skeletal	E34	I	B	1		3	2	1
Skeletal	E35	I	B	1		3	2	1
Skeletal	E36	I	B	1		13	6	7
Skeletal	E37	I	B	1		3	1	2
Skeletal	E39	I	B	1		4	2	2

Skeletal	E40	I	B	1		4	2	2
Skeletal	E41	I	B	1		4	3	1
Skeletal	E42	I	B	1		13	4	9
Skeletal	E43	I	B	1		5	3	2
Skeletal	E44	I	B	1		4	2	2
Skeletal	E45	I	B	1		6	2	4
Skeletal	E46	I	B	1		3	1	2
Skeletal	E48	I	B	1		2	1	1
Skeletal	E50	I	B	1		5	3	2
Skeletal	E54	I	B	1		4	1	3
Skeletal	E55	I	B	1		8	4	4
Skeletal	E56	I	B	1		5	2	3
Skeletal	E57	I	B	1		6	3	3
Skeletal	E58	I	B	1		7	5	2
Skeletal	E59	I	B	1		5	2	3
Skeletal	E60	I	B	1		5	2	3
Skeletal	E61	I	B	1		3	1	2
Skeletal	E62	I	B	1		4	2	2
Skeletal	E63	I	B	1		3	2	1
Skeletal	E64	I	B	1		4	2	2

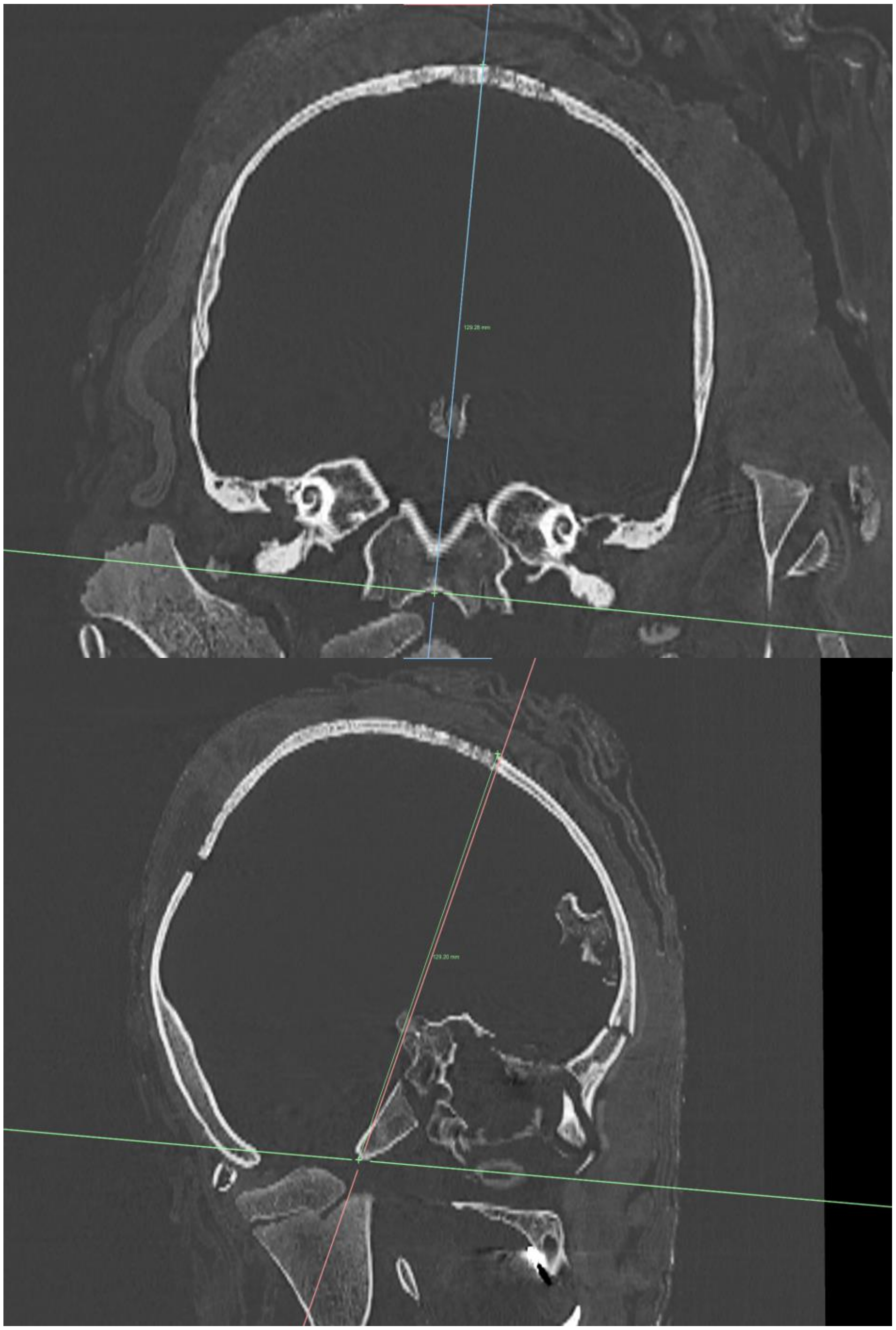
Skeletal	E65	I	B	1				
Skeletal	E66	I	B	1		5	2	3
Skeletal	E67	I	B	1		4	2	2
Skeletal	E72	I	A	1	2	1	0	1
Skeletal	E74	I	A	1	2	1	0	1
Skeletal	E75	I	A	2		6	5	1
Skeletal	E80	I	A	2	-	1	1	
Skeletal	E82	I	B	2	-	2	1	1
Skeletal	E82K	I	B	2	-	1	0	1
Skeletal	E82X	I	B	2	-	1	1	0
Skeletal	E83	I	B	2	-	2	2	0
Skeletal	E87	I	A	3	-	5	2	3
Skeletal	E88A	I	A	3	-	2	0	2
Skeletal	E90A	II	-	1	-	3	2	1
Skeletal	E90B	II	-	1	-	1	1	0
Skeletal	E94	III	-	1	1	7	3	4
Fardo	E21A	I	A	1	1	1	0	1
Fardo	E21B	I	A	1	1	1	1	0
Fardo	E26A	I	A	1	1	1	1	0
Fardo	E26B	I	A	1	1	1	1	0
Fardo	E67	I	B	1		4	2	2
Fardo	E68	I	A	1	2	1	0	1

Fardo	E69	I	A	1	2	1	1	0
Fardo	E70	I	A	1	2	1	0	1
Fardo	E74	I	A	1	2	1	0	1
Fardo	E76E	I	A	2	-	2	1	1
Fardo	E76H	I	A	2	-	1	0	1
Fardo	E77A	I	A	2	-	1	0	1
Fardo	E77B	I	A	2	-	3	2	1
Fardo	E77C	I	A	2	-	1	1	0
Fardo	E79	I	A	2	-	1	1	0
Fardo	E81	I	A	2	-	1	1	0
Fardo	E82A	I	B	2	-	1	0	1
Fardo	E82B	I	B	2	-	1	0	1
Fardo	E82C	I	B	2	-	1	1	0
Fardo	E82F	I	B	2	-	1	1	0
Fardo	E82H	I	B	2	-	1	1	0
Fardo	E82I	I	B	2	-	1	1	0
Fardo	E82J	I	B	2	-	1	1	0
Fardo	E82R	I	B	2	-	1	0	1
Fardo	E82S	I	B	2	-	1	1	0
Fardo	E82T	I	B	2	-	1	1	0
Fardo	E82U	I	B	2	-	1	1	0
Fardo	E82Y	I	B	2	-	1	0	1
Fardo	E84	I	A	1	2	1	0	1
Fardo	E88	I	A	3	-	2	0	2

Fardo	Fardo 4	HF	-	-	-	1	1	0
Fardo	Fardo 8	HF	-	-	-	1	1	0
Fardo	Fardo 9	HF	-	-	-	1	1	0

Appendix 3 X-ray and CT scan machines details, courtesy of Andrew Nelson.

Method	Equipment	Settings
X-rays	Panel: scilDX Mobile, 14x17 inch Detector-C08TX0N-030 (courtesy of Micheal Noël, Heska Canada Limited, Barrie ON) with the software dicomPACS®DX-R 7.0 from OR Technology.	kVp: 60 kVp (small fardos and skeletonized crania) to 90 kVp (large fardos). X-ray tube current: 5 mAs (2022 fardos and skeletonized crania).
	X-ray machine: 10040HF Orange BCF x-ray generator (courtesy of Dr. Rabanilla, Osteoray S.A.C., Lima Perú).	Film to focus distance (skeletonized crania): 180 cm.
CT scans	Scanner: SOMATOM Definition AS by Siemens (2019) and SOMATOM go.Up by Siemens Healthineers (2021-2022).	kVp: 120 kVp (2019) and 110 kVp (2021-2022) Pixel spacing: 0.79\0.79 (2019), 2.33\2.33 (2021) 0.68\0.68 (2022) Slice thickness: 0.5mm (2019) and 0.6mm (2021-2022) X-ray tube current: 160 mAs.



Appendix 4 An example of how a cranium was oriented to measure cranial height in Dragonfly. *Top:* cranium viewed from the coronal plane (anterior-posterior); *bottom:* cranium viewed from the sagittal plane (lateral). The lines cutting across the screen represent the x, y, and x axes used to orient the head.

Appendix 5 Recording method for mortuary practices in the fardo subsample.

Construction of the fardo		
Material	*How it was recorded*	
Textile	Presence/absence	
Organic fill	Presence/absence	
Mat/basket	Presence/absence	
Braided rope	Presence/absence	
Cane sticks	Presence/absence and by number	
Inside the fardo		
Material	*How it was recorded*	
Ceramic	Presence/absence	
Bone (animal)	Presence/absence	
Lithic	Number of lithics	
Metal	Number of metal items	
Organic	By number of types and number of single items (except beads).	*Type of organics*
		Tools (Spindles, needle, ball of yarn, *mate*, mace)
		Accessories (Necklace, beads, pouches/bags)
		Others (Maize, cane, feathers, gourds)
Shell	*Spondylus*	By number (2 halves = 1 complete shell)
	All other shells	Presence/absence

Appendix 6 Comparison between the two age-at-death and skeletal sex determination methods.

Skeletal sex determination comparison: cranial vs pelvis sex

For the female individuals, all pelvic sex results showed a high probability of being female (Table A6.1, Figure A6.1). In contrast, the cranial sex results had more variation as expected. Fardo 8 had slightly inconsistent results, as the pelvis showed a 98.8% probability of being female and the cranial traits only showed a 72.1% probability. Despite this inconsistency, the cranial sex result was close to our threshold of 75% between the ‘Indeterminate’ and ‘Probable female’ sex groups.

Overall, the male group showed more consistent results between the pelvic and cranial sex probabilities than the female individuals (Table A6.2, Figure A6.1). Five out of seven individuals had the results of both methods in the 90-100% range. E82I’s pelvic sex probability was also in the upper range, but the cranial sex probability was below the 90% ‘Male’ group limit at 89.4%. E82F was the only inconsistency out of the seven fardos analyzed, as the pelvis showed a 71.0% probability of being male, while the cranium showed a 97.8% probability. The low pelvis sex probability was likely because the right os coxae had only a 48.5% probability of being male—while the left os coxae had a 93.5% probability. We attributed this difference to individual variability of pelvic morphology, given that we did not find any pathological lesion, such as a fracture, associated with the os coxae of E82F.

Overall, the skeletal sex results from cranial and pelvic traits did not differ greatly in the individualized remains. With this, we can conclude that our skeletal sex results based on Walker’s (2008) method of cranial traits were accurate for this sample.

Table A6.1 Cranial and pelvis skeletal sex comparisons in female individuals.

Ind	Cranial %	Cranial sex	Pelvis % (R/L/Average)			Pelvis sex	Average %	Final skeletal sex
E77B	92.3%	F	99.9%	99.9%	99.9%	F	96.1%	F
E81	88.7%	PF	99.9%	98.2%	99.1%	F	93.9%	F
E82J	83.0%	PF	99.9%	99.8%	99.9%	F	91.4%	F
E82S	78.0%	PF	99.9%	99.9%	99.9%	F	89.0%	PF
E82X	96.0%	F	99.9%	99.9%	99.9%	F	98.0%	F
Fardo 8	72.1%	I	98.2%	99.5%	98.8%	F	85.4%	PF

F: female; PF: probable female; I: indeterminate

Table A6.2. Cranial and pelvis skeletal sex comparisons in male individuals.

Ind	Cranial %	Cranial sex	Pelvis % (R/L/Average)			Pelvis sex	Average %	Final skeletal sex
E26B	97.8%	M	99.9%	99.9%	99.9%	M	98.9%	M
E77C	92.4%	M	99.9%	99.9%	99.9%	M	96.2%	M
E79	96.4%	M	99.9%	99.8%	99.9%	M	98.2%	M
E82C	92.4%	M	99.8%	98.5%	99.2%	M	95.8%	M
E82F	97.8%	M	48.5%	93.5%	71.0%	I	84.4%	PM
E82I	89.4%	PM	93.5%	99.2%	96.4%	M	92.9%	M
Fardo 9	92.4%	M	93.5%	92.6%	93.1%	M	92.8%	M

M: male; PM: probable male; I: indeterminate

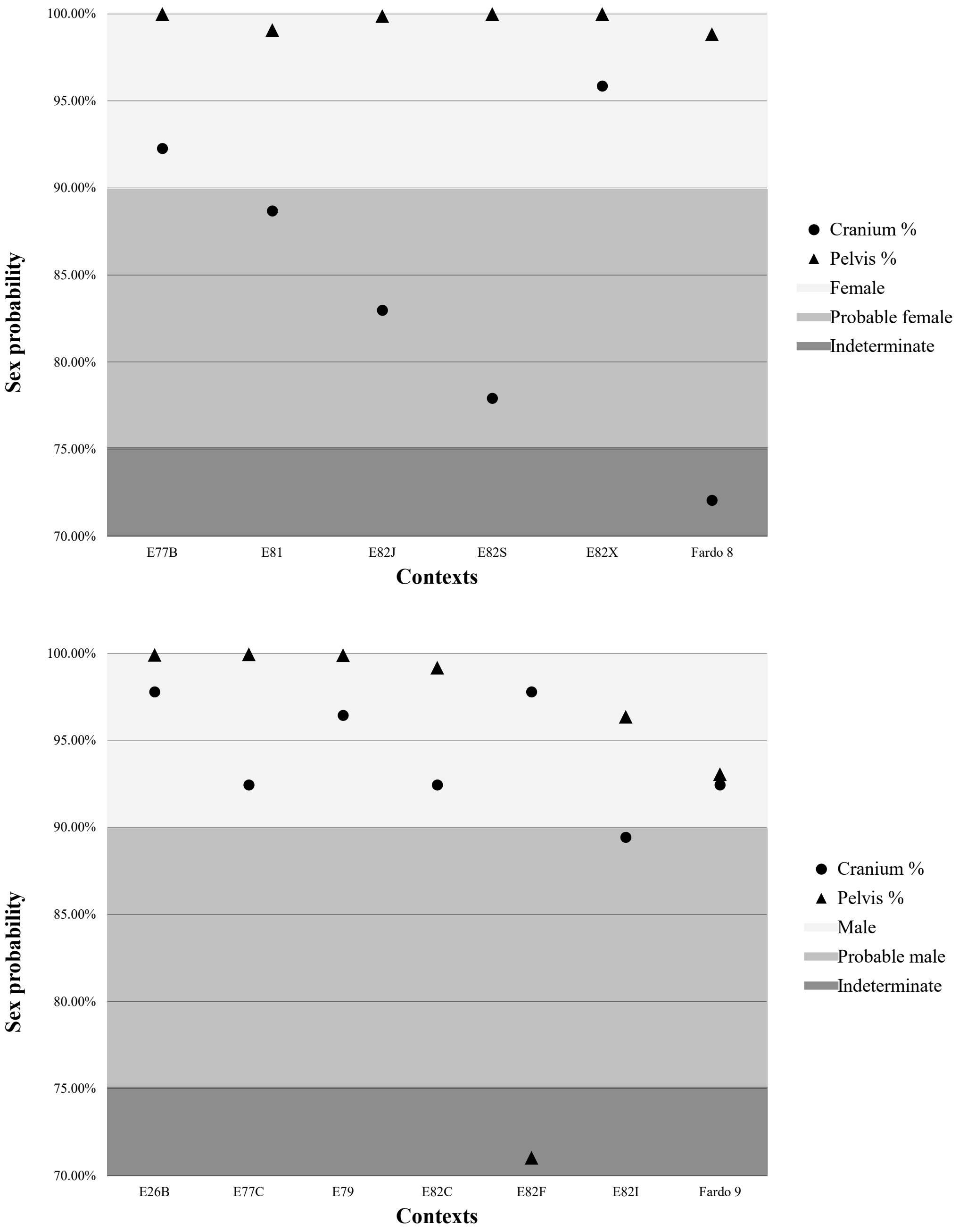


Figure A6.1. Comparison between cranial and pelvis sex determination methods in female (top) and male (bottom) individuals (Klales et al., 2012; Walker, 2008). X axis presents the individuals used in this section; Y axis indicates probability of being female or male.

Age-at-death estimation comparison: Pubic symphysis vs dental wear

For most individuals, there was a negative offset between the dental wear and pubic symphysis results (dental wear produced lower estimates) (Tables A6.3 and A6.4, Figure A6.2). The individuals who departed from that pattern were E82I and Fardo 9, both male adults. These differences could be attributed to pathological lesions and taphonomy in both cases. E82I had the second highest amount of caries per individual (8 caries) and Fardo 9 had more AMTL—9 teeth lost antemortem—than the sample mean of 5.14. Additionally, E82I only had maxillary teeth present for dental wear analysis (the mandible was absent), which could have introduced more error to the result; and we were only able to assess one of the two os coxae for both individuals due to taphonomic damage and preserved mummified tissue for Fardo 9 and E82I, respectively.

In the female group, only Fardo 8 had both age means within the ‘Young adult’ cohort; the other four individuals had both age means within a 15-year margin that included the ‘Young adult’ and ‘Middle adult’ cohorts. In contrast, generally, the male individuals had both age means within a single cohort. Overall, the age-at-death analyses showed that while the dental wear and pubic symphysis methods gave slightly different age-at-death results, they did not have drastic differences that complicated the categorization of the individuals into the established cohorts. Thus, we can conclude that our age-at-death results based on dental wear were accurate for this sample.

Table A6.3. Age-at-death results in female adult individuals (all ages are in years).

Individual	**Pubic symphysis (Range/mean)**		**Dental wear (Range/mean)**		**Final cohort**
E81	25-83	43.2	24-35	29.5	Middle adult
E82J	26-70	38.2	20-24	22.0	Young adult
E82S	26-70	38.2	30-35	32.5	Middle adult
E82X	26-70	38.2	30-35	32.5	Middle adult
Fardo 8	21-70	29.7	20-24	22.0	Young adult

Table A6.4. Age-at-death results in male adult individuals (all ages are in years).

Individual	Pubic symphysis (Range/mean)		Dental wear (Range/mean)		Final cohort
E26B	23-57	35.2	30-40	35.0	Young adult
E77C	23-57	35.2	30-35	32.5	Young adult
E79	23-57	35.2	24-30	27.0	Young adult
E82C	21-57	32.0	20-30	25.0	Young adult
E82F	21-46	28.7	20-24	22.0	Young adult
E82I	21-46	28.7	30-35	32.5	Young adult
Fardo 9	23-57	35.2	40-50	45.0	Middle adult

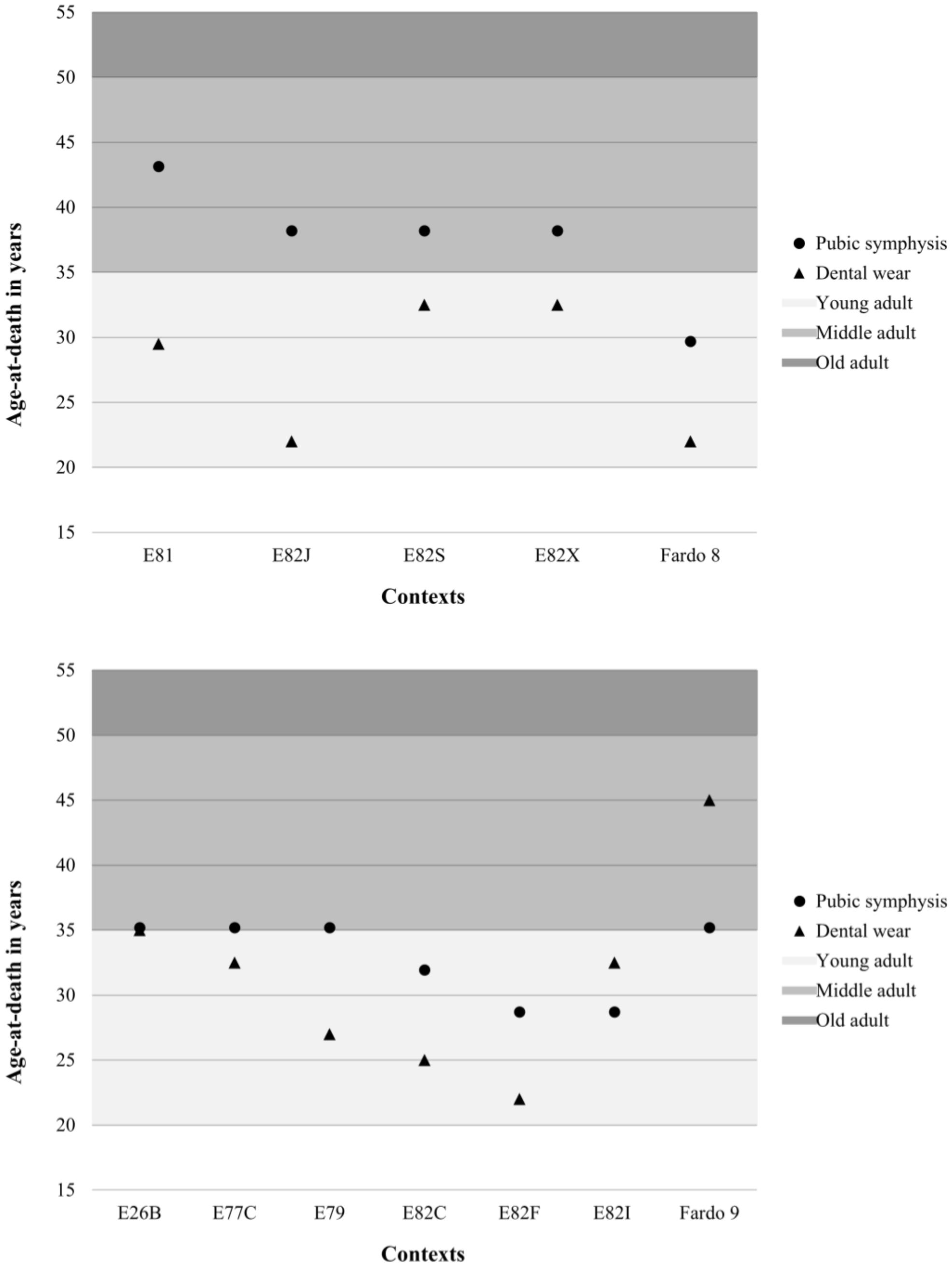


Figure A6.2. Comparison of age-at-death estimation methods in female (top) and male (bottom) individuals: pubic symphysis vs dental wear (Brooks & Suchey, 1990; Lovejoy, 1985). X axis presents the individuals used in this section; Y axis indicates age-at-death in years.

Appendix 7 Comparisons of cranial modification, dental pathology, and mortuary rituals between the skeletal and fardo subsamples.

The cranial modification analyses included 85 individuals—62 skeletonized crania and 23 crania from fardos. In some of the analyses, the number of crania from the skeletal subsample changed to 61 or 60 because a few crania had full heads of hair or textiles still attached and could not be analyzed in their entirety. Appendix 8, Appendix 9, and Appendix 10 present the cranial modification data. Appendix 8 includes the qualitative information for the cranial modification subtypes and the coronal and obelion depressions; Appendix 9 describes the qualitative data about the potential pathological conditions associated with cranial modification practices; and Appendix 10 includes the six cranial measurements and cranial index values used in the quantitative part of this study.

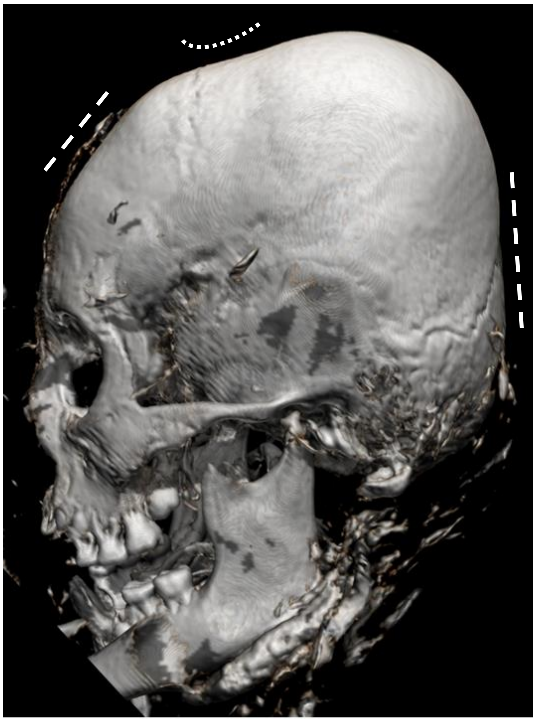
As expected, the only major type of cranial modification found in this coastal cemetery was the fronto-occipital type, Table 5.4 (in Chapter 5) describes the subtypes found and Figure A7.1 shows examples from this sample. The descriptions were solely based on the observation of the cranial modification of this sample; they were not based on other classifications or typologies.

A. B58 – Ind B, female young adult; not modified.

B. B101, male adult; mild Frontal modification.

B. E37, male young adult; moderate Occipital modification.

C. E45 – Ind B, adolescent; Fronto-occipital modification, moderate anterior and severe posterior.



D. E77A, child; moderate Fronto-occipital modification with mild coronal depression.

Figure A7.1 Examples of the subtypes of fronto-occipital modification found in the sample; photos represent the skeletal subsample and the digital 3D renderings represent the fardo subsample; dashed lines show where the cranium has been flattened and the dotted line indicates where the coronal depression is.

Qualitative analysis

Types of cranial modification

All the non-adult crania analyzed were modified, 14 from the skeletal subsample and eight from the fardo subsample (Figure A7.2). In the skeletal subsample, only one head was not modified (2%), a female young adult. Out of the 61 crania, 3% (n = 2) had the Frontal subtype, 34% (n = 21) had the Occipital subtype, and over half of the individuals in the skeletal subsample presented the Fronto-occipital subtype (61%, n = 37). Every cranium in the fardo subsample was modified. There were no crania with the Frontal subtype in the fardo subsample, 9% (n = 2) had the Occipital subtype, and 91% (n = 21) had the Fronto-occipital subtype. In general, both subsamples followed the same trend where the predominant subtype of cranial modification was the Fronto-occipital, then the

Occipital, followed by the Frontal subtypes, and last was the single unmodified cranium. Fisher's exact test did not show a significant association between the subsamples and the prevalence of cranial modification ($p = 1$); thus, the subsamples are not significantly different regarding the prevalence of cranial modification.

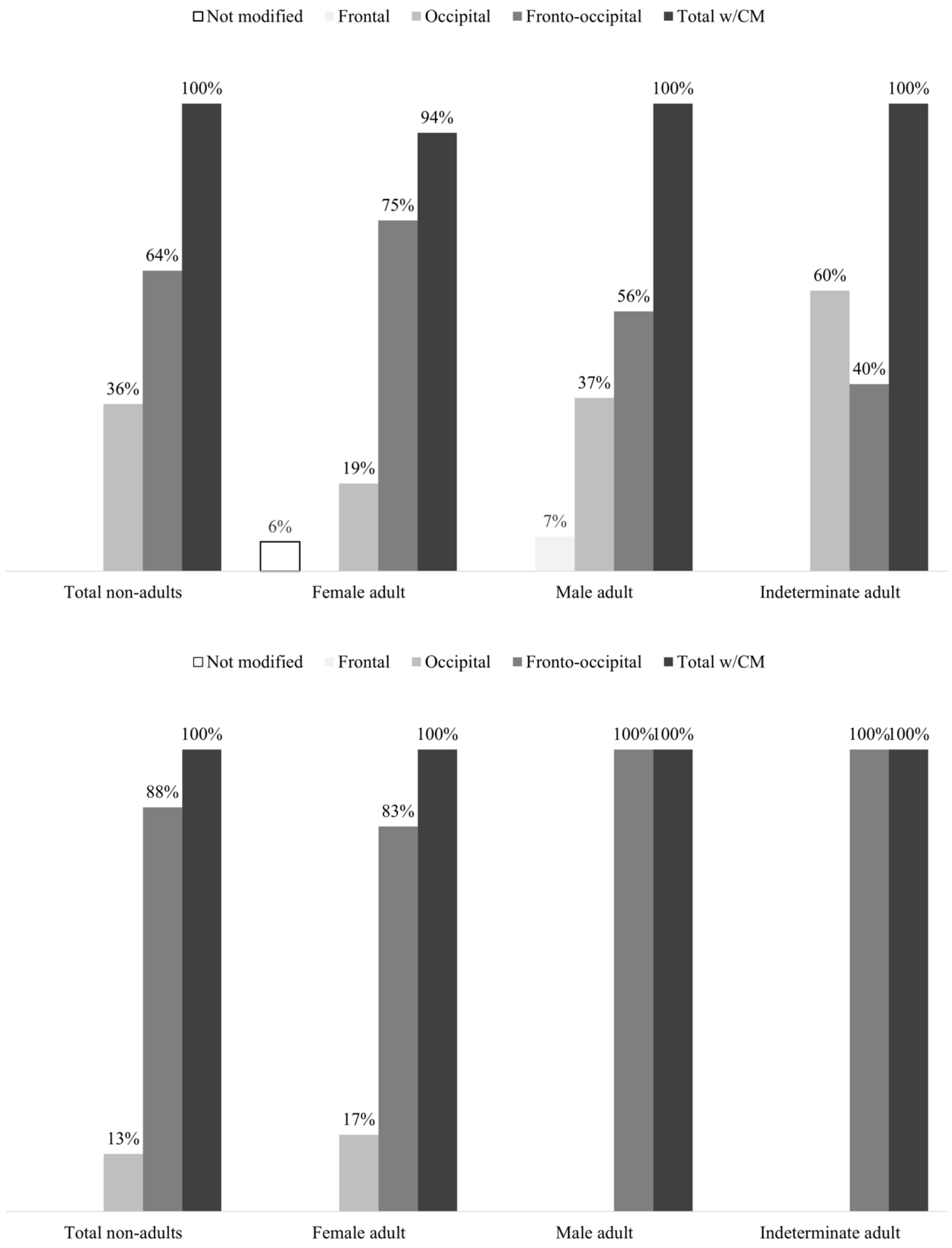


Figure A7.2 Distribution of subtypes of cranial modification per cohort in the skeletal subsample (top) and the fardo subsample (bottom); shades of gray indicate subtype of cranial modification. X axis indicates cohorts, Y axis indicates prevalence in percentages.

Anterior modification

In the skeletal subsample, 65% (n = 40) presented anterior modification[14], in the fardo subsample 91% (n = 21) presented this form of modification (Figure A7.3). Mild and moderate anterior modifications were the most common in both subsamples, with severe anterior modification only present in five individuals, three in the skeletal subsample (5%) and two in the fardo subsample (9%)[15]. The three individuals from the skeletal subsample with severe anterior modification presented moderate posterior modification. Meanwhile, the two individuals with severe anterior modification in the fardo subsample had severe posterior modification. There was an association between the skeletal and fardo subsamples and the prevalence of anterior modification, hence the subsamples are statistically significantly different (Fisher's exact test: $p = 0.02$, OR = 5.68, 95% CI = 1.20-54.48). However, there was no association between the subsamples and the degree of severity of anterior modification (Fisher's exact test: $p = 0.66$). Based on these results, it was more likely for a person in the fardo subsample to have anterior modification than for a person in the skeletal subsample. However, the fardo subsample had a reduced sample size, which possibly introduced sample bias. Additionally, no other differences were significant.

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[14] Anterior modification includes Frontal and Fronto-occipital subtypes.

[15] Severity of the anterior modification, posterior modification, and coronal depression was assessed by comparing the modified morphology to photographs and diagrams of unmodified crania (for more detail, see Chapter 3).

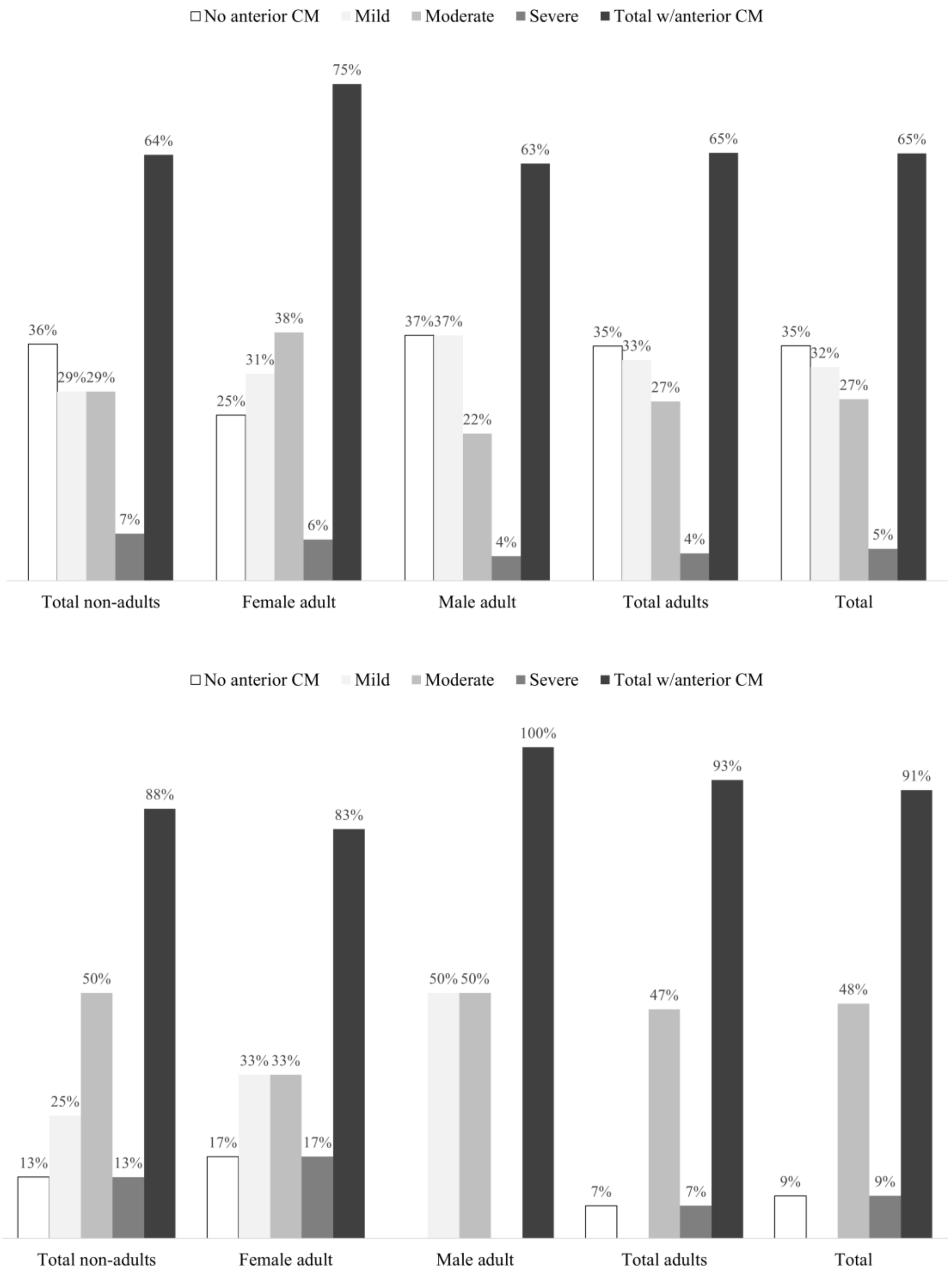

Figure A7.3 Distribution of anterior modification per cohort in the skeletal subsample (top) and the fardo subsample (bottom); shades of gray indicate severity of modification. X axis indicates cohorts, Y axis indicates prevalence in percentages.

Posterior modification and asymmetry

In both subsamples, moderate posterior modification[16] was the most common degree of severity, followed by mild, and lastly, severe (Figure A7.4). There were only two severe cases of posterior modification in each subsample (skeletal: 3%; fardo: 9%), and in all four cases the frontal bone was also modified. In the two skeletonized crania, the frontal modification was moderate, while in the fardo subsample, the frontal modification was severe. There was no association between the prevalence of posterior modification and the subsamples, meaning there were no significant differences between subsamples (Fisher's exact test: $p = 0.56$). Similarly, there were no significant differences in the number of individuals per severity of posterior modification between subsamples (Fisher's exact test: $p = 0.60$). The results show that the MUNA sample was homogenous in terms of posterior modification, but this form presented different degrees of severity.

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[16] The analysis of posterior modification included the Occipital and Fronto-occipital subtypes.

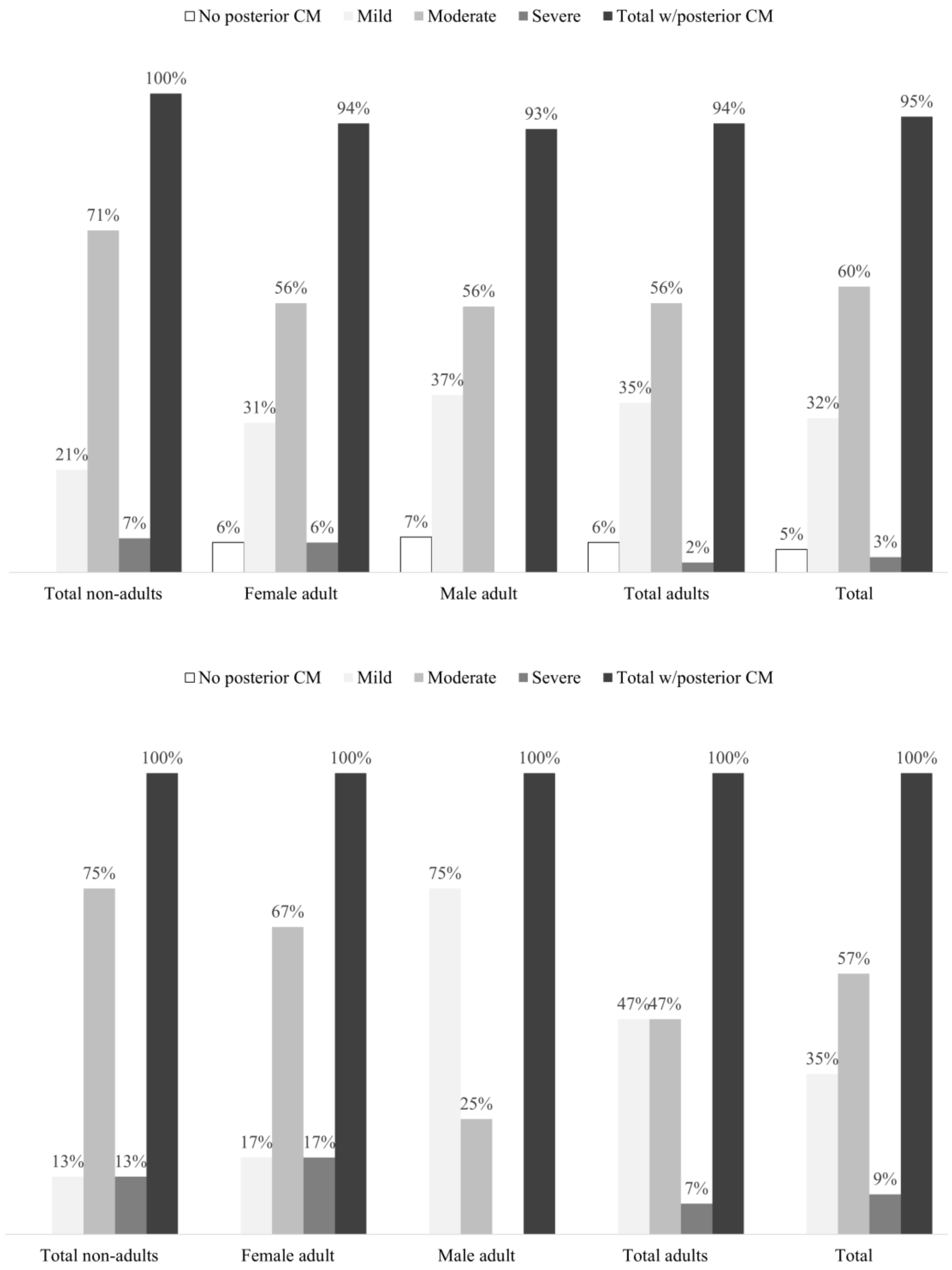

Figure A7.4 Distribution of posterior modification per cohort in the skeletal subsample (top) and the fardo subsample (bottom); shades of gray indicate severity of modification. X axis indicates cohorts, Y axis indicates prevalence in percentages.

Posterior asymmetry[17] was analyzed in 58 crania from the skeletal subsample and 23 from fardos. In the skeletal subsample, 22% (n = 13) of the individuals lacked asymmetry, 45% (n = 26) had the right side more flattened, and 33% (n = 19) had the left side more flattened (Figure A7.5). In the fardo subsample, 35% (n = 8) of the crania had no asymmetry, 35% (n = 8) had the right side more flattened, and 30% (n = 7) had the left side more flattened (Figure A7.5). There was no association between the subsamples and the prevalence of asymmetry (Fisher's exact test: $p = 0.43$). Similarly, there were no significant differences in the number of individuals with the right side or left side more flattened between subsamples (Fisher's exact test: $p = 0.77$).

Of the 45 crania with posterior asymmetry in the skeletal subsample, 41% (n = 24) had mild asymmetry, followed by 31% (n = 18) with moderate asymmetry, and 5% (n = 3) with severe asymmetry (Figure A7.6). Of the 15 crania with posterior asymmetry in the fardo subsample, 30% (n = 7) had mild asymmetry, 26% (n = 6) had moderate asymmetry, and only 9% (n = 2) had severe asymmetry (Figure A7.6). There were no significant differences in the number of individuals per degree of severity between subsamples (Fisher's exact test: $p = 0.73$). These results, along with the paragraph above, suggest that the subsamples were not different in terms of posterior asymmetry, but there was variability in the expression of asymmetry within the community.

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[17] Posterior asymmetry was analyzed in crania from the Occipital and Fronto-occipital subtypes.

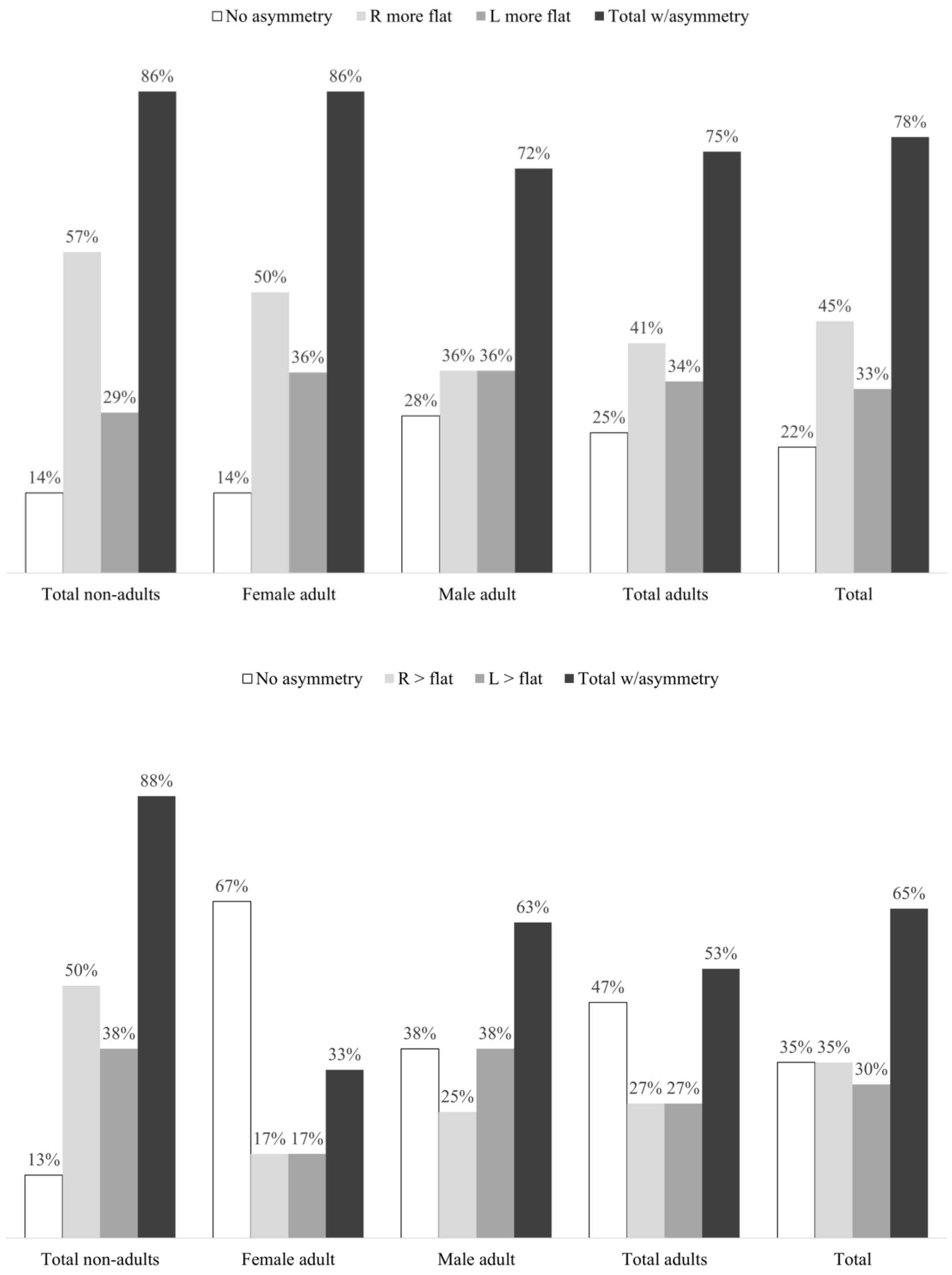


Figure A7.5 Distribution of posterior asymmetry per cohort in the skeletal subsample (top) and the fardo subsample (bottom); shades of gray indicate which side was more flattened. X axis indicates cohorts, Y axis indicates prevalence in percentages.

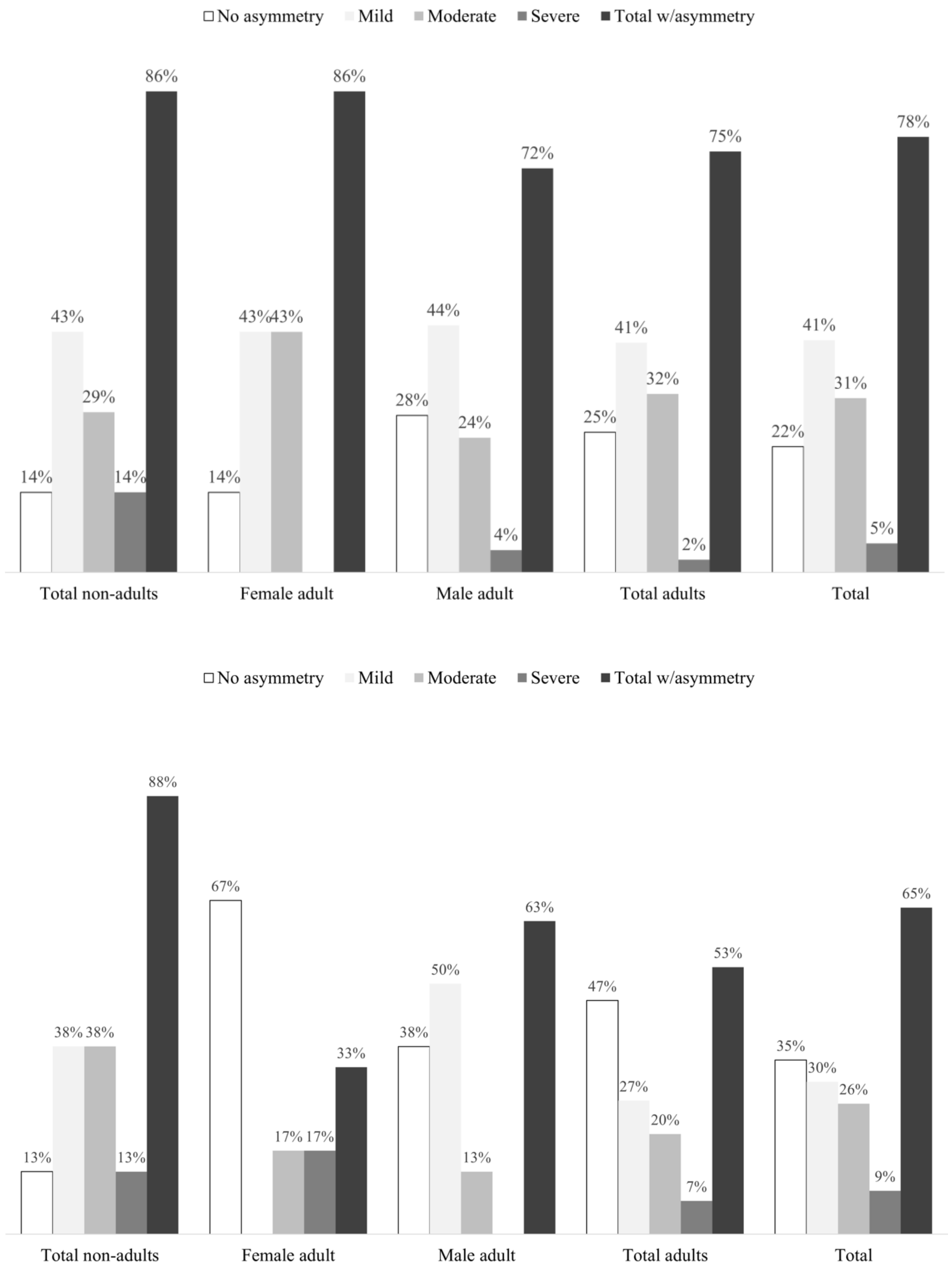
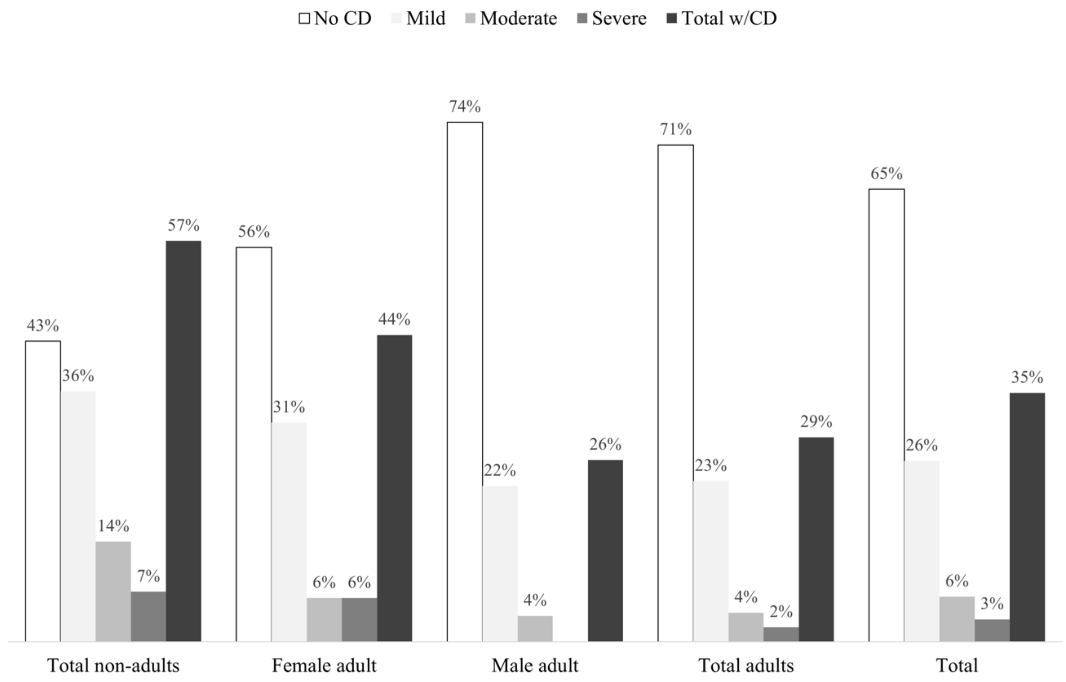


Figure A7.6 Distribution of posterior asymmetry per cohort in the skeletal subsample (top) and the fardo subsample (bottom); shades of gray indicate severity of asymmetry. X axis indicates cohorts, Y axis indicates prevalence in percentages.

Coronal depression

In some modified crania, there were depressions on the cranial vault likely associated with the cranial modification subtypes observed in the sample—one variant was along the coronal suture, usually posterior to it; and another variant was on obelion in the center of the flattened area on the posterior portion of the parietals above lambda. This section will only include the depression along the coronal suture; for the obelionic depression see Chapter 5.

Of the 62 skeletonized crania analyzed, 65% (n = 40) did not present the coronal depression, 26% (n = 16) had a mild depression, 6% (n = 4) had a moderate depression, and 3% (n = 2) had a severe depression along the coronal suture (Figure A7.7). In the fardo subsample, 39% (n = 9) did not present the depression along the coronal suture, 43% (n = 10) had a mild depression, 17% (n = 4) had moderate depressions, and none had the severe presentation (Figure A7.7). There was a marginally significant difference in the prevalence of the coronal depression in the two subsamples (Fisher's exact test: $p = 0.05$, OR = 2.79, 95% CI = 0.95-8.62). However, there were no significant differences in the number of individuals per severity between the subsamples (Fisher's exact test: $p = 0.76$).



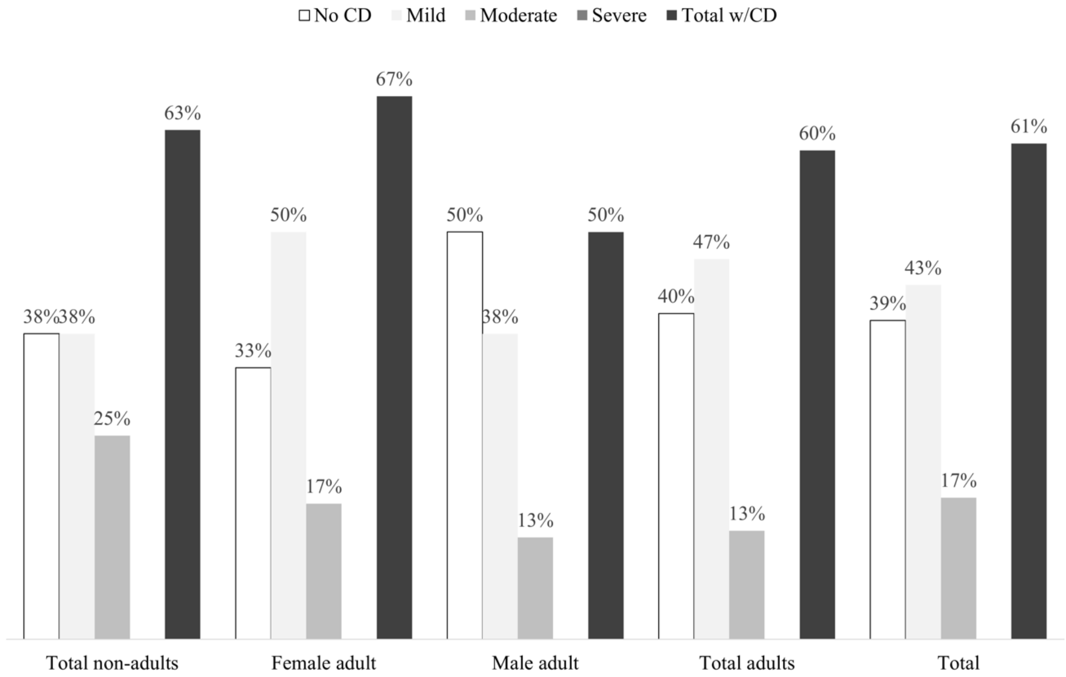


Figure A8.7 Distribution of the coronal depression per cohort in the skeletal subsample (top) and the fardo subsample (bottom); shades of gray indicate severity of depression. X axis indicates cohorts, Y axis indicates prevalence in percentages.

As the only two significant differences were found on modification that affected the frontal (anterior modification and the coronal depression), they were tested for possible association. However, the Fisher's exact test was not significant ($p = 0.21$).

Quantitative analysis

For this section of the analysis, I compared the cranial index between subsamples using a Student's t-test. The Shapiro-Wilk normality test showed that both subsamples were normally distributed, and the F-test showed that they did not have different variances, thus the subsamples could be compared using the Student's t-test (Tables A7.1 and A7.2). The Student's t-test showed that there were no significant differences in the mean values of the skeletal and fardo subsamples (Student's t-test: $t = 1.53$, $df = 77$, $p = 0.93$) (Table A7.1). For comparisons between different subdivisions of the MUNA sample (e.g., female vs male adults), refer to Chapter 5.

Table A7.1 Shapiro-Wilk normality test results for cranial index measurements.

Subsample	w	p-value
Skeletal	0.98	0.37
Fardo	0.92	0.09
Female (skeletal + fardo)	0.97	0.77
Male (skeletal + fardo)	0.96	0.32
Occipital subtype	0.97	0.73
Fronto-occipital subtype	0.98	0.52

$p > 0.05$ indicates normality

Table A7.2. F-tests results comparing variance of cranial index values between subsamples and sex groups.

Subgroup	f	p-value
Skeletal vs Fardo	0.88	0.78
Female vs Male	1.28	0.52
Occipital vs Fronto-occipital	1.23	0.62

p > 0.05 indicates variances are not different

Table A7.3. Cranial index minimum, maximum, and mean values per subsample (mm).

	Skeletal (n = 58)	Fardo (n = 21)
Minimum CI	75.14	83.29
Maximum CI	106.80	110.68
Mean	89.61	92.56
Standard deviation	7.71	7.24

Dental pathology

The dental pathology section included a total of 57 unpaired adult maxillae and mandibles: 42 from the skeletal subsample and 15 fardos. Non-adults were excluded to simplify the analysis and due to the poor preservation of deciduous teeth. Appendix 11 summarizes the dental pathology data for caries, abscesses, AMTL, dental wear, and dental calculus. Dental calculus was initially included in the analysis of both subsamples, but unfortunately it was not possible to accurately record this variable in the CT scans of the fardos. Thus, it was excluded from this section, but it is included in Chapter 5.

The prevalence of carious teeth was higher in the skeletal subsample than in the fardo subsample (26.1% vs 21.1%) (Figure A7.8), but this difference was not significant

(Fisher's exact test: $p = 0.11$). The prevalence of abscesses was lower in the skeletal subsample (3.4%) than in the fardo subsample (4%) (Figure A7.9), but this was not a significant difference (Fisher's exact test: $p = 0.15$). The prevalence of AMTL in both subsamples was not significantly different (Fisher's exact test: $p = 0.46$) (Figure A7.10). Hence, there were no significant associations between the subsamples and the prevalence of carious teeth, abscesses, or AMTL.

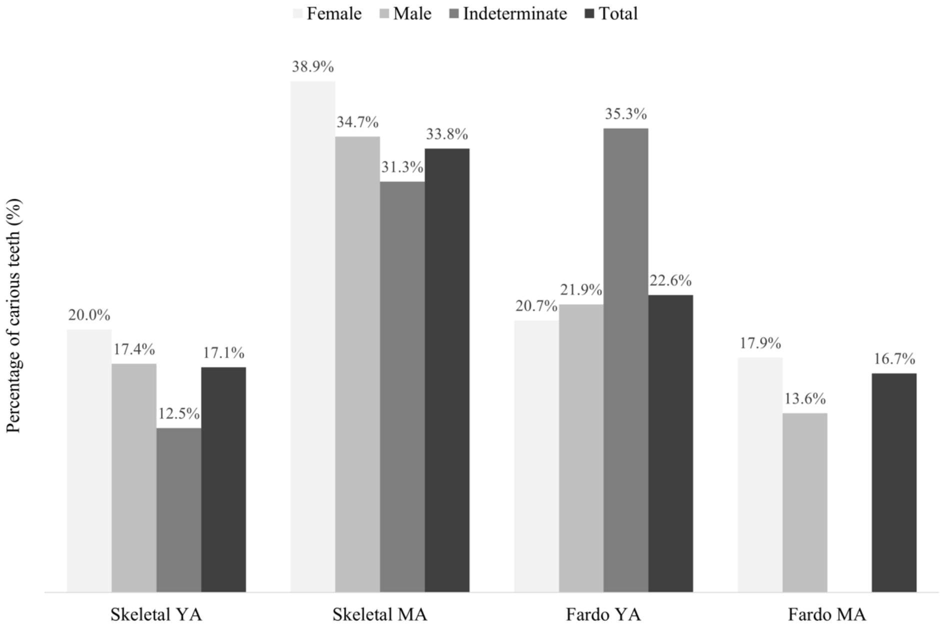


Figure A7.8 Prevalence of carious teeth (%) by cohort and subsample; YA: young adults, MA: middle adults; shades of grey indicate skeletal sex group. X axis indicates cohorts, Y axis indicates prevalence in percentages.

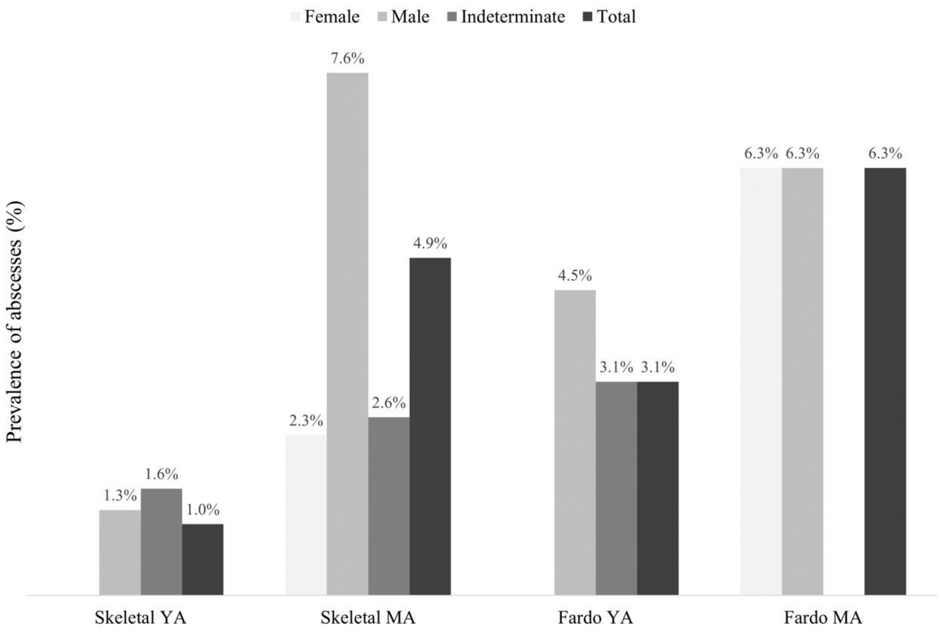


Figure A7.9 Prevalence of abscesses (%) by cohort and subsample; YA: young adults, MA: middle adults; shades of grey indicate skeletal sex group. X axis indicates cohorts, Y axis indicates prevalence in percentages.

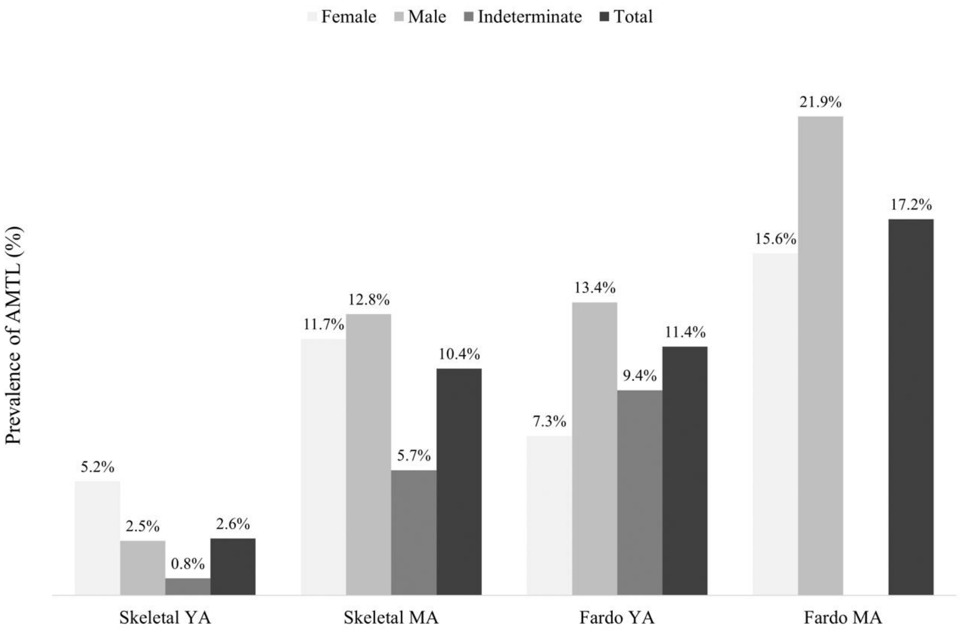


Figure A7.10. Prevalence of AMTL (%) by cohort and subsample; YA: young adults, MA: middle adults; shades of grey indicate skeletal sex group. X axis indicates cohorts, Y axis indicates prevalence in percentages.

In the skeletal subsample, 3% (n = 1) had mild dental wear, 63% (n = 22) had moderate dental wear, and 34% (n = 12) had severe dental wear (Figure A7.11). A similar trend was present in the fardo subsample, where 14% (n = 2) had mild dental wear, 64% (n = 9) had moderate dental wear, and 21% (n = 3) had severe dental wear (Figure A7.11). There were no significant differences in the number of individuals per degree of dental wear severity between subsamples (Fisher's exact test: *p* = 0.28).

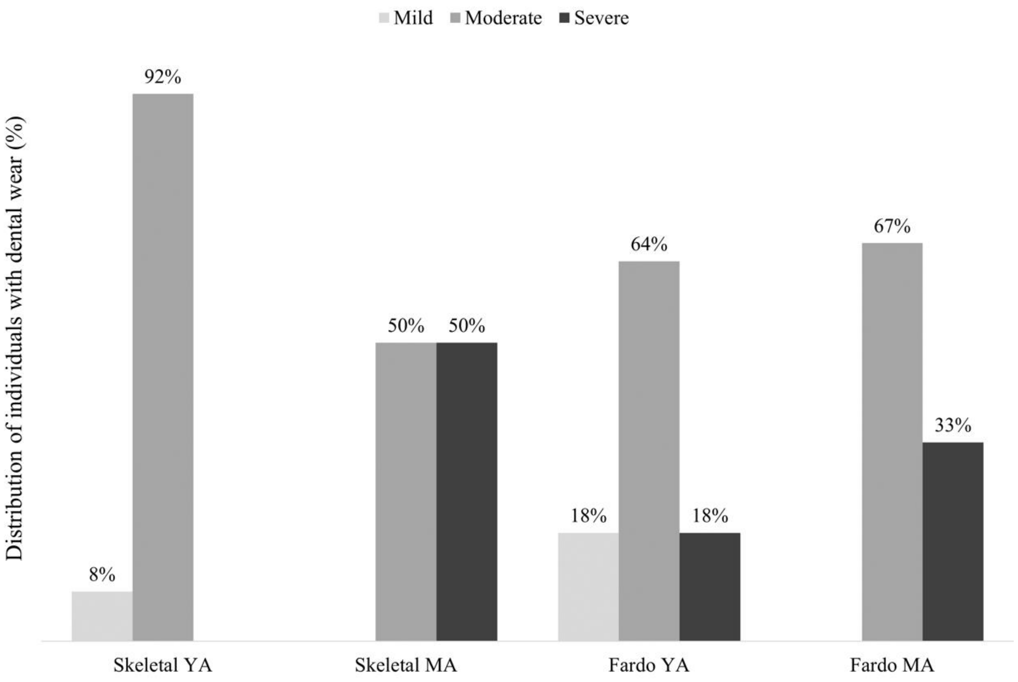


Figure A7.11. Distribution of dental wear by cohort and subsample; YA: young adults, MA: middle adults; shades of grey indicate dental wear severity. X axis indicates cohorts, Y axis indicates prevalence in percentages.

Mortuary treatment

This section of the thesis compares the skeletal and fardo subsamples based on the presence or absence of artifacts and/or ecofacts within the contexts[18]. Due to the commingled nature of the skeletal subsample and the secondary nature of this set of variables, the comparison was made on a subsample level, not an individual or context level. Similarly, this comparison did not differentiate between the archaeological items that were found inside, outside, or as part of the construction of the fardos, as it is not possible to do so for the skeletonized remains. The secondary information about the archaeological items from the skeletal subsample was taken from the final excavation

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[18] For the purposes of this comparison, artifacts and ecofacts have not been separated, rather, they are both referred to as the ‘archaeological items’ found associated with the human remains.

report from Jhon Baldeos (2015), and the primary information about archaeological items from the fardos was recorded from the CT scans through the 3D renderings and 2D slices.

Both subsamples had a wide range of types of archaeological items associated with the human remains. Among the excavated material was pottery (diagnostic of the Ychsma and potentially to the Inca periods); metal pieces[19]; plain and decorated textiles (diagnostic of the Ychsma and potentially to the Inca periods); ropes and baskets; animal bone (culturally modified and not); lithics; funerary masks; shells, including *Spondylus sp.*; and organics such as maize, canes, wooden items (e.g., spindles, needles, club), yarn, gourds, seed necklaces, etc. In general, there were no observable differences in the presence of different types of archaeological items between subsamples. However, the *Spondylus* shells were only recorded in the fardos (12 halves). Similarly, metal pieces were more common in the fardos than in the skeletal subsample, despite the larger number of contexts in the skeletonized remains. The lack of *Spondylus* shells and lower amount of metal pieces in the skeletal subsample is more likely associated with modern looting and other activities that disturbed the contexts, rather than differential mortuary treatments between the subsamples. Evidence that supports this hypothesis includes that there were no other significant differences in the variables examined in this study, the disturbed nature of the upper levels of the site, and because metal and *Spondylus* shells are perhaps two of the most eye-catching archaeological items in this cemetery, and thus likely looted more often than pottery sherds or plain cotton textiles.

During our bioarchaeological analysis of both subsamples, the maximum minimum number of individuals (MNI) for the skeletal material was 13, while for the fardos it was three individuals per fardo. Although this may have seemed like a difference in burial patterns, this was likely due to the disturbances the skeletal sample suffered, not due to different mortuary treatments.

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[19] Metal pieces in this section refers to both fragments and complete metal items.

Appendix 8 Qualitative cranial modification data for anterior and posterior modification, posterior asymmetry, and the coronal and obelionic depressions. 1: presence, 0: absence; F: female, M: male, I: indeterminate; YA: young adult, MA: middle adult, OA: old adult; Mi: mild, Mo: moderate, Se: severe; R: right side more flat, L: left side more flat.

				Anterior				**Posterior**				**Posterior asymmetry**						**Coronal depression**				**Obelion depression**			
Subsample	**Entierro**	**Individual**	**Cohort**	**No**	**Mi**	**Mo**	**Se**	**No**	**Mi**	**Mo**	**Se**	**P/A**	**R**	**L**	**Mi**	**Mo**	**Se**	**No**	**Mi**	**Mo**	**Se**	**No**	**Mi**	**Mo**	**Se**
Skeletal	E05	A	F YA			1				1		1	1		1			1				1			
Skeletal	E16A	A	I YA	1						1		1		1		1		1				1			
Skeletal	E16A	B	M A			1				1		1	1			1		1				1			
Skeletal	E17		M YA		1					1		1		1	1				1			1			
Skeletal	E18		M MA	1					1			0						1				1			
Skeletal	E20	A	Child	1						1		0							1				1		
Skeletal	E20	C	Child			1				1		1	1		1					1				1	
Skeletal	E21A-21B	A	M MA	1						1		1		1	1			1				1			
Skeletal	E25	A	M MA		1					1		1	1			1			1				1		
Skeletal	E28	A	Adolescent		1					1		0						1					1		
Skeletal	E32		F MA		1					1		0							1				1		
Skeletal	E33	A	Adolescent	1						1		1	1			1		1				1			
Skeletal	E37	A	M YA	1						1		1		1	1			1					1		
Skeletal	E41	A	I A	1					1			0						1					1		
Skeletal	E42	A	I MA	1					1			1	1		1			1				1			
Skeletal	E43	E	M YA		1					1		1		1	1			1						1	
Skeletal	E44	A	F A	1						1		1		1		1		1				1			
Skeletal	E45	A	F MA		1					1		1	1			1			1				1		
Skeletal	E45	B	Adolescent			1					1	1		1			1		1					1	
Skeletal	E45	C	Adolescent	1						1		1		1			1	1						1	
Skeletal	E46	A	M A	1					1			0						1				1			
Skeletal	E48	A	M MA		1				1			1	1		1			1					1		
Skeletal	E50	B	F MA	1					1			1	1		1			1				1			
Skeletal	E50	C	F A			1				1		1		1		1		1				1			
Skeletal	E54	D	M A		1				1			1		1	1			1				1			

Skeletal	E55	A	F YA	1						1		1	1			1			1				1		
Skeletal	E56	A	M A		1			1				0						1				1			
Skeletal	E57	A	M MA	1						1		0							1			1			
Skeletal	E57	B	M MA			1				1		1	1				1	1				1			
Skeletal	E58	A	F MA		1				1			1		1		1		1				1			
Skeletal	E60	B	Child	1						1		1	1		1			1					1		
Skeletal	E66	A	M MA		1					1		1	1			1		1					1		
Skeletal	E66	B	I MA		1					1		0						1				1			
Skeletal	E67		M YA			1				1		0								1		1			
Skeletal	E72		Adolescent		1				1			1		1	1			1				1			
Skeletal	E74		Adolescent			1				1		1	1		1				1				1		
Skeletal	E82K		Child	1					1			1	1			1			1			1			
Skeletal	E82X		F YA			1			1			No obs						1				1			
Skeletal	E83	A	I MA			1				1		1	1			1		1				1			
Skeletal	E83	B	M MA			1				1		1		1		1		1						1	
Skeletal	E88A	A	Child			1				1		1	1			1			1			1			
Skeletal	E90B		M MA			1				1		0						1				1			
Skeletal	E94	A	M YA			1				1		0							1			1			
Skeletal	E94	D	Child		1					1		1	1		1					1		1			
Skeletal	B15		F YA				1			1		1		1	1					1			1		
Skeletal	B22		M YA	1					1			1	1		1			1				1			
Skeletal	B30		M A	1					1			1		1		1			1			1			
Skeletal	B32		F A			1			1			0							1			1			
Skeletal	B42		Adolescent				1			1		1		1		1					1	1			
Skeletal	B56		M MA	1					1			1	1		1			1				1			
Skeletal	B57		F A			1					1	1	1		1						1	1			
Skeletal	B58	A	M YA		1					1		1		1		1		1							
Skeletal	B58	B	F YA	1				1				0						1				1			
Skeletal	B67		F MA		1				1			1	1		1			1				1			
Skeletal	B70		F YA			1				1		1		1		1			1					1	
Skeletal	B73		M MA	1					1			1	1		1			1				1			

Skeletal	B74		M MA	1					1			1		1	1				1			1			
Skeletal	B75		M MA		1				1			1	1		1			1				1			
Skeletal	B76		F MA		1					1		1	1		1			1				1			
Skeletal	B85		M MA				1			1		0						1				1			
Skeletal	B86		Adolescent		1				1			1	1		1			1				1			
Skeletal	B101		M A		1			1				0						1					1		
Fardo	E21A		Child	1					1			1	1		1			1				No obs			
Fardo	E26B		M YA		1				1			1	1		1			1				No obs			
Fardo	E70		Child		1					1		1		1	1			1				No obs			
Fardo	E76E	A	F YA		1				1			1		1		1			1			No obs			
Fardo	E76H		Child		1					1		1		1	1				1			No obs			
Fardo	E77A		Child			1				1		1		1		1			1			No obs			
Fardo	E77B	A	F MA			1				1		0								1		No obs			
Fardo	E77B	B	M YA		1					1		0							1			No obs			
Fardo	E77C		M YA			1			1			1		1	1				1			No obs			
Fardo	E79		M YA		1				1			0						1				No obs			
Fardo	E81		F MA		1					1		0						1				No obs			
Fardo	E82B		Child			1				1		1	1				1			1		No obs			
Fardo	E82C		M YA		1				1			1		1	1			1				No obs			
Fardo	E82F		M YA			1				1		1	1		1				1			No obs			
Fardo	E82I		M YA			1			1			0								1		No obs			
Fardo	E82J		F YA			1				1		0							1			No obs			
Fardo	E82S		F MA				1				1	1	1				1		1			No obs			
Fardo	E82Y		Child			1				1		0							1			No obs			
Fardo	E84		Adolescent				1				1	1	1			1		1				No obs			
Fardo	E88	A	Child			1				1		1	1			1				1		No obs			
Fardo	Fardo 4		I YA			1				1		1	1			1			1			No obs			
Fardo	Fardo 8		F YA	1						1		0						1				No obs			
Fardo	Fardo 9		M MA			1			1			1		1		1		1				No obs			

Appendix 9 Potential pathological lesions data in the skeletal subsample. 1: presence, 0: absence; F: female, M: male, I: indeterminate; YA: young adult, MA: middle adult, OA: old adult; Mi: mild, Mo: moderate, Se: severe; Ac: active, Hlng: healing, Hld: healed.

			Vault porosities							**Suprainian lesion**				**Periosteal reaction on nuchal crest**						
Entierro	**Individual**	**Cohort**	**No**	**Mi**	**Mo**	**Se**	**Ac**	**Hlng**	**Hld**	**No**	**S**	**Mo**	**Se**	**No**	**Mi**	**Mo**	**Se**	**Ac**	**Hlng**	**Hld**
E05	A	F YA	1							1				1						
E16A	A	I YA	1							1				1						
E16A	B	M A	1							1				1						
E17		M YA				1		1		1					1				1	
E18		M MA	1							1					1				1	
E20	A	Child	1							1				1						
E20	C	Child	1							1				1						
E21A-21B	A	M MA			1			1		1				1						
E25	A	M MA			1			1		1				1						
E28	A	Adolescent			1			1				1		1						
E32		F MA			1			1			1				1					1
E33	A	Adolescent		1					1	1					1				1	
E37	A	M YA	1							1				1						
E41	A	I A			1			1		1				1						
E42	A	I MA	1							1				1						
E43	E	M YA	1							1				1						
E44	A	F A		1				1		1				1						
E45	A	F MA			1			1		1				1						
E45	B	Adolescent			1			1		1				1						
E45	C	Adolescent			1			1		1				1						
E46	A	M A			1			1			1			1						
E48	A	M MA	No obs							1						1				1
E50	B	F MA	1							1				1						
E50	C	F A			1			1		1				1						
E54	D	M A			1			1		1					1					1
E55	A	F YA	1							1				1						

E56	A	M A			1			1		1				1						
E57	A	M MA	1							1				1						
E57	B	M MA	1							1				1						
E58	A	F MA	1							1				1						
E60	B	Child	1							1				1						
E66	A	M MA	1							1				1						
E66	B	I MA	1							1				1						
E67		M YA	1							1				1						
E72		Adolescent	1							1				1						
E74		Adolescent				1		1				1		1						
E82K		Child	1							1				1						
E82X		F YA	No obs							No obs				No obs						
E83	A	I MA			1			1		1				1						
E83	B	M MA			1			1		1				1						
E88A	A	Child				1		1		1				1						
E90B		M MA	1							1				1						
E94	A	M YA			1			1		1					1				1	
E94	D	Child			1			1		1				1						
B15		F YA			1				1	1				1						
B22		M YA			1			1		1				1						
B30		M A		1					1	1				1						
B32		F A	1							1				1						
B42		Adolescent			1				1	1				1						
B56		M MA			1			1		1				1						
B57		F A		1					1	1				1						
B58	A	M YA			1				1	1					1					1
B58	B	F YA			1			1		1				1						
B67		F MA			1			1		1				1						
B70		F YA				1		1		1				1						
B73		M MA		1					1	1				1						
B74		M MA			1				1	1				1						

B75		M MA			1				1	1				1						
B76		F MA				1		1		1				1						
B85		M MA			1				1	1				1						
B86		Adolescent			1				1	1				1						
B101		M A			1				1	1				1						

Appendix 10 Cranial measurements for the MUNA sample.

Subsample	**Entierro**	**Individual**	**Cohort**	**Cranial length**	**Cranial breadth**	**Cranial height**	**Cranial index**	**Frontal chord**	**Parietal chord**	**Occipital chord**
Skeletal	E05	A	F YA	162	136	134	84.0	103.3	92.1	102.6
Skeletal	E16A	A	I YA	157	143	132	91.1	109.7	105.6	93.1
Skeletal	E16A	B	M A	164	135	No obs	82.3	103.9	95.7	No obs
Skeletal	E17		M YA	166	148	134	89.2	108.1	99.4	100.9
Skeletal	E18		M MA	163	143	122	87.7	104.7	102.6	88.7
Skeletal	E20	C	Child	137	141	117	102.9	93.5	No obs	No obs
Skeletal	E21A-21B	A	M MA	176	135	138	76.7	107.1	97.9	100.1
Skeletal	E25	A	M MA	176	141	139	80.1	109.8	99.5	95.1
Skeletal	E28	A	Adolescent	154	142	123	92.2	97.6	95.5	87.1
Skeletal	E32		F MA	169	135	123	79.9	103.5	97.5	105.6
Skeletal	E33	A	Adolescent	157	141	126	89.8	101.5	87.1	104.6
Skeletal	E37	A	M YA	176	138	135	78.4	109.3	97.4	107.5
Skeletal	E41	A	I A	164	135	126	82.3	106.3	98.1	92.2
Skeletal	E42	A	I MA	160	135	120	84.4	99.9	93.7	89.5
Skeletal	E43	E	M YA	165	147	128	89.1	106.2	107.7	82.5
Skeletal	E44	A	F A	149	147	126	98.7	94.7	89.9	100.3
Skeletal	E45	A	F MA	163	147	132	90.2	105.5	90.0	108.3
Skeletal	E45	B	Adolescent	166	163	127	98.2	110.4	109.3	92.5
Skeletal	E45	C	Adolescent	150	137	129	91.3	100.4	No obs	No obs
Skeletal	E46	A	M A	175	141	127	80.6	104.4	103.5	99.1
Skeletal	E48	A	M MA	161	163	124	101.2	109.8	92.7	93.5
Skeletal	E50	B	F MA	160	147	123	91.9	99.2	94.1	107.6
Skeletal	E50	C	F A	151	147	124	97.4	98.8	74.2	89.3
Skeletal	E54	D	M A	168	142	137	84.5	113.7	118.5	93.6
Skeletal	E55	A	F YA	147	141	124	95.9	94.8	102.0	87.4
Skeletal	E56	A	M A	176	159	134	90.3	103.9	104.1	90.4
Skeletal	E57	A	M MA	177	133	141	75.1	113.2	116.2	95.6

Skeletal	E57	B	M MA	162	143	130	88.3	104.5	99.3	97.2
Skeletal	E58	A	F MA	161	160	127	99.4	105.4	102.8	91.3
Skeletal	E66	A	M MA	162	143	134	88.3	104.3	102.6	94.8
Skeletal	E66	B	I MA	172	143	131	83.1	113.2	103.3	98.5
Skeletal	E67		M YA	156	154	129	98.7	109.3	89.9	100.9
Skeletal	E72		Adolescent	153	143	124	93.5	101.5	92.8	96.7
Skeletal	E74		Adolescent	155	140	121	90.3	99.3	91.3	89.9
Skeletal	E83	A	I MA	165	143	130	86.7	111.2	103.3	85.2
Skeletal	E83	B	M MA	178	137	136	77.0	114.3	102.7	90.3
Skeletal	E88A	A	Child	161	141	114	87.6	101.4	93.2	89.1
Skeletal	E94	A	M YA	162	150	134	92.6	102.2	109.2	88.4
Skeletal	E94	D	Child	154	141	125	91.6	101.3	-	-
Skeletal	E82K		Child	160	138	119	86.3	-	88.1	90.1
Skeletal	E82X		F YA	152	132	No obs	86.8	No obs	No obs	No obs
Skeletal	E90B		M MA	159	157	131	98.7	102.0	95.4	103.2
Skeletal	B15		F YA	147	157	114	106.8	93.5	-	-
Skeletal	B22		M YA	172	140	132	81.4	110.8	-	-
Skeletal	B30		M A	172	150	139	87.2	109.5	-	-
Skeletal	B32		F A	159	143	121	89.9	103.3	-	-
Skeletal	B42		Adolescent	150	148	122	98.7	102.3	-	-
Skeletal	B56		M MA	172	136	128	79.1	105.6	-	-
Skeletal	B57		F A	149	154	131	103.4	103.9	-	-
Skeletal	B58	A	M YA	166	No obs	134	-	108.5	-	-
Skeletal	B58	B	F YA	165	No obs	124	-	105.2	-	-
Skeletal	B67		F MA	160	154	130	96.3	108.1	-	-
Skeletal	B70		F YA	146	149	122	102.1	102.1	-	-
Skeletal	B73		M MA	165	128	123	77.6	105.4	-	-
Skeletal	B74		M MA	154	136	127	88.3	103.9	-	-
Skeletal	B75		M MA	151	135	123	89.4	103.3	-	-
Skeletal	B76		F MA	145	145	119	100.0	104.6	-	-

Skeletal	B85		M MA	161	151	129	93.8	107.4	-	-
Skeletal	B86		Adolescent	157	140	130	89.2	103.4	-	-
Skeletal	B101		M A	167	134	136	80.2	105	-	-
Fardo	E21A		Child	159.3	149.3	129.2	93.7	103.4	99.6	98.7
Fardo	E26B		M YA	172.7	144.9	136.0	83.9	106.1	112.0	90.0
Fardo	E76E		F YA	158.0	131.6	126.5	83.3	100.9	98.3	100.2
Fardo	E77A		Child	145.1	141.2	119.8	97.3	101.1	95.9	86.2
Fardo	E77B	A	F MA	161.2	143.3	120.2	88.9	110.0	99.4	90.6
Fardo	E77B	B	M YA	153.4	140.1	123.6	91.4	100.4	92.4	89.6
Fardo	E77C		M YA	175.2	147.8	135.0	84.3	112.9	96.1	107.5
Fardo	E79		M YA	170.3	145.4	130.6	85.4	105.6	93.1	104.7
Fardo	E81		F MA	163.2	144.0	128.6	88.2	108.2	105.8	97.5
Fardo	E82B		Child	151.1	153.8	126.4	101.8	101.4	90.5	104.0
Fardo	E82C		M YA	164.1	151.5	130.9	92.3	105.3	94.6	110.5
Fardo	E82F		M YA	172.4	153.4	135.9	89.0	109.8	105.5	99.8
Fardo	E82I		M YA	170.0	151.0	131.1	88.8	109.0	93.4	109.3
Fardo	E82J		F YA	154.5	147.8	118.7	95.6	100.8	90.8	89.6
Fardo	E82S		F MA	149.4	154.2	123.8	103.2	98.0	89.5	99.1
Fardo	E82Y		Child	158.2	143.0	123.3	90.4	97.2	107.9	92.3
Fardo	E84		Adolescent	132.1	146.3	131.9	110.7	97.1	87.9	95.7
Fardo	E88	A	Child	132.9	136.5	No obs	102.7	88.9	84.6	78.0
Fardo	Fardo 4		I YA	162.5	155.0	143.1	95.3	111.1	105.6	95.1
Fardo	Fardo 8		F YA	161.4	142.1	133.0	88.0	110.0	92.8	103.7
Fardo	Fardo 9		M MA	160.8	143.8	139.4	89.4	110.7	102.4	92.3

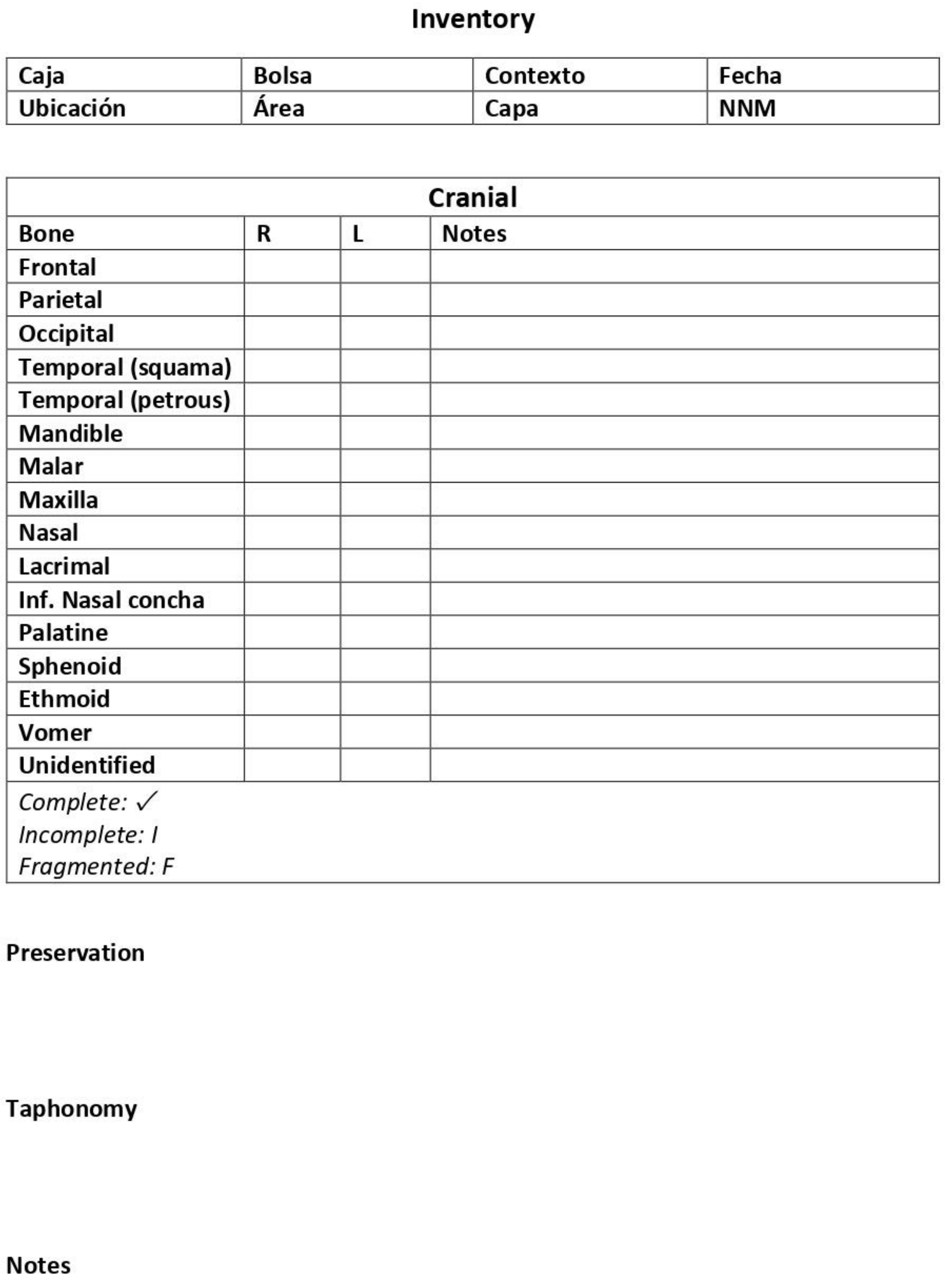
Appendix 11 Dental pathology data for the MUNA sample.

				Caries					AMTL	Abscesses	Dental wear			Dental calculus
Subsample	**Entierro**	**Individual**	**Cohort**	**Maxilla (n)**	**Total maxilla (N)**	**Mandible (n)**	**Total mandible (N)**	**Total caries (n)**			**Mild**	**Moderate**	**Severe**	**P/A**
Skeletal	E05	A	F YA	2	11	No obs	No obs	5	2	0	0	1	0	1
Skeletal	E13	B	I MA	3	8	1	6	4	4	1	0	1	0	1
Skeletal	E16A	A	I YA	0	4	No obs	No obs	0	0	0	0	1	0	0
Skeletal	E16A	B	M A	No obs	No obs	No obs	No obs	0	7	1	No obs	No obs	No obs	No obs
Skeletal	E17		M YA	0	7	No obs	No obs	0	0	0	0	1	0	0
Skeletal	E18		M MA	2	3	4	7	6	12	5	0	0	1	1
Skeletal	E21A-21B	A	M MA	0	0	2	9	3	12	4	0	1	0	1
Skeletal	E25	A	M MA	1	7	No obs	No obs	1	2	0	0	1	0	0
Skeletal	E32		F MA	1	2	No obs	No obs	1	2	1	0	0	1	1
Skeletal	E36	A	I A	No obs	No obs	1	3	1	4	0	0	0	1	1
Skeletal	E36	B	I A	No obs	No obs	1	8	1	0	0	0	1	0	1
Skeletal	E36	C	I A	No obs	No obs	3	4	5	5	0	0	1	0	1
Skeletal	E37	A	M YA	1	14	2	13	4	0	0	0	1	0	1
Skeletal	E41	A	I A	1	1	No obs	No obs	1	6	0	No obs	No obs	No obs	No obs
Skeletal	E41	B	I YA	No obs	No obs	2	13	2	0	0	0	1	0	1
Skeletal	E42	A	I MA	6	12	No obs	No obs	6	3	1	0	0	1	0
Skeletal	E43	E	M YA	3	9	No obs	No obs	4	0	0	0	1	0	1
Skeletal	E44	A	F A	0	0	No obs	No obs	0	4	0	No obs	No obs	No obs	No obs
Skeletal	E45	A	F MA	0	2	No obs	No obs	0	7	2	0	0	1	1
Skeletal	E46	A	M A	0	0	No obs	No obs	0	9	0	No obs	No obs	No obs	No obs
Skeletal	E48	A	M MA	1	10	No obs	No obs	1	0	1	0	1	0	1
Skeletal	E48	B	I YA	No obs	No obs	2	15	2	0	0	0	1	0	1
Skeletal	E50	A	M A	0	2	No obs	No obs	0	10	2	0	0	1	1
Skeletal	E50	B	F MA	4	6	0	4	4	1	0	0	0	1	1
Skeletal	E50	C	F A	0	0	No obs	No obs	0	11	0	No obs	No obs	No obs	No obs

Skeletal	E54	D	M A	0	1	No obs	No obs	0	9	2	0	0	1	0
Skeletal	E55	A	F YA	0	7	No obs	No obs	0	0	0	0	1	0	1
Skeletal	E55	B	I YA	No obs	No obs	0	7	0	1	2	0	1	0	1
Skeletal	E56	A	M A	0	0	No obs	No obs	0	16	0	No obs	No obs	No obs	No obs
Skeletal	E57	A	M MA	5	8	No obs	No obs	6	3	4	0	0	1	1
Skeletal	E57	B	M MA	6	12	No obs	No obs	6	1	0	0	1	0	1
Skeletal	E58	A	F MA	2	3	No obs	No obs	2	5	0	0	0	1	1
Skeletal	E58	B	I MA	5	11	1	2	8	1	2	0	1	0	1
Skeletal	E66	A	M MA	1	12	No obs	No obs	1	0	0	0	1	0	1
Skeletal	E66	B	I MA	0	6	No obs	No obs	0	0	0	0	0	1	1
Skeletal	E67		M YA	1	9	No obs	No obs	1	0	0	1	0	0	0
Skeletal	E83	A	I MA	1	7	No obs	No obs	1	0	0	0	1	0	1
Skeletal	E83	B	M MA	3	6	No obs	No obs	3	2	3	0	0	1	0
Skeletal	E94	A	M YA	2	10	3	6	5	4	2	0	1	0	1
Skeletal	E82X		F YA	4	16	2	11	6	3	0	0	1	0	1
Skeletal	E90A	Mandible	I MA	No obs	No obs	3	10	3	3	1	0	1	0	1
Skeletal	E90B		M MA	1	1	0	1	1	5	5	No obs	No obs	No obs	1
Fardo	E26B		M YA	4	13	2	16	7	3	0	0	1	0	0
Fardo	E76E		F YA	7	9	2	12	10	6	0	0	1	0	0
Fardo	E77B	A	F MA	2	2	No obs	No obs	2	12	5	No obs	No obs	No obs	No obs
Fardo	E77B	B	M YA	3	5	1	1	4	13	4	0	1	0	0
Fardo	E77C		M YA	4	12	3	11	7	1	0	0	1	0	0
Fardo	E79		M YA	1	15	1	12	2	3	0	0	1	0	0
Fardo	E81		F MA	2	13	0	15	2	0	0	0	1	0	0
Fardo	E82C		M YA	1	9	1	12	2	8	2	0	0	1	1
Fardo	E82F		M YA	2	12	2	15	4	1	4	1	0	0	1
Fardo	E82I		M YA	7	13	No obs	No obs	8	1	0	0	0	1	0
Fardo	E82J		F YA	1	13	0	16	1	1	0	0	1	0	0
Fardo	E82S		F MA	2	11	4	14	6	3	1	0	1	0	0
Fardo	Fardo 4		I YA	2	12	4	15	7	3	1	0	1	0	0

Fardo	Fardo 8		F YA	0	5	2	3	2	0	0	1	0	0	0
Fardo	Fardo 9		M MA	0	10	3	12	3	7	2	0	0	1	0

Appendix 12 Recording sheets used for this thesis.



Inventory

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**

Cranial

Bone	**R**	**L**	**Notes**
Frontal			
Parietal			
Occipital			
Temporal (squama)			
Temporal (petrous)			
Mandible			
Malar			
Maxilla			
Nasal			
Lacrimal			
Inf. Nasal concha			
Palatine			
Sphenoid			
Ethmoid			
Vomer			
Unidentified			

Complete: ✓
Incomplete: I
Fragmented: F

Preservation

Taphonomy

Notes

Adult biological profile

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**

Sex		
Cranial	**R**	**L**
Nuchal crest		
Mastoid process		
Supraorbital margin		
Glabella		
Mental eminence		
Sex		

Pelvis	**R**	**L**
Ventral arch		
Subpubic concavity		
Ischiopubic ramus		
Greater sciatic notch		
Preauricular sulcus		
Sex		

Age		
Dental wear	**Maxilla**	**Mandible**
Phase		
Age		

Pelvis	**R**	**L**
Pubic Symphysis		
Auricular surface		
Age		

4th rib		
Phase		
Age		

SEX
AGE

Cranial modification

Notes

Non-adult biological profile

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**

Age

Dental development

Method	Range	Notes
Ubelaker		
Gaither		

Skeletal development

Bone	Trait	Age

Notes

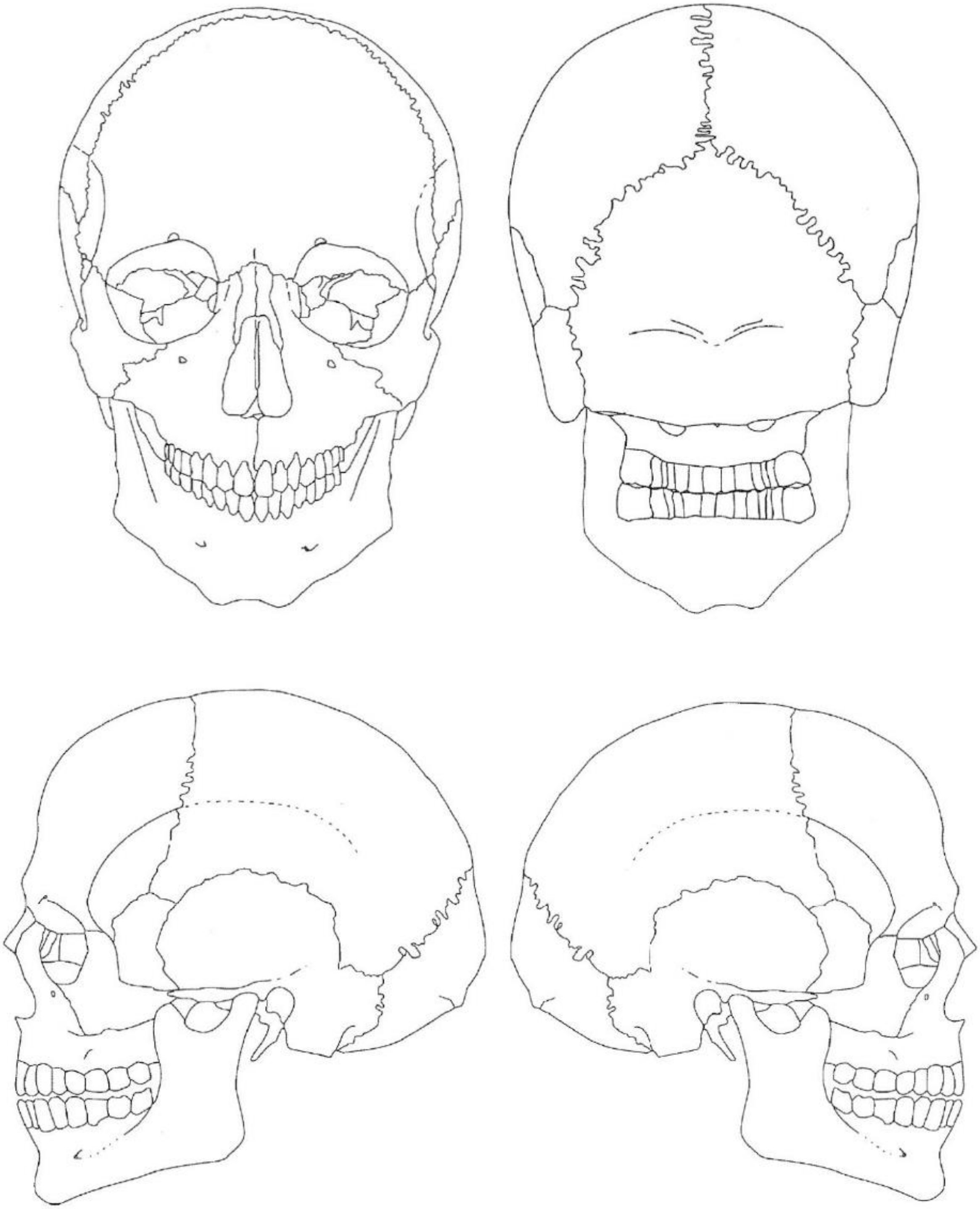
Craniofacial measurements

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**

Measurements (Buikstra & Ubelaker, 1994)		**mm**	**Notes**
1	Maximum cranial length (g-op)		
2	Maximum cranial breath (eu-eu)		
3	Bizygomatic diameter (zy-zy)		
4	Basion-bregma height (ba-b)		
5	Cranial base length (ba-n)		
6	Basion-prosthion length (ba-pr)		
7	Maxillo-alveolar breath (ecm-ecm)		
8	Maxillo-alveolar length (pr-alv)		
9	Biauricular breath (au-au)		
10	Upper facial height (n-pr)		
11	Minimum frontal breath (ft-ft)		
12	Upper facial breath (fmt-fmt)		
13	Nasal height (n-ns)		
14	Nasal breath (al-al)		
15	Orbital breath (d-ec)		
16	Orbital height		
17	Biorbital breath (ec-ec)		
18	Interorbital breath (d-d)		
19	Frontal chord (n-b)		
20	Parietal chord (b-l)		
21	Occipital chord (l-o)		
22	Foramen magnum length (ba-o)		
23	Foramen magnum breath		
24	Mastoid length		
25	Chin height (id-gn)		
26	Height of the mandibular body		
27	Breadth of the mandibular body		
28	Bigonial width (go-go)		
29	Bicondylar breadth (cdl-cdl)		
30	Minimum ramus breadth		
31	Maximum ramus breadth		
32	Maximum ramus height		
33	Mandibular length		
34	Mandibular angle		

Adult crania and mandible

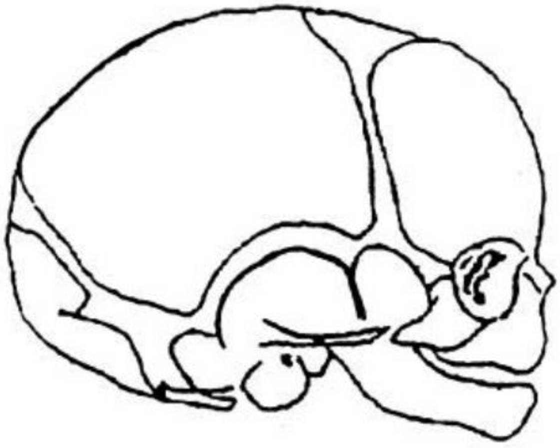
Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**

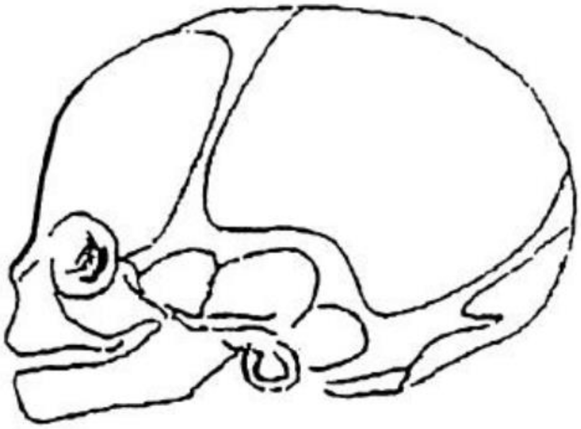


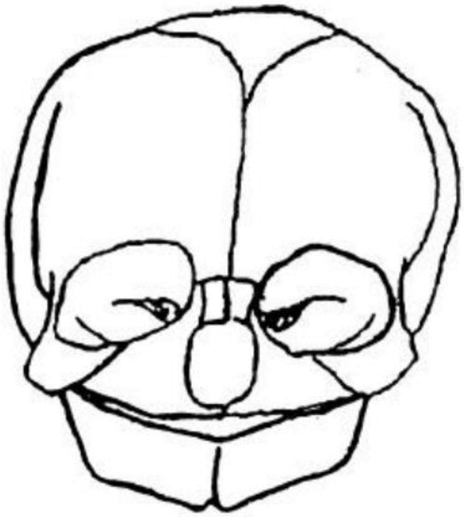
Adapted from Standards for data collection from human remains by Buikstra and Ubelaker

Non-adult crania and mandible

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**



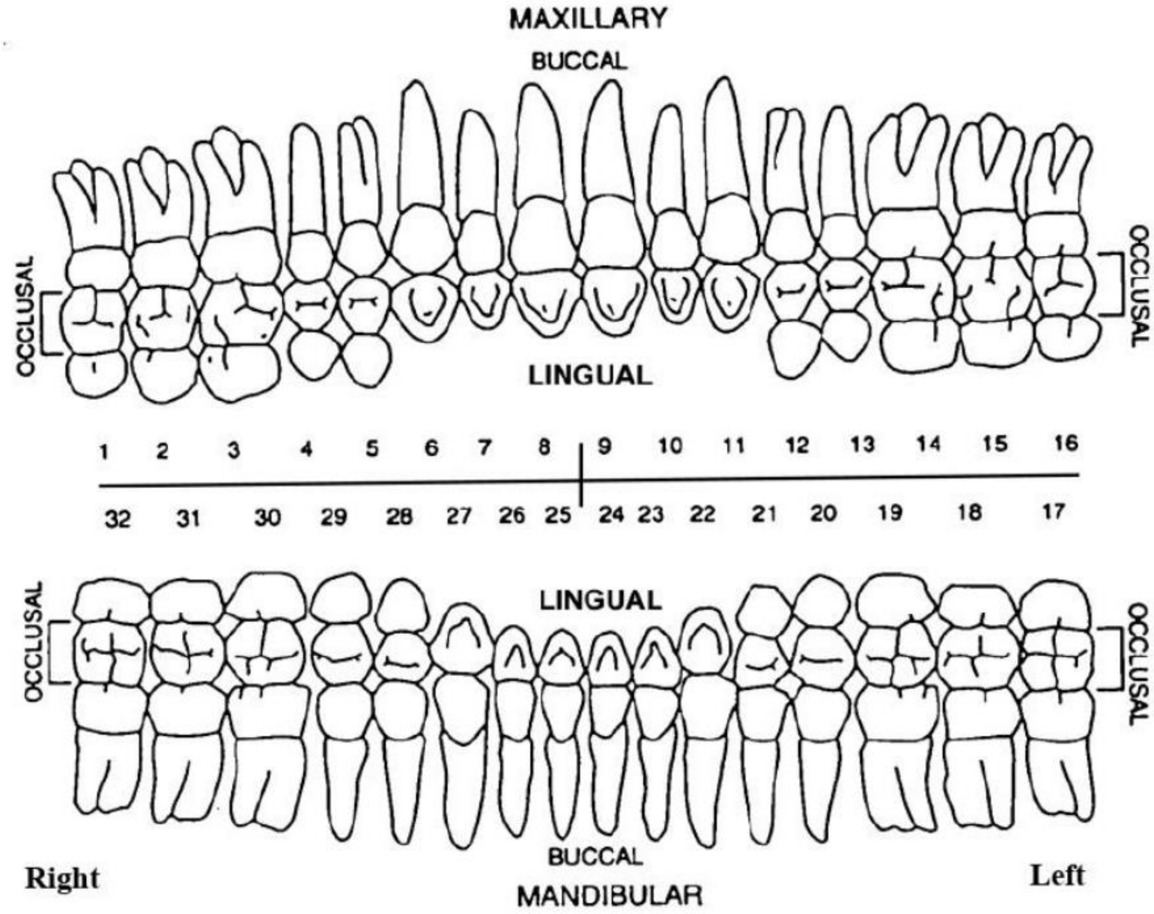




Adapted from Guidelines to the Standards for Recording Human Remains by Megan Brickley and Jacqueline I McKinley

Adult dental pathology

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**



✓ Present	X PM loss	/ ATL	# Not erupted
/// Fragmented			
Caries	Calculus	Dental wear	PBL

Calculus

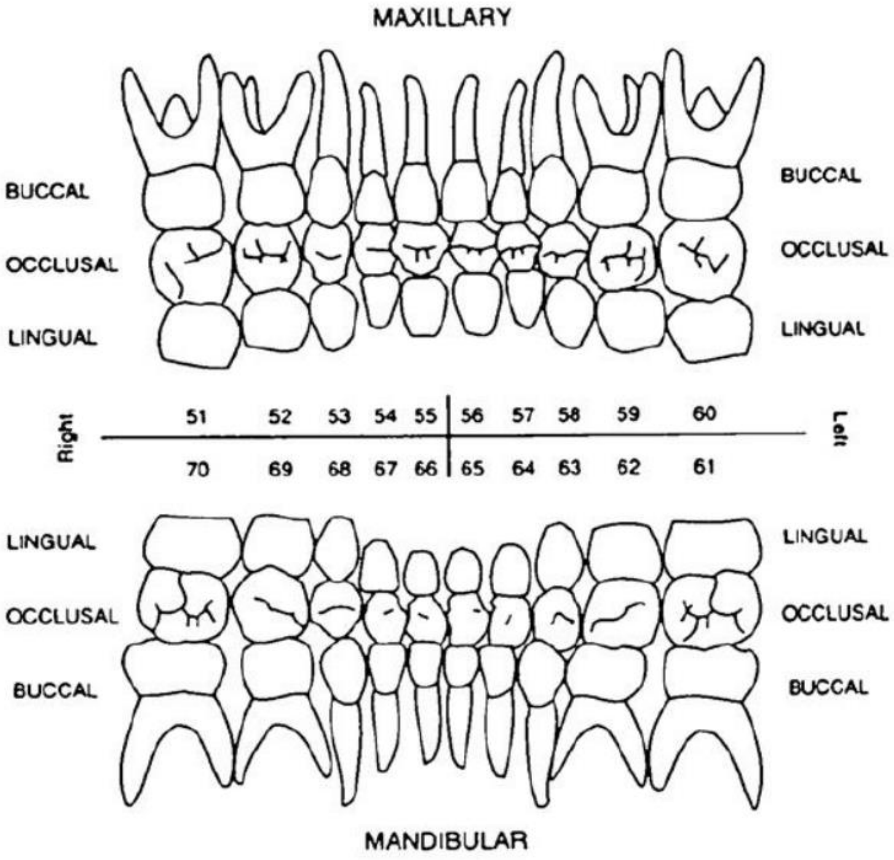
Dental wear

Notes

Adapted from the Arizona State Museum Human Remains Documentation Packet

Non-adult dental pathology

Caja	**Bolsa**	**Contexto**	**Fecha**
Ubicación	**Área**	**Capa**	**NNM**



✓ Present	X PM loss	/ ATL	# Not erupted
/// Fragmented			
Caries	Calculus	Dental wear	PBL

Calculus

Dental wear

Notes

Adapted from the Arizona State Museum Human Remains Documentation Packet

Curriculum Vitae

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Post-secondary Education and Degrees:	Universidad Peruana Cayetano Heredia Lima, Perú 2013-2018 B.Sc.
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	Henry Bogal-Szot Graduate Anthropology Fieldwork Award 2022
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Publications:
Rutherford, I., Nakahodo, N., Holland, S., Ward, A., Agoston, Z., Alvarez, J. (2023). Frankenstein's Journal: Introducing the Reanimated University of Western Ontario Journal of Anthropology. *The University of Western Ontario Journal of Anthropology*. DOI: https://doi.org/10.5206/uwoja.v25i1.16315.

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Nelson, A., Motley, J., Watson, L., Williams, J., Poeta, L., Ward, A., Nakahodo, N., Woodley, K., Kirgis, P., Fuentes, S. and Pozzi-Escot, D. (2022). Old school – new school – radiological imaging of funerary bundles from Peru. Podium presentation to the *49th in person annual meeting of the Canadian Association for Biological Anthropology*, Saskatoon, SK, October 2022.

Nelson, A.J. editor, Durham, S., Nakahodo, N., Stephens, N., Ward, A. & Woldum, K. (2022). Living Connections with the Dead: An Anthropological Exploration of Relics Cared for by the Roman Catholic Diocese, London, Ontario. Group project for the Mortuary Archaeology Course. The Catholic tradition of relics and the analysis of relics from the Roman Catholic Diocese of London. https://ir.lib.uwo.ca/archaeology_ebooks/3/