# EVIDENCE FOR COMMUNAL LABOR DURING THE INTEGRATION PERIOD AT URCUQUI, ECUADOR

by

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A thesis submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Master of Arts in
Anthropology

Charlotte

2024

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# ABSTRACT

TAYLOR RECUERO. Evidence for communal labor during the Integration Period at Urcuquí, Ecuador. (Under the direction of DR. SARA JUENGST)

The study of labor related diseases provides bioarchaeologists with the ability to try to better understand the social structure of a past community. In this study, I will present findings on a sample of 33 individuals from Urcuquí, Ecuador from the Integration Period (), to gain a better understanding of how much labor affected the people. To do so, I will evaluate labor-related pathologies, general pathologies, demographic information (age and sex), and any signs of trauma. This research leads to insight into the heterarchical and hierarchical nature of the Urcuquí, and how the people shared labor and reduced their own individual burdens. The data found that the rates of pathologies at Urcuquí were similar to other farming communities and across the sample support the idea of communal labor.

# ACKNOWLEDGEMENTS

To begin, I would like to thank my advisor Dr. Sara Juengst for everything you have done for me. Without your encouragement and support I would not have felt so confident throughout this whole process. To my committee member Dr. Dennis Ogburn, for teaching me about the chroniclers whose work illustrated my study area. To my committee member Dr. María Ordoñez Alverez for opening your lab at the Universidad de San Francisco de Quito to me, for allowing me access to this amazing collection, and for recruiting help from your students for my time in the lab. None of the work I did would have been possible without all the help and support you have given me. I would also like to thank the Kathy Reichs Scholarship and the UNC Charlotte Department of Anthropology for financially helping me to be able to stay in Ecuador for the month I was gone to do my data collection.

To Blue for traveling with me to Quito and staying in the lab with me every day to assist me with whatever I needed that day. Your help and companionship throughout the month were invaluable in allowing me to get my work done. To Mara for helping me get set up and always offering encouragement in Ecuador. To Marti for being in the lab as often as you were, helping me to adjust to living in Quito for the time, and always helping us find good food for lunch. To Dominica and all the Universidad de San Francisco de Quito students who came to the lab to help clean the remains, I would not have gotten through as many individuals without your preparatory help speeding the process along.

To my undergraduate advisor Dr Alexandra Klales for teaching me all the techniques I used for research, and my undergraduate research mentor Dr. Ashley Maxwell for supporting me while even I procrastinate on writing our paper because of my thesis.

To my family, Mom, Dad, Rachel, and the extended family for supporting me moving around the states every few years to chase degrees and helping me to plan my summer in Ecuador.

To Blue, Connor, India, Kristen, Matt, Zeke, Strick, Brice, and Mozelle for being incredibly supportive friends and the best graduate co-hort, showing up to my defense, and always listening to me complain about my problems that I might have caused myself. I hope we all stay colleagues and friends after graduation.

# DEDICATION

This thesis is dedicated to everyone who helped me through my academic journey.

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# LIST OF ABBREVIATIONS

OA: Osteoarthritis

EC: Entheseal Changes

OT: Other pathologies

LEH: Linear Enamel Hypoplasia

ICM: Intentional Cranial Modification

TOS: Thoracic Outlet Syndrome

IND: Indeterminate

USFQ: Universidad de San Francisco de Quito

# CHAPTER 1: INTRODUCTION

Ecuador is historically underrepresented in archaeological research when compared to the rest of South America. However, through the contribution of private and national institutions there has been an increase in research done into the country's past. The history of archaeological research can be broken into three time periods. The oldest period (1850-1945) focused on descriptive archaeology which was characterized by the beginning of the field and the creation of the techniques. Next, the middle period (1945-1970) focused on descriptive-interpretive archaeology in which there were innovations in the theoretical and technical techniques used. The current period (1970-present) focused on interpretive archaeology. It was during this time that archaeology became professionalized, both in discipline and technique (Sebastian Gallegos Aguilar, 2020).

There has not been as much information collected from the highland sites because of the gap in research done in the area. The oldest known research into the area was done around 1889 by Federico Gonzales Suárez, the next notable research was not completed until about 20 years later in 1909 (Sebastian Gallegos Aguilar, 2020). It was during the second period of investigations that the archaeologist Jijón y Caamaño (1952) called the northern Ecuadorian Andes "Caranqui Country", later changed to Pais Caranqui. The Pais Caranqui was an ecologically and politically rich area that developed intensely over time. Within Pais Caranqui lays the modern city and archaeological site of Urcuquí. The site in particular falls into the date range of 500AD - 1500AD and is located north of modern-day Quito. The site of Urcuquí in highland Ecuador has been studied briefly with only a few bioarchaeological reports having been published about the region. In 2014, the Yachay City of Knowledge project, Figure 1, was created and later began construction. During construction, archaeological remains were recovered for conservation and study by the Yachay EP Public Company (Sebastian Gallegos Aguilar, 2020). The sample that I studied came from these excavations.

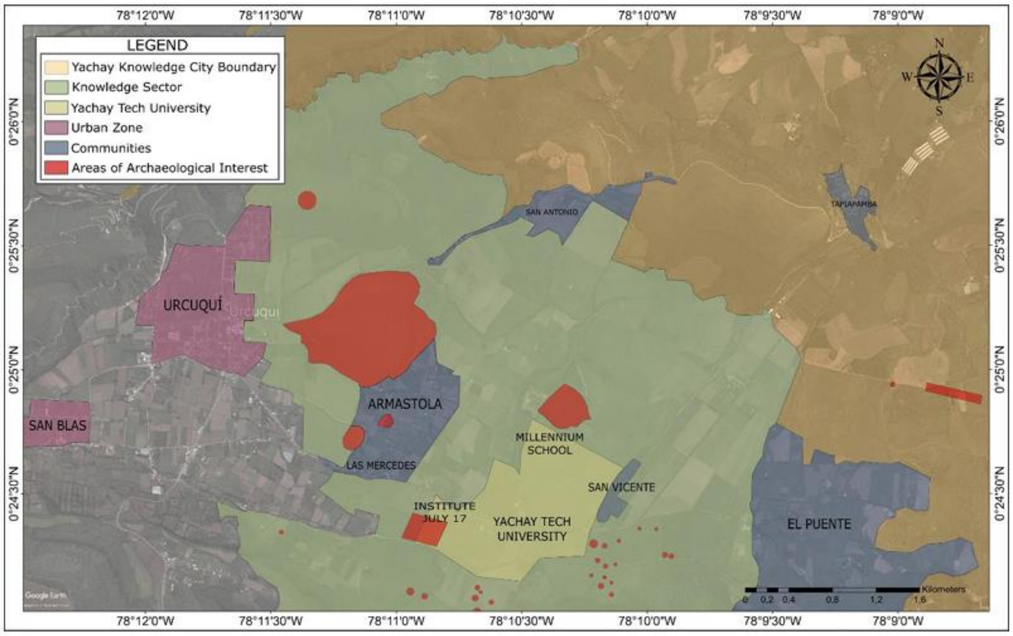


**Figure 1**. Location map of Yachay City of Knowledge and archaeological sites of interest from Sebastian Gallegos Aguilar, 2020.

Working with Universidad de San Francisco de Quito, I investigated if there were signs of shared labor burden and care across the collection of excavated remains that have not yet been studied. The methodology used for data collection was skeletal analysis of the human remains for demographics, diseases, trauma, and labor related physical changes. This data also shed light on the development of hierarchy or heterarchy at the site. This new information adds to the growing knowledge of settlement organizations research done in the highlands of Ecuador. At this site, there are still many unknowns. For example, we do not know if and how labor was shared among the adults, or how much labor was affecting the bodies of the people, subjects which this paper is looking to provide some context to.

# CHAPTER 2: ECUADORIAN ANDEAN CHRONOLOGY

As a standard, the chronology created by Meggers (1966) is used in this research (Table 1). This chronology is widely used by archaeologists in Ecuador and divides the past into a teleological scheme that indicates progression from mobile hunter-gatherers in the Archaic Period to "complex" communities in the Integration Period. Modifications and objections to this chronology exist (Zeidler, 1998), but this is still the most used framework.

**Table 1**. Chronology of the Highlands from Valdez (2008) and Meggers (1966)

| Year | Period | N. Highlands Cultural Phase | C. / S. Highlands Cultural Phase |
|---|---|---|---|
| 1460 CE | Inca | | |
| 500 CE | Integration | Negativo<br>Carchi<br>Tuza / Capuli<br>Cochasqui (Cuasmal Piartal)<br>Chaupicruz | Caranquí<br>Panzaleo / Cosanga<br>Puruha<br>Tuncahuan<br>Cañar (Cashaloma)<br>Tacalshapa |
| 500 BCE | Regional Development | La Florida | Cerro Narrio II |
| 1500 BCE | Late Formative | La Chimba | Cerro Narrio I<br>Chaullabamba |
| 2000 BCE | Middle Formative | Cotocollao | Alausi |

## *2.1 The Formative Period*

The Formative Period lasted from 4,400 BCE until 300 BCE (Zeidler, 2008). During the Formative period, Ecuadorian settlements seemed to become permanent instead of transient.

Unfortunately, because of a lack of preservation, it is unclear exactly when the shift occurred. However, the sedentism process in highland Ecuador seems to have happened later than on the coast. In any case, though the exact timing of sedentism in this area cannot be fully determined, there are known sedentary sites that can be studied. The Formative period in Ecuador can generally be described as a period in which a group of specific traits developed in societies from Archaic antecedents. These traits were "sedentism, reliance of maize and/or manioc agricultural production, ceramics, polished stone tools, and handmade figurines…" (Zeidler, 2008, p.459). These new traits are like a Raymond (2008) theory that sedentism can generally be identified by the development of agricultural fields and ceramic patterning. Other defining Andean characteristics are the agricultural fields, consistent ceramic styles that show development into a set of patterns, and low populations that seem somewhat spread across the shared landscape. Each household was likely responsible for their own agricultural production, so the settlements were dispersed around the region. However, the existence of non-household architecture shows that there was some level of ceremonial gathering among the separate households of the time (Martin, 2010).

As settlement size grew, political economies likely elaborated, as the population became less dispersed across the landscape. This time frame is believed to be when the political economies began to develop in the area as the elites in society would begin to identify themselves and look to consolidate more power. Individuals who could harness labor or gain ritual control may have begun to establish themselves in this time. These elites would most likely arise via control over the best land for agricultural production or through the creation or import of important rituals/ritualistic objects. Trade relations between the separate geographical areas in Ecuador were established most likely in the Early Formative period for utilitarianism and symbolic reasons. Trade would have been important for access to both symbolic and commonly used goods (Valdez, 2008). The symbolic items would have included the marine shell (*Spondylus*), which is common in coastal sites and has been excavated from most highland and inland sites, showing a shared importance across cultural and geographic area. The *Spondylus* is a genus of the thorny oyster. This bivalve is brightly colored and large and was generally used to make ornaments such as beads. Because of its notoriety, the shell was used frequently in religious ceremonies and was very important in the development of trade routes (Bray, 2008a). The inhabitants of the highlands also held the shell in high regard and would partake in a long-distance trade to ensure that it was available in their inland territories (Zeidler, 2008). For utilitarian purposes, obsidian, salt, and other food trade routes have been long established from the highlands to the coastal settlements (Valdez, 2008).

### *2.2 The Regional Development Period*

The Regional Development period followed the Formative period, from about 500 BCE until 500 CE (Masucci, 2008). This new period is generally characterized by the rise of regional styles in ceramics and art that allow for better separation of the cultural groups at the known urban centers. As the cultural groups of the highlands had more contact with one another, they began to centralize their own areas, while differentiating themselves from the other cultural groups in the area. The variation in the groups of the different cultural areas can be attributed to a combination of the environment, trade, competition, and conflict. The growing networks produced by the *spondylus* shell trade worked as a backdrop for the increasing artifact and craft specializations. The new ceramic statues that were created across Ecuador at this time often depicted individuals who seemed to be of high rank, as they were generally adorned with elaborate jewelry and headdresses (Masucci, 2008). The changes in the figurines show a society where social rank was recognized.

### *2.3 The Integration Period*

The next period, from around 500 until 1500 CE was the Integration Period (Ramos, 1993). This period is characterized by growing populations and social stratification in the early phases. The later phases are defined by the conquering of the native Ecuador groups by the Inca empire in the highlands. The growing population expended time and resources to adapt and modify their environments, which resulted in more monumental architecture. There was also an increase in craft specialization, with an increase in metallurgy and textile production, while ceramics became more standardized for mass production. These trends are also the result of the increase in economic reliance on trade across the country (Ramos, 1993).

A major change that occurred in the Integration Period is the development of regional chiefdoms. Archaeologists have worked to develop a definition of a chiefdom based on various societal aspects. Generally, Drennan (1995) defined chiefdoms as “the story of the emergence of substantial inequality, but it has a number of other aspects as well, such as spatial and demographic scale, centralization, economic specialization, exchange, supralocal political organization, and others” (pg.304). The development of a chiefdom can and may look different for each region, or even every chiefdom. Because of this variation, all aspects of a chiefdom should be considered when deciding to label a past society as one. These traits are warfare, agricultural production, centralized storage, local exchange and long-distance exchange, elite burial practices, political instability, and feasting (Drennan 1995 & Yanchar 2013). Not all these traits will be visible in every society, but a combination of some in the same society during a period of development can lead to archaeologists labeling the society a chiefdom. Previous research in Ecuador shows that the chiefdoms may have been smaller in scale, but that they were also highly centralized (Yanchar 2013).

Chiefdoms developed over time in Ecuador, from “big-man societies” (Drennan, 1995). A “big-man society” is somewhat like a chiefdom in which there are aspects of a chiefdom present in the society, but they do not allow one human to have a continuous control of the social hierarchy. Once the person looking for control can solidify their power to a hereditary point, they are a chief (Drennan 1995). The chiefs could gain their authority through economic control of resources considered essential to the community, control of prestige items, or the creation of debt to the aspiring elite within society. This authority can also be achieved through the manipulation of ritual power within a society who will turn to the chief for stability, such as the building of monuments or earthworks. The trade of items with high ritual significance combines these two types of strategies, so control of these items would be most sought after for the elites. Chiefs would attempt to gain followers through ritual feasting, which would also work as a social debt for the food and drink the chief provided. This manipulation would allow them to gain cheap labor and continue the cycle of feasting and labor from the community (Ramos, 1993). The chiefs would also work to retain their authority once achieved by trading the prestige items with neighboring powerful elites, meaning the creation of trade routes were important to the eventual growth of the chiefdoms.

Northern highland Ecuadorian chiefdoms were regularly built through long-distance trade and control of exotic items. This resulted in the specialization of the *mindaláes*, or “a person authorized to operate extraterritorially as a politically sponsored long-distance trader” (Salomon, 1987, p.65). The native lords used *mindaláes* to conduct trade, so the traders received special treatment and a higher status in the community. They were able to pay lower tributes to their lords and were also generally exempt from collective labor as well. Because of their connections to the lords' authority, the *mindaláe*s held a political role in the important process of redistribution. The chiefdoms had long relied on both specialization and redistribution as sources of authority. The chief needed a good relationship with the traders to provide their communities with the essential non-local subsistence goods. The exotic wealth goods were also used in social and political transactions between the chiefs to demonstrate their similar authority over trade. The more wealth the chief had, the more they could manipulate those outside their community to expand the area in which they had power (Salomon, 1986). The chiefs within an area, such as the northern highlands, could have similar social and cultural structures for their chiefdoms. This is true for the Caranqui polity, which was composed of multiple chiefdoms.

### *2.4 The Pais Caranqui Polity*

The Pais Caranqui (Figure 2) was a political region in the northern highlands of Ecuador. This region relied on natural boundaries to delineate the different territories that were found throughout northern Ecuador. However, the boundaries were somewhat malleable, as it has been found that even the sites and chiefdoms outside of the Pais Caranqui may have been settled by Caranqui people, based on similarities of cultural material. The northern and southern boundaries were generally defined by rivers; the Rio Chota-Mira was on the northern border while the Rio Guayllabamba was on the southern border. The southern border was directly north of modern Quito. The Cordillera Real and the Cordillera Occidental formed the east and west boundaries of the Pais Carnaqui generally. The east could also be defined by the Rio Pisque.


**Figure 2**. Map of Ecuador indicating the approximate location of the Pais Caranqui from Yanchar (2013).

Within these boundaries, the people during Integration Period had a high degree of cultural homogeneity, expressed through a mother language, ceramic patterning, artistic traditions, technological expertise, and uniformity in earthen mound styles. However, despite the shared cultural expression, the region was made up of distinct political units (Ramos, 1993). The Pais Caranqui during the Integration period consisted of four important chiefdoms: the Caranqui, Otavalo, Cayambe, and Cochasqui. At this time, the population was close to 45,000 people, with certain people holding high status acting as political authorities. “The head of the most important *llacta* (community) would typically have been recognized as the head of the *cacicazgo* (chiefdom)” (Bray, 2008, p.530). There were complex social networks designed by those in authority to maintain their power over the communities.

The main forces that chiefdoms generally operate under are warfare, agricultural production, centralized storage, local exchange, long distance trade, and demographic growth (Drennan, 1995). For warfare, since land is usually limited, fighting may be necessary to grow the chiefdom. As populations grow, there is a higher need for land, which may cause some chiefs to look to other chiefdoms to see if they could fight for more area (Yanchar, 2013). Within the northern highlands of Ecuador, there is not much archaeological evidence for warfare between neighboring chiefs. However, this does not mean that there was no tension between the chiefdoms, just that the tension was dealt with politically and socially instead (Ramos, 1993). The chiefdoms did compete with one another, however they maintained similar levels of power most likely because of the varying ecological environments. When groups are in different ecological niches, their goods are more desirable to the other groups, and the other groups’ goods are more desirable to them. This equal exchange of non-local goods creates a power balance that forces a less stratified regional system. Instead, stratification may occur within the groups themselves to establish control over the production and distribution of the valued goods to go to the outsiders (Yanchar, 2013).

This combination of stratification strategies is not uncommon throughout Andean societies. Many societies have small scale but complex stratification in their organization. The political and economic structures would be highly complex, but the society would be largely decentralized in nature. There is not a clear power or hierarchy over the territory that would cause differential access to resources or exclusion from prestige goods to the others of similar status who were in a different culture (Bray, 2008). Four social classes have been found in the Pais Caranqui. These include the paramount chief, an intermediate chief class of lesser lords, a commoner class, and a class of *mindaláes.* The *mindaláes*, however, were not considered to be low class, they were somewhere between the commoners and the intermediate chiefs, as they allowed the area to have access to prestige and foreign goods.

For the Pais Caranqui area, trade networks laid the political footwork for power and control. The goods that were associated with areas outside the *llacta* were controlled by the *mindaláes* and other specialized trades, such as hunters. The exotic goods from the coasts or farther areas that were not necessary for consumption but added value to food, such as salt or specialized peppers, were controlled by whoever had access to the trade routes. The last category of goods is those that are considered portable, valuable, and exotic, such as personal adornment. The distribution of these goods was controlled by the elites who had the funds to purchase them (Salomon, 1986). Since the people were the ones doing the labor, the chief may have maintained control by controlling the knowledge or other non-material resources that were essential to the culture, by controlling prestige items, or by creating a debt.  These types of control were more psychological, but they would allow the chief to maintain power without having to take part in the general labor (Ramos, 1993).

The chiefs recognized that they would need to interact with the other elites to maintain status, so people developed traditions to help with economic and social power structures. These traditions included exogamy, child exchange, slave capture, institutionalized trade, and sponsoring of *mindaláes* to move exotic goods to and from their households (Yanchar, 2013).

The people of this region also began using monumental earthworks in religious ceremonies, which would benefit the chief by asserting their status and authority over the other people.

During the Integration period, but prior to the Inca, the Pais Caranqui's political and economic organizations developed more complexity; however, there was not a regional hierarchy. Because of this, each chief's authority rested solely on their number of citizens, while having no strong differentiation in power to the other chiefs in the area because of limited interactions between the chiefdoms (Yanchar, 2013).  While there is evidence for social stratification, such that there were elites and chiefs, the overall social organization of the territory was largely non-stratified because the people controlled their own access to necessities and general trade items. In Pais Caranqui, excavations have revealed little evidence that economic specialization was apparent, except for the production of coca, salt, and cotton (Bray, 2008 & Athens, 1992). Generally, the excavated materials point to each social unit producing their own crafts and other materials to meet the needs of the people in their households. In this way, the people retained their shared internal social identity, while in close contact with the other chiefdoms around the territory. Even access to non-local products seems to have been managed by the household, except for prestigious goods, which were privileged rights given to the chiefs before the common people. Because of this internal reliance, the communities shared a mother language, but not much else. Not one site dominated the others, even if they were in a better production zone.

# CHAPTER 3: LABOR TYPES OF THE PAIS CARANQUI

The physical landscape was important for chiefs to maintain control over their people. Because of how the Pais Caranqui chiefdoms were set up, the chief would need to rely on control over labor and production to control the people. They needed people working for them because land work was important to political power in that the production would provide economic stability for the community and chief.

## *3.1 Agriculture*

In the highlands, people practiced raised-field agriculture with irrigation systems. These fields were maintained with foot plows and controlled by small groups who oversaw large plots of land while working together. The economy was highly reliant on agriculture and people carried out three annual harvests. According to European chroniclers (Guaman Poma, 2009), agriculture was driven by foot-plows (Figure 3): a farming implement that is used to prepare fields for seeding using the heel of the foot. The four stages of the agricultural process were sowing, weeding, fertilizing and hilling (creating small ridges around the crops (Andrea Quinzo Caiminagua, 2019). much of the information known about plant cultivation comes from the chroniclers who documented what was grown at contact, and identification through archaeological methods. However, as with much of the archaeological record, the highlands were somewhat less documented by modern techniques in comparison to the coastal sites as many of the sites end up buried, leaving only a few records of the environment. Based on accelerator mass spectrometry dating techniques of crops such as maize, plant domestication and agricultural practices began around 5,000 BCE (Pearsall, 2008).


**Figure 3**. Illustration of a farmer using a foot plow (Guaman Poma de Ayalla, 2009).

The crops produced depended on the climate of the specific site as the highlands could vary significantly in temperature based on the location within the mountain ranges. Some highland sites were on grassland plateaus (*páramos*) above valleys that were subject to constant fog, mist, rain, and sometimes freezing temperatures, making these areas typically cold yet humid. Found around 3,000 meters above sea level, *páramo* were an important part of the Andean geography because they were the habitat of many of the animals hunted by the people, such as rabbits and deer. These lands were generally near to the worked lands used for agriculture, separated by forestland (Stahl & Athens, 2001).

Above the *páramo* zones were forests, and above the forests and *páramo* zone could be found the highest agricultural zones in the Andes. On the eastern and western flanks of the mountain ranges, the climate transitioned into humid tropical and rainforest zones (Athens, 1992). The landscape also had many volcanoes, which may have contributed to the challenges of living in this geographic area that many cultures during the time periods faced. This can be seen in the San Pablo site cores through the amount of tephra deposits. The deposits have made preservation extremely difficult at these sites. There is a record of very active volcanoes that erupted frequently from the middle Holocene into the Late Pleistocene, and some remain active to this day (Athens et al., 2016).

The climate was generally mild in temperature and the seasons were wet and dry (Valdez, 2008). Between June and September, the weather was drier and windier, this time considered the summer. The temperatures were around 50°F in the morning. The rest of the year has cool rains which were used for agricultural production. However, the crops found at some sites include maize of various kernel size that was introduced most likely from a spread from Mexico (Athens et al., 2016). Other important crops include potatoes, tree fruits, oca, peanuts, common bean, lupine, mashua, and coca (Pearsall, 2008).

### *3.2 Community Labor*

Community labor took place in various ways within the Pais Caranqui, such as agriculture as mentioned above, and monumental architecture, such as *tolas* and *camellones.* Within the Andes, there were typically three socially accepted systems to encourage communal labor. *Ayni* as a system was based on neighborly assistance between family or members of the same social group. If an individual asks for assistance, they are expected to return the same amount of labor to those who helped. *Minka* was a more formal system that benefited the needs of the larger community. Tasks under this system would include the maintenance of irrigation canals or diversion ditches. *Mita* was the tribute system under which the chiefdoms lived. Under this system they would donate their labor to construction under the chief, such as for temples, working in mines, or creating specialized ritual goods (Rhode, 2006).

*Tolas* were tiered earthen platform mounds of varying sizes used for purposes such as ritual, burial, or ceremonial (McEwan & Espinoza 2008). Almost all types of *tolas* have produced burials (Bray, 2008 & Yanchar, 2013). There were also truncated pyramidal *tolas* that housed circular buildings and were up to 90m in diameter and 10m in height. They were built as stepped pyramids. Some *tolas* have evidence of hearths built in their structures which supports the theory that they were used for ritualistic purposes. Those researching the *tolas* generally assign them purposes that surround religion or ceremony, though it is agreed that some were platforms for housing structures (Bray, 2008). While some of the *tolas* have acted as housing platforms, it should be noted that they would have only served the elite individuals in this way. Many of the individuals lived in communities spread around the agricultural fields, and not on *tolas*.

*Tolas* were the link between the physical changes made to the environment and the political aspirations of the chief. The presence of *tolas* in society signal that there was a centralization of the wealth distribution, an increase in group labor, and a potential for ceremonial activity. These larger architectural feats could psychologically imprint on the people that the chief was powerful, which would help him in maintaining elite status (Yanchar, 2013). They would make sure that their living quarters were distinguishable from the rest, in that they may be on the *tolas* so they were raised, they may use uncommon building materials, may have elaborate designs, and may be a large physical distance from the lower-ranking public. They may instead try to be placed near to the resource production area, so that they can establish these areas as “theirs” as opposed to them being controlled by the people who work to produce the resources. They may have also erected elaborate monuments for themselves or their families (Yanchar, 2013). In this way the individual chiefdoms exhibited signs of hierarchical organization, while the overall area of Pais Caranqui that contained the chiefdoms seemed non-centralized. The chiefdoms were equal, and no one chief commanded the entire area.

*Camellones* also necessitated communal labor. These were ridge-and furrow fields for use in agriculture (Yanchar, 2013). *Camellones* were created using a combination of ridges and ditches that will channel water flow, improve the surface temperature, and provide fertilization to the crops (Bray, 2008). They worked best for the past more marsh-like conditions that existed in the highlands before the areas were converted into pastureland following the Spanish conquest (Yanchar, 2013). These raised fields allowed the people to extend the growing season, protect the crops from the frosts that come with higher elevations, and partake in double-cropping. With double cropping, it is estimated that the fields could have supported around 700 individuals per $km^2$ (Yanchar, 2013). The population of this area was thought to be around 155,000 people (Athens, 1992). This means about 221 $km^2$ of field space would be needed to feed the entire population. The raised and flooded areas of the *camellones* could be used separately, or together, offering a wider variety of topography to grow crops in.

*3.3 Exchange and Goods*

Trade networks were an important part of Andean economic systems throughout all time periods. The establishment of long-distance trade networks allowed the highlands and coastal regions to develop in similar manners socio-politically, ritually, and economically. These networks were created by people with geographic and cultural knowledge of other places, and they grew in importance as imported goods took on high statuses within the communities (Scaffidi 2020). This led to the creation of the title of "*mindaláes*". The native lords utilized *mindaláes* to conduct their trades, so the traders received special treatment and a higher status in the community. They were able to pay lower tributes to their lords and were also generally exempt from the collective labor as well, though for their trade they needed to traverse whole countries (Salamon, 1987).

The craft specializations of the highlands include ceramics, textiles, and metallurgy. Ceramic production in the Integration Period became more specialized and varied. The types of figurines created in this period show a gradual differentiation of the economic trades. Some human effigies are believed to depict long distance traders. This idea is based on the figurines created with baskets on their backs, with body positioning reflecting authority and high status. This shows that the ceramic workers were depicting a probable trade emissary. Trade network development allowed for easier access to items that could be used for ritual purposes. This is evidenced by figurines with drug related paraphernalia, which would have needed to be imported into the population that it was found (Valdez 2008). The trade with the lowlands allowed for a high predominance of cotton in the textile-making of the highlands, despite the availability of camelid hair as an option (Rowe & Meisch 2011). These textiles may not have been consistently worn, as the figurines tend to depict the people as naked. However, there is evidence that textiles were used in burials, though they do not tend to last until they are excavated, the beading is what shows that the textiles used to be there.

Metallurgy in Ecuador most likely started in the Middle Formative and developed into a specialized trade with religious importance (Guevara-Durque, 2018). Figurines made of gold of the style of La Tolita, a coastal site, have been found in distant sites in the highlands, such as

Carchi. Metallurgy created a strong relationship between the regions because the craftsmen needed the metals for their work, though the mines for the metal may not have been native to the area in which the craftsmen lived. So, the craftsmen would rely on trade to bring the metal to them so that they could sell their wares locally. This is shown through the development of copper in figurines at the La Tolita site, despite copper mines having only been found in the northern highlands (Valdez, 2008). All portions of craft specialization over the Integration Period show signs of economic development. For ceramics, they become less specialized as they were created for mass production instead of local exchange (Meggers, 1966). The craftsmen would need to make many more pots to sell through the long-distance traders. The figurines, on the other hand, became more specialized and began to depict high status and various trades. There was also the use of more techniques in the creation of the wares, such as the use of gold and copper in the figurines. These examples show that there is a correlation between the rise of craft specialization and the economic development of the population.

# CHAPTER 4: STRUCTURAL VIOLENCE AND POLITICAL ORGANIZATION

A differentiation of physical labor, such that can be seen through the labor types within a region, may be an indicator of structural violence, or social structures that can cause injury or death to human beings within the society, caused by social pressure to participate in the labor throughout the people's lives. The lack of access to certain foods, while simultaneously being expected to perform labor tribute could increase the risk of developing labor-related diseases (Klaus, 2012). Structural violence was first defined by John Galtung (1969) as social structures that prevent individuals or groups from reaching their social, economic, or biological potential. "The phenomenon is structural because its mechanisms are within the political and economic constructions of a social world, and it is violent because it causes direct injury or death to human beings. Structural violence is often considered an invisible or subtle form of violence because it is embedded in long-standing and multigenerational social structure" (Klaus 2012: pg 31). These social structures lead to social inequities that can influence the health of an individual through the deprivation of nutrition or the addition of unnecessary stress throughout life. There are understood pathologies associated with structural violence in bioarchaeology because of physical labor and nutrient deprivation, such as stunted growth, linear enamel hypoplasia, and periosteal reactions, (Klaus 2012; Juengst 2020). This violent phenomenon is common within societies because the struggle for power will generally include a need to control access for another group. Violence can have strong socio political and economic consequences, so it becomes a tool for those looking to gain power in their community (Scaffidi 2020). For structural violence, the stressor is usually cultural and can most commonly be identified in hierarchical societies, though it is known in heterarchical societies as well.

## *4.1 Hierarchical Societies*

A hierarchical power distribution in a society means that the power is accumulated in a vertical manner: those at the top will have more or the most power and those at the bottom have the least amount of power. The classes of society will be ranked and organized based on power and access to necessary goods (Crumley 1979). These societies are built on competition, in which those at the bottom are the most responsible for the manual labor in the community since they do not have the power to resist (Juengst 2020). There would be less reliance on collective labor between the classes. For these societies, labor will fall to the marginalized communities before the elites. In the highlands, this power distribution would be seen through a lack of labor-related diseases on remains of those buried with high status goods. There would be a noticeable difference between a chief, a trader, and a farmer, based on how society viewed the labor within the hierarchy. The marginalized populations would be seen through damage to the bones because of continuous high-impact labor or a lack of access to essential nutrients and resources (Juengst 2020).

### *4.2 Heterarchical Societies*

A heterarchical power distribution in a society means generally that there is not one individual who has accumulated all control over the community, instead there are multiple power structures within the society. These societies are also more reliant on reciprocal, community labor, especially for large projects and to maintain cooperative relationships (Juengst, 2020; Scaffidi, 2020). For these societies, labor may be more evenly distributed throughout the whole community, instead of the highest amounts of labor falling to the lowest status, as would be seen in a hierarchical society. Within the highlands of the Andes, collective labor has been noted through various excavations. The Late Preceramic has shown widespread cooperation without hierarchy institutionalized in the communities (Sharp, 2020). Research done in Tiwanaku, Bolivia demonstrated that as heterarchical organization became more popular, the skeletal remains showed a reduction in workload. This reduction coupled with the lack of a centralized elite group allowed Tiwanaku to continuously grow in population as more people moved in and those who lived there chose to stay (Becker, 2020).

### *4.3 Socioeconomic Status and Labor*

Socioeconomic status is interpreted in the archaeological record to have an effect on workload. Individuals from the lower-statuses are more likely to have higher physical and mental workloads and more responsibilities tied to the movement of goods and services throughout the community for those of high-status because of unwritten social constructs that prioritize the health of the higher-status individuals (Farmer 2003). Trade systems can be used for the creation of political cohesion in non-centralized political units (Cuellar 1997). The high-status individuals would not be conducting trade for themselves, but they would own and potentially be buried with imported goods. When societies are based on classes, labor and activity will also be separated based on the classes (Farmer 2003). Bioarchaeology can be used to detect status or labor differentiation throughout a society by examining the skeletal markers that show patterns of power differences. A lack of access to resources because of status can cause skeletal and dental deficiencies in childhood that could persist until adulthood and be worsened by the hard labor expected from low-status individuals (Juengst 2020).

### *4.4 Urcuquí*

Within the Pais Caranqui region, including Urcuquí, (Figure 4), people lived in decentralized communities, with a regional chief. This dichotomy shows that hierarchy may still be seen in a broad heterarchical polity and was discussed in more detail above.

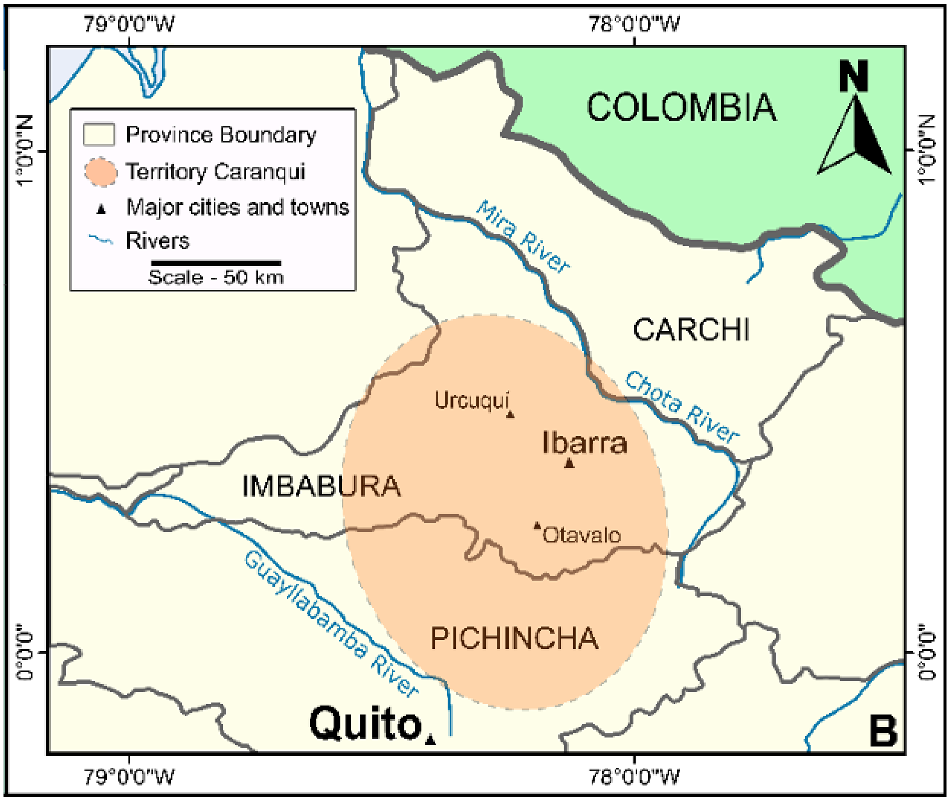


**Figure 4.** Close up location map of Urcuquí in the Pais Caranqui (Sebastian Gallegos Aguilar, 2020).

The site of Urcuquí is located 22 kilometers northwest of the city of Ibarra in the Imbabura province of Northern Ecuador (Figure 5) (Andrea Quinzo Caiminagua, 2019). During the Integration Period, the territory of Urcuquí was a part of the chiefdom of Otavalo (Salomon, 1986). The people of Urcuquí used forms of high-impact labor to build and maintain the territory. These labor forms include the aforementioned agricultural work, walking long distance trade routes from the highlands to the coast, detailed craftsmanship of ceramics and trade goods, and the building of monumental architecture, such as *tolas.* These forms of labor were integrated into the society and acted as a labor tax to be paid to the chief, a form of economic stability for the family, and as a community building process.


**Figure 5.** Location of Urcuquí in Ecuador using Google Maps.

Within society, there was a strong presence of collective participation in the labor, as indicated by construction of the *tolas,* cleaning of irrigation canals for the crops, and construction of defense platforms. Those who did not take part in the collective labor did not attend the social gatherings. This community-based social structure was created during the Integration Period with the establishment of the Otavalo chiefdom (Andrea Quinzo Caiminagua, 2019). This chiefdom is believed to have followed the same social structure that was described above. Despite the political power wielded by the chief, the chiefdom of Otavalo seems to be decentralized and reliant on a mix of political and economic powers. The modes of resource control tend to conform more to patterns of heterarchical modes of organization. Most Andean societies seem to follow the theme of small scales with stratified complex organizations, of which Otavalo is no different, giving it a more hierarchical organization within the community (Bray, 2008). The territory of Urcuquí still partook in the previously mentioned community high-impact labor, which would have a physical toll on their bodies.

*4.5 Previous Excavations*

Urcuquí is divided into four zones, two of which included burials (Figure 6). Zone One had sixty-eight burials, Zone Two had twelve burials, Zone Three had no cultural materials, and Zone Four had ceramics but no skeletal remains (Bray & Echeverría, 2008, 2010 & Andrea Quinzo Caiminagua, 2019).  Research in this area began in the 1970s; materials dating from 700BCE until after the Spanish conquest have been recovered from the site (Camino, 2019). Previous excavations have focused on the architecture of the buildings and the collection of the remains, with some preliminary study of the skeletal remains. The research done on the some of the remains after the excavations found that the people died while in poor health, with poor preservation in burials that tend to be multiple individuals. Ceramic wares were from Tuza/Capuli, Panzaleo/Cosanga, Caranquí, and Inca cultures (Figure 6).

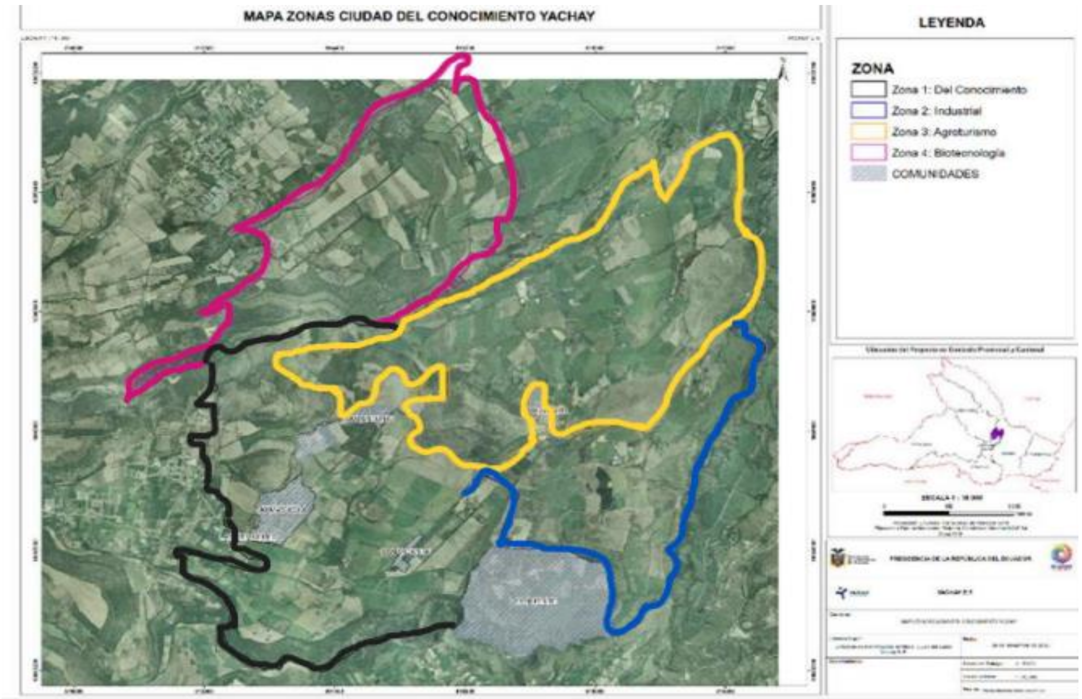


**Figure 6**. Approximate locations of the Zones (Andrea Quinzo Caiminagua, 2019).

# CHAPTER 5: BIOARCHAEOLOGICAL RESEARCH

Bioarchaeology and mortuary archaeology provide methods of study that allow researchers to investigate power and labor in the past through human skeletons in connection to the known lived experiences they might have encountered and burial goods that may have been contained with the skeleton. Osteobiographies can also allow researchers to dive more in-depth into individuals, instead of always looking at a population level. This thesis uses a combination of bioarchaeological methods of skeletal labor analysis and osteobiographies to investigate the labor of individuals at Urcuquí.

## *5.1 Burial Goods*

Through burial goods, archaeologists can reconstruct identities for the deceased, however these identities are not necessarily formed from the roles that the person held in life but a combination of their economic and social status with cultural expectations. The burial goods are deposited to reflect what was of importance to society, which could be status and wealth, or could be honor and trade (Pearson, 1999). Because of this, the burial goods provided can be studied to determine if occupation and status could have been deemed important enough in the culture to be portrayed after death.

## *5.2 Osteobiographies*

The idea of an osteobiography was created by Saul and Saul (1989) and later adapted by Robb (2002) for a more modern definition. This new definition focuses on the ability to study human cultures through the study of human remains (Hosek, 2019). The osteobiography can provide a tool to branch bioarchaeology into a more humanistic approach by contextualizing the osteological data of an individual when combined with the social and historical contextual evidence of the site. The research themes that osteobiographies have been assisting include trauma and violence, social organization, epidemiology, social perceptions and stigma, disability and impairment, personhood, and bio historical research (Boutin, 2022).

Osteobiographies evaluate what is visible on human remains in a way that examines not only what was wrong but how what was wrong could affect the day-to-day life experience of the individual. Did they live with chronic pain? Were they reliant on outside intervention to live comfortably? Were they still able to work? What could they eat? Questions like these are ones that osteobiographies attempt to answer in a more narrative style approach, as compared to the bioarchaeological analytical approach. What is visible tends to be the remnants of pathologies and manual labor (Hosek and Robb, 2019). To truly write an osteobiography, you must evaluate the individual body at both the individual level and in the broader context of the population in which you are working. This type of analysis provides a more in-depth perspective on how the life of an individual will change their physical body. Habitual use of an object in a specific manner can shape the body by affecting the bones directly. For example, a seamstress notch in a tooth is something that is visible, but also tells a distinct and identifiable story to the investigator, while also being only a small part of the individual’s identity. This can give information about the individual's job, and on a population level, could be expanded to provide information about the possibility of gendered labor, the spread of craftsmanship, and how hard the labor was on the body (Hosek, 2019). Writing an osteobiography is done by layering various types of data. These data include the broader context of the site and what is known about the history of the people, the demography of the individual in question, any information known from isotopic and DNA analysis for health and diet, mobility and if anything could have impaired it, signs of activity and degeneration, any modifications done to the body on purpose, and burial processes (Hosek and Robb, 2019).

### *5.3 Labor-related Diseases*

Bioarchaeological methods investigate labor and power through embodiment theory, which suggests that an individual's body is not just physical, but also social. People are shaped by their social experiences and the culture that surrounds them. Lived experiences are visible to researchers through diseases and wear of the bones and joints (Schrader, 2019). If an individual is not partaking in large amounts of high-impact labor, the bones will not be as affected and there will not be many signs of labor visible on the bones. Bioarchaeological information can also help to determine if the labor was causing stress and diseases for the people, such as osteoarthritis, linear enamel hypoplasia, and entheseal changes (White & Folkens, 2005). Having periods of high stress or nutrient deficiency during childhood can cause changes to the skeleton and teeth that continue into adulthood. Also, as the person ages, their bones can begin to degrade through experience with various diseases, both pathological and labor-related (Juengst, 2020).

#### *Osteoarthritis*

Osteoarthritis (OA) is the most common form of arthritis. It is characterized by destruction of cartilage, formation of bone within a joint, or eburnation. The bone re-formation will occur as lipping or osteophyte formation around the edges of the joint. The joint erosion will begin as small pitting, but over time as it becomes more severe, it will cause widespread porosity. Eburnation occurs when there is little or no cartilage remaining in the joint and bone-on-bone movement causes a polished appearance of the joint surface. This will later develop into striations as the joint movement continues to take place (Schrader 2019).

The cause of osteoarthritis can be unknown mechanical stress, age-related degradation of the joints, injury, or infection (Brothwell, 1981). Osteoarthritis can be either primary or secondary. Primary results from multiple factors such as age, hormones, mechanical stress, and genetic predisposition combined while secondary results from trauma or infection of the bone (White & Folkens, 2005).

Osteoarthritis can be commonly found in archaeological remains, and can be interpreted in various ways, including as stemming from age or labor related processes. When OA rates increase in a given population, they are usually following a shift in the socioeconomic structure. For example, in Tiwanaku, Bolivia, OA rates in the spinal column increased while rates in the knee and ankle joint stayed the same. This shift was determined to have been from an increase in the weight of the goods carried on the backs, while the general mobility patterns were unchanged. Another shift at this site, as an increase in the hip and sacroiliac joint, shows that a new technological innovation (an *aguayo*, or cloth backpack) was beginning to be widely used for transporting goods (Becker, 2020).

*Entheseal Changes*

Entheses are the places on the bone where the ligaments connect bone to bone or where tendons connect a muscle to bone. They are the components that allow for physical motion while not being directly involved in synovial degeneration. As activity occurs throughout life, ligaments and tendons undergo pressure which causes stress to the bony places to which they attach. The outer cortex of the bone in these places becomes agitated and reacts by producing more bone. These bony productions create ridges or crests that can be observed by bioarchaeologists to reveal differences in activity patterns among members of the same population. The most informative attachment sites are on the extremities that connect to larger muscles because they are more likely to be associated with repetitive physical activity (Schrader, 2019, Martin et.al., 2013).

Entheseal changes can demonstrate increases or decreases in labor over time. For example, at the site of Tiwanaku, Bolivia, as the state became more established as a heterarchy, there was a noticeable decrease in entheseal changes of the joints as caused by repetitive movements. Labor became more evenly distributed across the population, so people generally did not have as high of a workload. This allowed their bodies to be less intensely muscular than those who were dependent on only themselves for labor when compared to a late Formative population of the same area (Becker, 2020).

*Linear Enamel Hypoplasia*

Linear enamel hypoplasia (LEH) is a disruption to the formation of the enamel that results in transverse bands of depressions or pitting on the tooth crown. These grooves can be visible to the naked eye. They result from metabolic stress in childhood growth, usually a nutritional deficiency. Stress can cause a change in ameloblast activity which results in the enamel marking during development. This process can only occur during the development of the tooth since there is no addition of enamel once formed, so only childhood deficiencies can be measured. By measuring the distance between the hypoplasia and the root of the tooth, the time when the stress occurred can be documented. The side of the area of disturbance will depend on how many teeth were forming, how much of the crown was already formed, and how long the stress factor affected the individual (Martin et. al., 2013; White & Folkens, 2005; Brothwell, 1981).

Linear enamel hypoplasia documentation on remains allows for determination of the general rates of child morbidity as compared to similar sites. At Challuabamba, Ecuador, the small sample size had a higher instance of LEH than comparable highland sites (Grieder et. al., 2009; pg.161) The observed hypoplasia showed that biological stressors usually occurred in the individual's life between the ages of four and five, which shows that the individuals were able to overcome the disturbance and live on. However, disturbances of LEH in childhood demonstrate that at a time, the individuals did not have access to the nutrients they needed in development, which can be because of societal structure or a traumatic event across the community. The higher rates of LEH led researchers to determine that the people who lived at the site potentially had higher childhood morbidity rates, especially coupled with a general lack of dental caries (Grieder et. al., 2009).

*Osteomyelitis*

Osteomyelitis is a form of bone inflammation that is caused by bacteria. The bacteria could enter the bone through a wound and are always pus-producing microorganisms. While this generally affects the long bones, it can occur in other bones as well. Since this type of inflammation is generally caused by the introduction of bacteria, it can occur at any age. The bacteria will generally reach the bone via the bloodstream or directly from an injury. Osteomyelitis has two physical forms on the bone, including woven bone that can occur around the original bone and a cloaca for draining the pus which will open through the new bone deposits (White & Folkens, 2005).

Since osteomyelitis can result from infection or trauma, its presence can demonstrate a variety of stressors. Because of this, researchers must be careful when documenting it so that health related data does not impact other types of data, such as labor or trauma. Infections resulting from trauma or labor are more likely to be isolated on single skeletal elements or areas of bone, whereas lesions resulting from inflammation and infection are more likely to be systemic and present on multiple skeletal elements. One site, Challuabamba, Ecuador, had high rates of lesions when compared to other highland sites. This was determined to be caused by a higher adult morbidity rate and infection rate, though the sample was too small to make anything more than general determinations (Grieder et. al., 2009). In this case, the systemic nature of the periosteal lesions allowed the researchers to make observations about health. Infections resulting from trauma or labor are more likely to be isolated on single skeletal elements or areas of bone, whereas lesions resulting from inflammation and infection are more likely to be systemic and present on multiple skeletal elements. For example, an individual at an Ecuadorian Integration period site, Japotó, had signs of infection on every observable long bone. Since every long bone demonstrated this disease, the cause was more likely a systemic infection, rather than labor or trauma related problems (Delabarde 2015).

*Cranial Modifications*

Cranial modifications, or intentional cranial modification (ICM), are a form of permanent body modification that takes place in infancy and result in various head shapes (Gómez-Mejía et al., 2022). The skulls are modified by wraps containing boards that are used on the skull to hold it in the desired shape as the bones grow and connect. There are three main types of ICM. The first type can be called Tabular Erect and Tabular Oblique and is characterized by the flattening of the occipital region of the skull. The parietal region will increase in breadth, while the frontal region will be unaffected by the changes (Pomeroy et al., 2010 & Gómez-Mejía et al., 2022). There is some chance that the flattening may be unintentional depending on the cradle practices of the area and time, though this would still relate to the cultural practices. The second type of modification is called Bilobate because of the lobes that are formed in the parietal regions when this is done. To be identified, the skull needs to have modifications in the parietal region, frontal region, and along the sagittal suture (Pomeroy et al., 2010 & Gómez-Mejía et al., 2022). The third type of modification is the Annular shape, which is characterized by a high and elongated skull (Pomeroy et al., 2010 & Gómez-Mejía et al., 2022).

Thus, bioarchaeological methods investigating osteoarthritis, entheseal changes, infection and other general pathologies, and artificial body modification provide an opportunity to investigate the lived experience of power of past peoples. This data will be used to answer the following questions at Urcuquí: What labor-related diseases are visible on the skeletal remains? What is the relationship between individual experience of labor-related diseases and individual experience with general pathologies? Can I describe the lived experiences of individuals based on knowledge of their pathologies and how they could interact with life?

# CHAPTER 6: SAMPLE AND METHODS

To investigate the potential forms of labor, I investigated human skeletal remains from Urcuquí in highland Ecuador. This section presents an introduction into the sample that was used and the methods I used to investigate my research questions.

## *6.1 Sample*

The skeletal sample I studied from Urcuquí included only 33 of the individuals excavated from five sectors and 15 subsectors of the site. The number of people buried at the site is still unknown, however I studied six of 49 boxes that contain human remains. I did the analysis at the Universidad San Francisco de Quito (USFQ) over the course of four weeks in June 2023. One UNC Charlotte MA student and USFQ undergraduate students assisted in the data collection by pre-cleaning the remains for me and laying them in an anatomical position. I assessed each set of remains for demographics, pathologies, and indicators of labor (OA and entheseal change) and recorded burial goods when present. I photographed each instance of pathology with a camera and additionally recorded LEH with a DinoLite MicroCamera. I examined and described the burial goods associated with the excavated remains when they were still contained in the remains' bags. The majority of the excavated burial goods were held in another institution, so I was unable to fully document all contained goods for each unit or have any data related to the types of goods. I photographed the burial goods from multiple angles to ensure that they are accurately documented for identification. No cranial modification was found on my sample. I later entered all data into an Excel sheet for analysis. The frequencies were done through general division using Excel equations. All data was evaluated through frequency comparisons. No statistical methods were used because of the small sample size and the data being unable to be translated into comparable ordinal categories.

**Table 2.** Distribution of individuals, EC, and OA across the excavated sectors.

| Sector Name | Number of Subsectors | Number of Individuals | Percent of Individuals | Percent with EC | Percent with OA |
|---|---|---|---|---|---|
| Las Marias | 9 | 18/33 | 55% | 13/18; 72% | 9/18; 50% |
| San Jose | 1 | 1/33 | 3% | 0 | 0 |
| Las Marias/ San Jose | 1 | 2/33 | 6% | 2/2; 100% | 0 |
| El Rosario | 3 | 9/33 | 27% | 3/9; 33% | 1/9; 11% |
| Hoja Blanca | 1 | 3/33 | 9% | 2/3; 67% | 1/3; 33% |

A note on preservation: The preservation of the collection was mainly fragmented. Five of the individuals were too fragmented for any type of demographic or pathological analysis, for these individuals the fragments were separated into long bone, skull, hand, feet, and unidentifiable fragments. Four of the individuals were considered to have full bodies, with all to most of the joints being available for pathological study. The midline, which consisted of the skull, the vertebrae and sacrum, and the ribs, was the most available for study. The forearm area of the body was the least available across the collection.

## *6.2 Methods*

### *Sex Estimation*

Sex estimation methods can provide information on the probable morphological sex of individual, which may or may not correlated with the societal gender of that individual. For my research, sex data was used as one variable among many related to identity and distribution of labor. When available, the pelvis and skull were used for sex estimation. In general, sex developmental differences cause the adult male and female pelves to display a range of different traits. To estimate sex from the pelvis the traits scored were the ventral arc, subpubic concavity, and ischiopubic ramus following Phenice 1969, the greater sciatic notch following Buikstra and Ubelaker (1994), and the preauricular sulcus following Milner (1992). For highest accuracy, the skull was used in conjunction with the pelvis when possible, or by itself when necessary. Sex estimation based on the skull relies on the robusticity differences between males and females. The traits analyzed for the skull were the nuchal crest, mastoid process, supra-orbital margin, supra-orbital ridge/glabella, and mental eminence following Ascadi and Nemeskeri (1970). The traits were scored one through five, the lower scores (1-2) were for more gracile and considered female, and the higher scores (4-5) were for more robust and considered male. For the individuals that were not able to be scored, I marked them as indeterminate.

*Age Estimation*

The skeletal sample contained both adult and subadult individuals. The areas of the body used for adult age estimation were the pubic symphysis, the auricular surface, and cranial sutures. The most reliable area for age estimation is the pubic symphysis because of the noticeable changes it sustains throughout life. The scoring for the pubic symphysis followed Todd (1921a, 1921b) and Brooks and Suchey (1990) methods. The Suchey-Brooks method was used for when sex had been estimated, as the scores are broken into male and female. The auricular surface of the ilium was scored to a phase describing the four sections of the surface, apex, superior demiface, inferior demiface, and retroarticular area following Lovejoy et al. (1985) and Meindl and Lovejoy (1989). The pelvis trait scores were combined with the cranial suture scores. The cranial suture closure was scored zero through three depending on how much of the suture has closed. This determination was based on photos by P.I. Walker from Buikstra and Ubelaker (1994). The scores, both vault and lateral-anterior and superior sites were combined into two scores that give an age range following Meindl and Lovejoy (1985). For the individuals that I was not able to score, I marked them indeterminate.

For the subadults, age was determined through a combination of tooth eruption and development and bone measurements when available. The dental age was determined through comparisons to the images from Ubelaker (1989) which demonstrate the stages of tooth development and eruption from about five months until 35 years old. The bone measurements focused mainly on the complete long bones, though all bones available were measured for accuracy. The measurement followed two different sources. Some measurements were done following the Jastrzebski drawings in Buikstra and Ubelaker (1994). These drawings show how to do the measurements, they do not provide an age estimation in the book. The other source of measurements was the laboratory manual by Schaefer et al. (2009). All bones available were measured, though preference was given to complete long bones. As this book is a field and laboratory manual it contains a collection by various authors for measurements for each of the bones. In this book, the age ranges were provided with the approximate measurements.

*Osteoarthritis*

Osteoarthritis was scored by location on remains and severity. All locations of OA on the body were recorded, though the score was taken from the largest expression of arthritis. The severity was based on lipping, surface porosity, eburnation, and osteophytes following the scoring of Buikstra and Ubelaker (1994). Lipping was recorded by degree of discernibility, and extent of circumference based on the most severe expression. Surface porosity was recorded based on the degree of pinpoints and extents of surface affected. Eburnation was recorded based on degree of discernibility, and extent of surface affected. All three were scored one through three of increasing affectedness. Osteophytes were recorded as either barely discernible or clearly present.

### *Entheseal Changes*

For the entheseal changes, I followed Mariotti et. al (2004, 2007)'s scoring method. The method breaks down scoring of entheseal changes into zero through three for enthesophyte formation (EF), zero through three for osteolytic formation (OL), and one through three for robusticity (RO). Each EF stage increases the size and visibility of the exostoses on the enthesis, with score one being less than one millimeter and score three being greater than four. Each OL stage increases the amount and effect that porosity has on the enthesis and its development into an osteolytic area. For robusticity, the development was measured based on the bone and muscle attachment site. Each site has different descriptions; however, one will be the lowest and three the highest scores.

### *Linear Enamel Hypoplasia*

Linear enamel hypoplasia (LEH) was recorded as seven categories: absent, linear horizontal grooves, linear vertical grooves, linear horizontal pits, nonlinear arrays of pits, single pits, discrete boundary opacity, and diffuse boundary opacity following Buikstra and Ubelaker (1994). The frequency of hypoplasia was recorded as well, since the number and duration of the disruptions can affect the enamel. To assist with the dental health assessment, I also took crown height measurements of the affected teeth. All teeth available were examined for hypoplasia.

*Osteomyelitis*

Osteomyelitis was recorded based on the location and severity for each individual. The severity was recorded through the determination of the lamellae or vertical spicule, descriptions of the lamellae, and descriptions of the spicules. The instances were recorded based on the woven bone from the remodeling into a smoother bone. The stage of healing was taken into consideration and separated into active, healing, and fully healed following Buikstra and Ubelaker (1994). The appearance of cloacae from infection was also recorded based on the location of the bone in which it occurred.

# CHAPTER 7: RESULTS

In total, there were 33 individuals who were studied (Table 3), including 28 adults and five subadults. I estimated sex for six adult individuals; of these, three were estimated to be possible female and three possible males. The remaining 22 adults were indeterminate (IND), mostly because of lack of preservation of pelvic remains. I did not estimate sex for the five subadults because of their pre-pubescent status.

For age, the demographics are more complicated. Of the 28 adults, there was one 25-50 years old (3%), two 20-35 years old (6%), four 35-50 years old (12%), and 21 adults (64%) that could not be assigned a distinct age range because of the lack of a viable skull or pelvis. Five (15%) individuals were estimated to be subadults (under the age of 10).

**Table 3.** Demographics of the sample; IND is indeterminate.

| Demographics | Male | Female | IND | Total |
|---|---|---|---|---|
| Subadult | 0 | 0 | 5 | 5 |
| 20 - 35 | 0 | 0 | 2 | 2 |
| 25 - 50 | 0 | 1 | 0 | 1 |
| 35 - 50 | 2 | 2 | 0 | 4 |
| Adult | 1 | 0 | 20 | 21 |
| Total | 3 | 3 | 27 | 33 |

## *7.1 Entheseal Changes*

EC locations were grouped based on the general location and movement. The groups created were midline, shoulder, elbow, forearm, wrist/hand, hip, knee, and ankle/foot. All of the documented muscle attachments are named in Appendix B and are separated based on the named areas. Entheseal changes (EC) were found in 61% of the whole population (20/33) and 71% of the adult population (20/28) (Table 4, Figure 7). There were no differences in EC based on sex or adult age. At the individual level, many of the individuals with EC (75% or 15/20) had instances of EC in the knee. The hip was the second highest with 12/20 individuals (60%) and the shoulder and elbow areas were the third highest with 11/20 individuals (55%) each. The midline and the ankle/foot both had 10/20 individuals (50%), while the forearm had 9/20 (45%), and wrist/hand was the lowest at 6/20 individuals (30%). Moreso, at the individual level, only 1/20 individuals (163A) had instances of EC in all eight body locations. 4/20 individuals had seven, 3/20 2/20 had six, 2/20 3/20 had five, 3/20 had three, 4/20 had two, and 3/20 had one.

In the sample, there were 127 of the 197 possible areas (64%) affected by EC across 20 of 28 total individuals. Of the affected areas, the knee had the most with 17% (22/127) instances of EC, then the hip with 16% (20/127), the elbow with 15% (19/127), the shoulder with 13% (17/127), the forearm and ankle/foot both with 11% (14/127), the midline with 10% (13/127), and then the wrist/hand with 6% (8/127). In comparison to all the available areas in the EC sample, the midline naturally had more available as it was scored out of three, for the spine, cranium, and ribs, instead of the two that the other areas were scored out of for right or left with 18% (35/197). For the ones scored out of two, the hip had the highest with 16% (32/197), then the knee with 14% (28/197), the elbow with 13% (25/197), the ankle/foot with 11% (21/197), the forearm with 10% (20/197), the shoulder with 10% (19/197), and lastly the wrist/hand with 9% (17/197).

Per area and within the EC-affected population, 89% of the possible shoulder areas (17/19) were affected, 79% of the possible knee areas (22/28) were affected, 76% of the elbow (17/19), 70% of the forearm (14/20), 67% of the ankle/foot (14/21), 63% of the hip (20/32), 47% of the wrist/hand (8/17), and 37% of the midline. For the midline, the lumbar vertebrae were affected by EC at higher rates 75% (12/16) than the thoracic (25% or 4/16) or cervical vertebrae (0% or 0/16). Per area at the level of the whole population, 74% of the shoulder (17/23), 65% of the knee (22/34), 63% of the elbow (19/30), 58% of the forearm and ankle/foot (14/24), 57% of the hip (20/35), 38% of the wrist/hand (8/21), and 27% of the midline (13/49) were affected. A total 53% of the areas available were affected (127/240).

**Table 4.** Areas with entheseal changes across the whole population.

| **Location** | **Frequency Affected in Whole Population** | **Percent Affected in Whole Population** | **Frequency Observed in Population with other EC changes** | **Percent Affected in Population with other EC changes** |
|---|---|---|---|---|
| Midline | 13/49 | 27% | 13/35 | 37% |
| Shoulder | 17/23 | 74% | 17/19 | 89% |
| Elbow | 19/30 | 63% | 19/25 | 76% |
| Forearm | 14/24 | 58% | 14/20 | 70% |
| Wrist/Hand | 8/21 | 38% | 8/17 | 47% |
| Hip | 20/35 | 57% | 20/32 | 63% |
| Knee | 22/34 | 65% | 22/28 | 79% |
| Ankle/Foot | 14/24 | 58% | 14/21 | 67% |
| **Totals** | **127/240** | **53%** | **127/197** | **64%** |

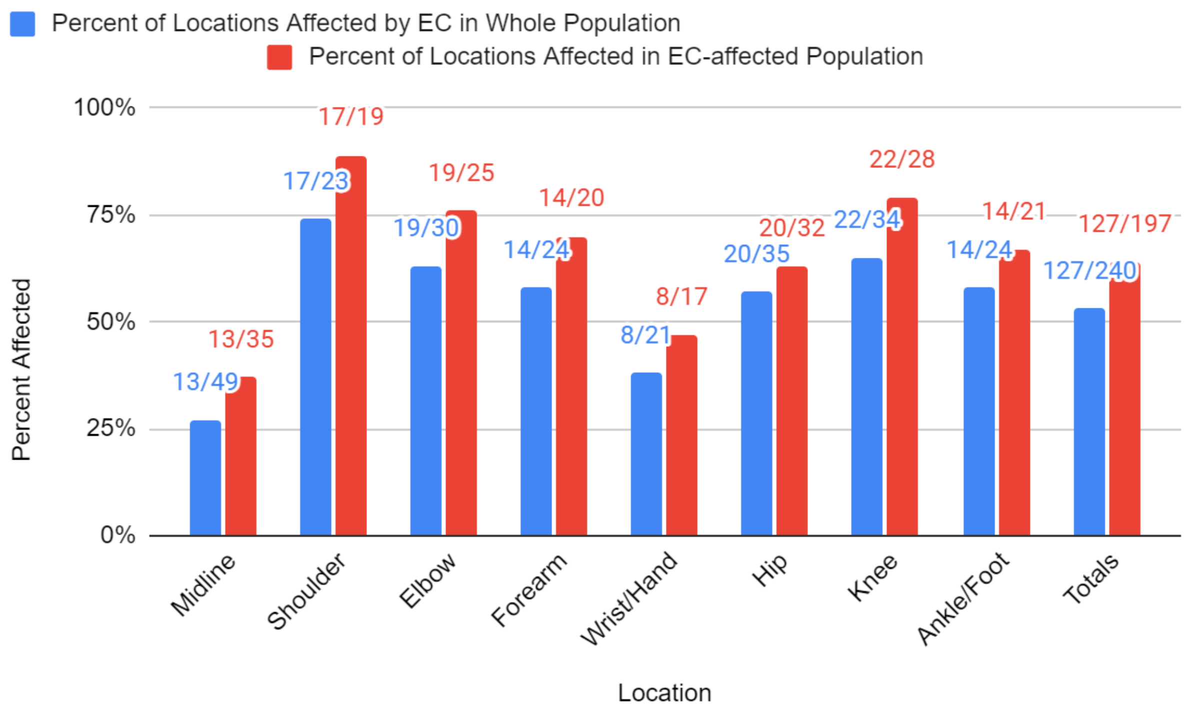


**Figure 7.** Bar graph showing how many areas were affected by entheseal changes (EC) in each area across the whole population (Blue) and the EC population (red).

*7.2 Osteoarthritis*

OA locations were grouped based on the general location and movement. The groups created were midline, shoulder, elbow, forearm, wrist/hand, hip, knee, and ankle/foot. Osteoarthritis was found in 33.3% of the whole population (10/33) and 36% of the adult population (10/28) (Table 5, Figure 8). There were no differences based on sex or age. Among individuals with OA, the midline was most commonly affected, with 80% (8/10) of affected individuals presenting OA here. Twenty percent of individuals had OA on the knee, the hip, and ankle/foot, and one individual had shoulder OA. No individual had OA in all eight locations. In fact, the highest number of locations was three, found on individual 163A. Three individuals had two locations impacted by OA and seven had one instance of OA.

In the sample, there were 18 of the 124 possible areas (15%) affected by OA across 10 individuals. Of the affected areas, the midline had the most with 56% (10/18), then the hip with 22% (4/18), the knee with 11% (2/18), the shoulder and ankle/foot both with 6% (1/18), and then the elbow, forearm, and wrist/hand all with 0% (0/18). When comparing available areas, most of them were again in the midline at 21% (26/124) because, the same as EC, this section was scored out of three instead of two. For the areas scored out of two, the highest amount available was the hip with 12% (15/124), then the elbow, forearm, wrist/hand, knee, and ankle/foot with 11% each (14/124), and lastly the shoulder with 10% (13/124).

By area within the OA population, 38% of the possible midline areas (10/26) were affected, 27% of the possible hip areas (4/15) were affected, 14% of the knee (2/14), 8% of the shoulder (1/13), 7% of the ankle/foot (1/14), and 0% elbow, forearm, and wrist/hand (0/0). For the midline, the thoracic vertebrae were affected by OA at higher rates 44% (23/52) than the cervical (31% or 16/52) or lumbar vertebrae (25% or 13/52). Per area at the level of the whole population, 20% of the midlines (10/49) were affected, 11% of the hip (4/35), 9% of the shoulder (2/23), 6% of the knee (2/34), 4% of the ankle/foot (1/24), and 0% for the elbow (0/30), forearm (0/24), and wrist/hand (0/21) were affected. A total of 8% of the available areas were affected (18/240).

**Table 5**. Areas with osteoarthritis across the whole population

| **Location** | **Frequency of Locations Affected in Whole Population** | **Percent of Locations Affected** | **Frequency of Locations Observed in OA Population** | **Percent of Locations Affected** |
|---|---|---|---|---|
| Midline | 10/49 | 20% | 10/26 | 38% |
| Shoulder | 2/23 | 9% | 2/14 | 14% |
| Elbow | 0/30 | 0 | 0/14 | 0 |
| Forearm | 0/24 | 0 | 0/14 | 0 |
| Wrist/Hand | 0/21 | 0 | 0/14 | 0 |
| Hip | 4/35 | 11% | 4/15 | 27% |
| Knee | 2/34 | 6% | 2/16 | 13% |
| Ankle/Foot | 1/24 | 4% | 1/16 | 6% |
| **Totals** | **18/240** | **8%** | **19/129** | **15%** |

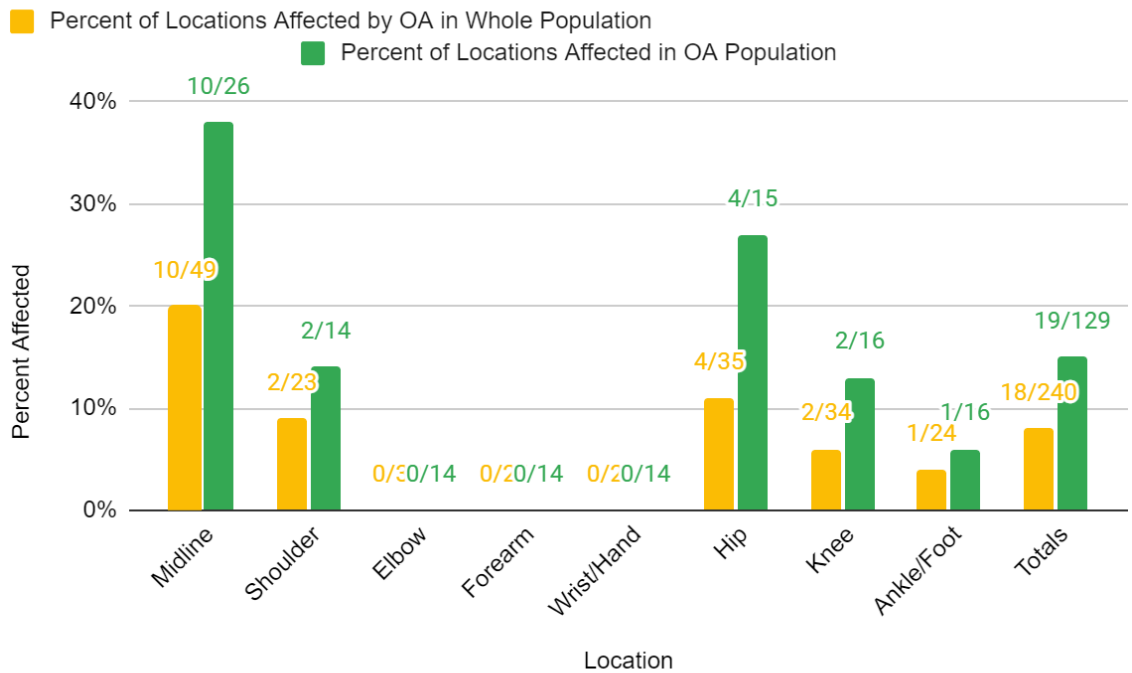


**Figure 8.** Bar graph showing how many areas were affected by osteoarthritis (OA) in each area across the whole population (Yellow) and the OA population (Green).

*7.3 Entheseal Changes and Osteoarthritis*

Nine of the 33 total individuals had instances of both EC and OA (Table 6, Figure 9), making up 27.3% of the whole population and 32% of the adult population (9/28). This means that 45% of the full EC population (9/20) and 82% of the OA population (9/11) had both EC and OA. Like the overall calculations, the midline had the highest number of individuals at 100% (9/9), while the shoulder and knee had the second highest number with (8/9) 89% of individuals each. The elbow and the hip both have 78% (7/9), the forearm and ankle/foot both have 67% (6/9) individuals, and the wrist/hand is the lowest with 55% (5/9) individuals. Within the individuals, 2/9 individuals (R11 & 163A) had instances of either EC or OA on all eight possible locations. 3/10 of the individuals had instances in seven of the locations, 2/10 two individuals had six locations, individual 89 had five locations, and 88B had two locations.

In the collection, there were 89 of the 120 possible areas (74%) affected by both across 9 individuals. In the affected areas, the midline had the most with 17% (15/89), then the shoulder, elbow, and knee with 13% (12/89), then the hip and ankle/foot with 12% (11/89), the forearm with 10% (9/89), and then the wrist/hand with 8% (7/89). When comparing available areas, most of them were again in the midline at 19% (23/120) because, the same as before, this section was scored out of three instead of two. For the areas scored out of two, the highest amount available was the hip with 13% (15/120), then the elbow, forearm, knee, and ankle/foot with 12% each (14/120), and lastly the shoulder and wrist/hand with 11% (13/120).

By area in the dual group, 93% of the shoulder (13/14) were affected, 86% of the elbow (12/14), 75% of the knee (12/16), 73% of the hip (11/15), 69% of the ankle/foot (11/16), 65% of the midline (15/23), 64% of the forearm (9/14), and 54% of the wrist/hand (7/13) were affected. For the midline, the thoracic vertebrae were affected by EC and OA at higher rates 39% (25/64) than the lumbar (36% or 23/64) or cervical vertebrae (25% or 16/64). Per area at the level of the whole population, 57% of the shoulder (13/23) were affected, 46% of the ankle/foot (11/24), 40% of the elbow (12/30), 38% of the forearm (9/24), 35% of the knee (12/34), 33%of the wrist/hand (7/21), and 31% of both the midline (15/49) and the hip (11/35). A total of 37% of the body areas (89/240) were affected by both pathologies.

**Table 6.** Areas with entheseal changes and osteoarthritis across the whole population

| **Location** | **Frequency Locations Affected in Whole Population** | **Percent Locations Affected** | **Locations Observed in EC and OA Population** | **Percent Locations Affected** |
|---|---|---|---|---|
| Midline | 15/49 | 31% | 15/23 | 65% |
| Shoulder | 13/23 | 57% | 13/24 | 54% |
| Elbow | 12/30 | 40% | 12/14 | 86% |
| Forearm | 9/24 | 38% | 9/14 | 64% |
| Wrist/Hand | 7/21 | 33% | 7/13 | 54% |
| Hip | 11/35 | 31% | 11/15 | 73% |
| Knee | 12/34 | 35% | 12/16 | 75% |
| Ankle/Foot | 11/24 | 46% | 11/16 | 69% |
| **Totals** | **89/240** | **37%** | **89/120** | **74%** |

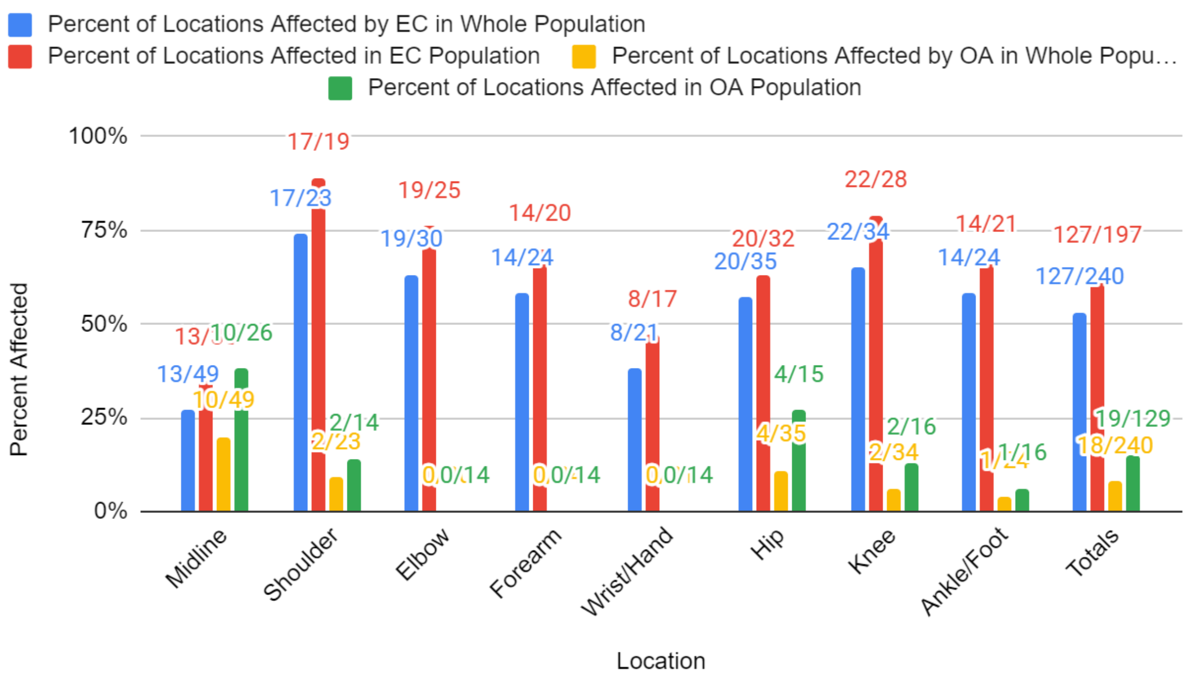


**Figure 9.** Combined bar graph of the percent of location affected by EC and OA.

## *7.4 Other Pathologies Present*

Along with EC and OA, there were other pathologies recorded in the population. The other pathologies (Table 7) include linear enamel hypoplasia, dental abscess, sinusitis, osteomyelitis, porotic hyperostosis, thoracic outlet syndrome, and scoliosis. There were also various congenital deformities that would have various amounts of lasting effects on the body. These include lumbarization of the S1, a deformed root, and double transverse foramen.

The other pathology population of 14 individuals was made up of 11 adults and 3 subadults, 42% of the whole population (14/33), 39% of the adult population (11/28), and 60% of the subadult populations (3/5). Within this population, 43% had only signs of other pathologies (6/14). None of the individuals had just other pathologies and osteoarthritis. However, 21% of the other population had entheseal changes, osteoarthritis, and other pathologies (3/14) and 36% of the population had just entheseal changes and other pathologies

(5/14). In the entheseal changes population of 20 individuals, only six of the units had EC without OA or other pathologies present, 30% of the EC population. The osteoarthritis population was 11 individuals, and only two of the units did not show signs of EC or other pathologies, 18% of the OA population. The "both" population was nine individuals, and five of them had no signs of other pathologies, 56% of the population. There are six individuals of the 14 that only had "other" and no EC or OA, 42% of that population (Figure 10).

**Table 7**. Number of individuals per "other" pathologies.

| **Pathology** | **Number** |
|---|---|
| Osteomyelitis | 7 |
| Congenital Deformities | 4 |
| Porotic Hyperostosis | 2 |
| Dental Abscess | 2 |
| Linear Enamel Hypoplasia | 2 |
| Sinusitis | 2 |
| Scoliosis | 1 |
| Thoracic Outlet Syndrome | 1 |
| Schmorl's Node | 1 |

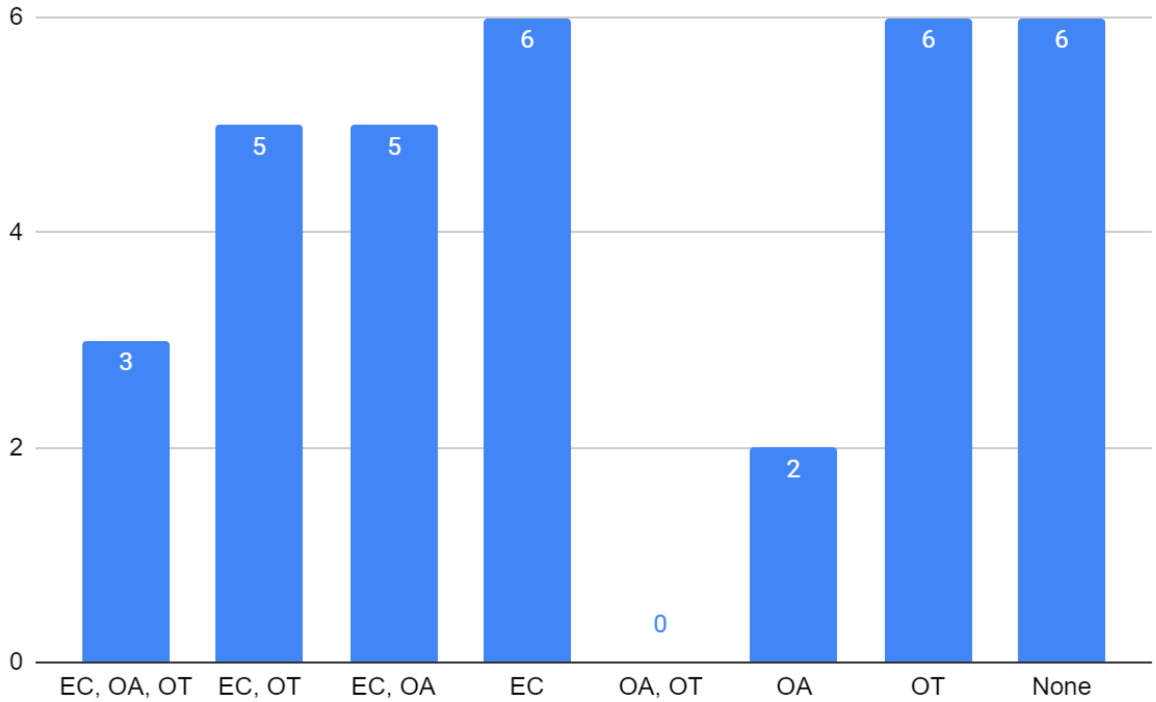


**Figure 10.** Bar graph showing how many individuals were affected by entheseal changes (EC), osteoarthritis (OA), and other (OT) pathologies by individual.

# CHAPTER 8: DISCUSSION

## *8.1 What do the pathology rates mean?*

Osteoarthritis seemed to have affected the midline and lower limb areas, while the only upper limb location with OA was a single shoulder. In contrast, EC was found in all the body locations, and the midline had the second lowest amounts of affected areas. The upper and lower limbs were affected by EC at similar rates, though the knee and hip were the highest and second highest. Since the knees and hips were affected at higher rates for both pathologies, the individuals in question may have been doing more repetitive motions that affected their lower limbs more often than their upper limbs. These repetitive movements would result in entheseal changes, as well as a faster degradation that could lead to osteoarthritis in a later age.

Lower limb EC and OA had been documented in other Andean populations as well. Rhode (2006) compared the rates of entheseal changes between Andean fishing and farming communities. I will be focusing most on the farming communities. One was a Late Archaic (3000-1800 BCE) Northern highland Peru site called La Galgada and the other was a Late Intermediate Period (900-1450 CE) middle valley Chile site from the Azapa valley (Rhode, 2006). That study found that farmers exhibited a higher rate of changes to their lower body, when compared to the fishers. While the data collected in this research is not compared based on occupation, the higher rates of lower body enthesopathies, the lower rates of forearm changes, and the history of agricultural subsistence strategies suggest that the patterns of EC and OA at Urcuquí may have also been driven by farming labor, since it is known that the area participated in annual harvesting of multiple crops to support the family and the community (Pearsall, 2008 & Andrea Quinzo Caiminagua, 2019)

The repetitive motions that would result in more changes to the lower limb are in line with farming work. There are seven main categories provided by Rhode (2006) in which repetitive motions for farming societies are described. The categories are field preparation, planting, field tending, harvesting, carrying objects, habitual exercise, and communal labor. For field preparation, the body movements may favor the shoulder and elbow, as the individual would be pulling up weeds with an upward and backward motion of the arm or using a hand plow. While planting, the individual would again be engaging the shoulder in the digging motions if using a digging stick. However, it is known that people living near Urcuquí used foot plow; the movements associated with this tool would have engaged the thigh, knee, and foot as the main stressors (Figure 7). Field tending would include a repetition of the weeding activities, as well as guarding the fields from animals. Once ready, the field harvesting would engage different bodily areas depending on the type of plants, but those lower in the ground would require actions like weeding, while also activating the lower limb through kneeling and squatting.

Throughout the year, the farmers and others would be engaging in non-agricultural activities that would stress the body. The first of these is the category of carrying objects. There are different ways to carry, but the best known would be through strapping a piece of cloth that contains the objects around the back and across the forehead or shoulder (Figure 8) (Rhode, 2006). This activity would stress the midline and the lower limbs, especially when combined with the next category, habitual exercise. Mostly this category focuses on walking and carrying needed items long distances and stresses the lower limbs. The lower limb rates could also be affected by the amount of walking that the people would do on a day-to-day basis. Since the fields were terraced, the farmers may not have lived nearby and would need to walk to their fields carrying their tools for the day. Also, the general terrain in the highlands would make walking more difficult on the body over time, as the people did not use other means of transportation within their towns. Those who worked in trade would also have to walk long distances down from the highlands and onto the coasts, which may have been rough on the body.

Additionally, communal labor would stress all parts of the body, depending on the labor that was being completed (Rhode, 2006). These labor types have been described above, but the communal projects could include the building and repair of temples, canals, and terraced walls. The labor would include repetitive motions, such as lifting, and the placing of heavy loads on the back. All these types of motions would be strenuous and would stress the upper limbs, lower back, and lower limbs over time and repetition (Rhode, 2006).

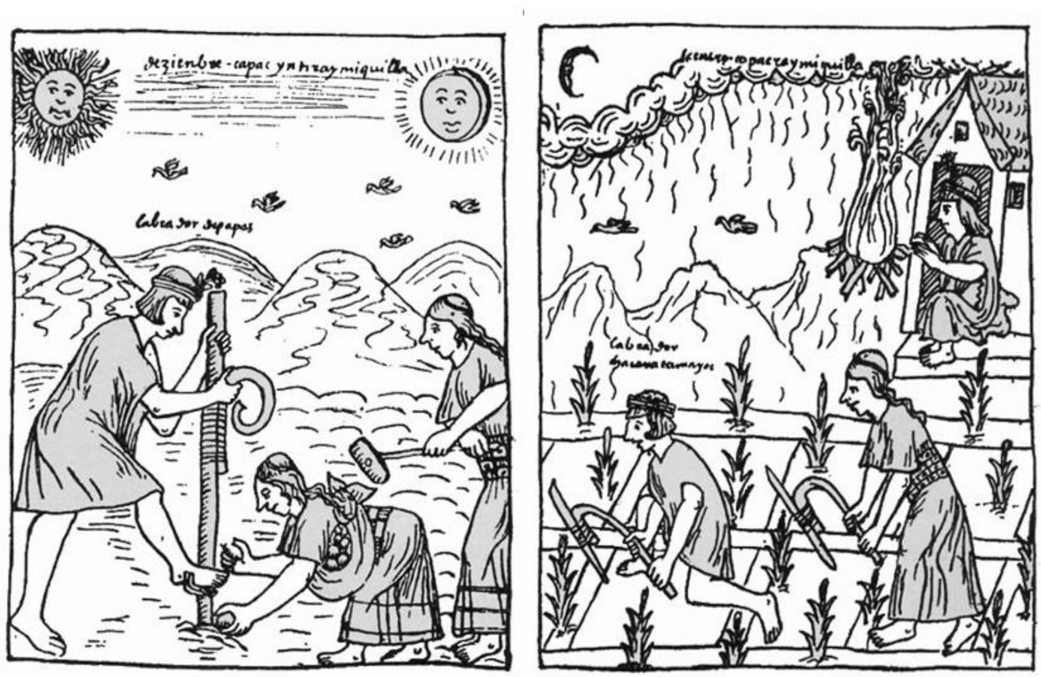

**Figure 7**. Illustrations of farmers planting fields from Guaman Poma de Ayala ([1615] 1993.)

**Figure 8**. Illustrations of people using *Aguayo* to carry harvested produce from Guaman Poma de Ayala, ([1615] 1993.)

*8.2 Andean Site Comparison*

The most prominent pattern in this collection was the higher rates of entheseal changes across most of the individuals when compared to the rates of osteoarthritis. None of the individuals who were able to be aged fell into a category over 50 years old, so they may not have had the time to develop the more age-related pathologies that are common in the older age range. On the surface, the low rate of osteoarthritis seems to counter the amount of labor that seems to be spread across the population. However, we can account for the lower rates of OA in a few ways, including the idea of shared labor reducing individual burden to a manageable rate and OA being more of an indicator of age than physical activity.

OA has been seen as a potential labor-related pathology, though recently it has been more linked to age and the natural deterioration of the body over time. As discussed earlier, sharing hard labor is generally accepted for Andean communities. The use of *ayni*, *minka*, and *mita* systems to create social bonds would help with reducing the amount of labor a single individual was responsible for. Since ethnohistories have pointed to the fact that farming is generally a group activity in Andean agriculturalist societies that value communal labor, the sharing of labor in the Urcuquí population would fall in line with what is already known about the people they were living near at the time (Rhode, 2006).

Another study by Becker (2020) on the advent of the Tiwanaku state has determined the possibility that a change into a communal labor-based society can reduce the prominence of enthesopathies. This occurs through a reduction in the repetitive movements that cause entheseal changes, so that all individuals within the population begin to experience less dramatic changes in their joints and attachment sites. In the Tiwanaku study, the rates associated with workload and repetition became reduced once the population moved to a more heterachically organized distribution of labor (Becker, 2020). While I do not have pathology rates from earlier time periods for Urcuquí, the general rates of enthesopathies across majority of the adult population, while simultaneously not having signs of osteoarthritis from younger ages could support the theory of shared labor at the site. As stated earlier, Pais Caranqui and the internal territories relied on communal labor as a part of their cultural identity. This importance placed on the community aspect of labor would encourage most of the able-bodied people to partake to help their neighbors and pay respect to their elites (Ramos, 1993). In this way, the people of Urcuquí could have shared the burden of the labor, and in doing so, diminished the harm done to their own bodies.

The sites used thus far, La Galgada, Azapa, and Tiwanaku, are Andean, but the climate and geography are different than where the people in my sample would have lived. La Galgada is in the Northern highlands in Peru, at about 1,100masl. The site itself is in a passage between the coastal desert, the highlands, and the Amazon Basin. It is situated in a canyon, on the bank of a river (Rhode, 2006). The Azapa sites are from Chile, with sites located on the northern and southern slopes of the valley. The agriculture for this area was done by cultivating floodplains after rain (Rhode, 2006). Tiwanaku is in Bolivia at between 900 to 3800masl. It is located on the shores of a lake and located between said lake and dry highlands (Becker, 2020). In contrast to all these sites, Urcuquí is about 2,295m in elevation. The terrain varies from valleys to mountainous forests. In particular, the *páramos*, where agriculture could be done, were subject to fog, mist, rain, humidity, and sometimes freezing temperatures (Athens, 1992).

However, when discussing how the rates found at La Galgada, Azapa, and Tiwanaku can be compared to Urcuquí, it must be noted that there is a lack of Ecuadorian highland sites to compare data too. Ecuador is underrepresented in the archaeological record, and the northern highlands in particular are very infrequently published about. Because of this, I chose to compare Urcuquí to sites throughout the Andes to make a discussion, instead of being able to stay within Ecuador or the surrounding areas.

### *8.3 Efficacy of EC and OA usage*

In modern research, the etiology of OA relies on “(a)ge, sex, obesity, genes, metabolic factors, articular cartilage nutrition, endocrine factors, bone density, overloading of the musculoskeletal system, joint injuries, joint infections, congenital defects, joint instability, congenital and/or developmental joint deformities, physical activity and occupation, or even muscle weakness…" (Myszka et al., 2019, pp. 2357). In bioarchaeological research however, there is not a unanimous consensus about the cause and many articles have found contradictory results about whether OA can be considered an activity-based pathology. Recently, OA has been related more to being an age-related pathology, potentially because of the biochemical changes in the body that weaken cartilage over time, as well as the idea that continued use with age will deteriorate the body (Myszka et al., 2019, He & Prado, 2020). In some studies, OA was caused by muscle contractions and increased loads on the joints, however other studies have found that increased muscle can protect bones from degenerative diseases such as OA. However, the theory of a positive relationship between enthesopathies and OA is still being tested and could be true. Since strain over a certain threshold is what causes entheseal changes and stress on an area could be a cause of OA, they seem to have overlapped mechanisms (He and Prado, 2020).

In this way, the fact that OA is only on the individuals with EC, while EC is more across the entire population would follow the general idea about OA developing after intense EC and EC developing because of repetition, but not be a degenerative disease. The current theory for the site of shared labor could mean that the individuals were all doing enough work to develop EC, but only a few reached an age associated with OA, or were doing such high amounts of labor that they developed OA on top of their EC. This can also be further demonstrated by the care that seems to have been taken of the individuals in the population that endured trauma or were born with congenital deformities that may have affected their quality of life. A few of these individuals' lives are studied below.

### *8.4 Osteobiographies*

In this section, three individuals will be examined using Osteobiographies. Appendix C provides the colored inventory of what bones were available and affected with keys. As explained earlier, osteobiographies give an insight into the day-to-day lives of individuals that can lead to a better understanding of the population when put into the social context. The three individuals were chosen because they demonstrate a variety of life experiences. Individual 88A was a subadult with signs of trauma and pathology that would have greatly affected their life experience, potentially even leading to their death. However, the healing does show a level of care was given to the child prior to death. Individual 218 is a potential female of middle age who was born with a congenital deformity that affected the stability of her spine. Later in life she also experienced a trauma that led to a reduced ability to chew, but again she shows signs of care and life after the inciting incidences of trauma. Individual 163A is also a potential female of middle age. In comparison to 218, she does not show signs of congenital deformities or lifelong pathologies. However, her body does show more signs of labor consistently throughout the bones. These three individuals at different levels of health and age demonstrate a small picture about what it was like to live at Urcuquí when they did.

*Individual 88A*

This individual was a subadult aged to 6 - 8 years old at the time of death. This age range was based on bone measurements and tooth development and eruption. Since this individual was not able to be sexed, I will refer to them with the neutral pronoun “they”. Individual 88A was included in a double burial, alongside an adult. The adult was represented by about six bones, including a vertebra with evidence of scoliosis. The two individuals had a piece of limestone included in their burial (probably among other burial goods removed prior to analysis). While there are other double burials on the premises, two individuals with spinal issues buried together could be indicative of a pattern for burial. Also, since burial goods have not been associated with grave sites yet, the limestone could indicate that one or both individuals were buried with goods, that the limestone was originally a part of before becoming separated.

Individual 88A had many instances of pathology and trauma across their body. To begin, two of their incisors had linear enamel hypoplasias (Figure 9). These hypoplasias would have occurred while the tooth was developing. These could be caused by many things, such as malnutrition, trauma, or stress.

**Figure 9.** Linear enamel hypoplasia on two incisors.

The child also suffered from a break to the left first rib at some point in their young life, an injury that would have had a major effect on their life (Figure 10). While the injury does not have a conclusive cause; fractures in this area have been linked to activity such as the lifting of heavy objects, violent force, or life-threatening injury, though those from activity tend to occur in young adults (Brickley, 2006). This break would have taken approximately four weeks to heal, though healing would have varied depending on the health of the child. Breaks in the first rib have been known to cause damage to the vascular structures, though these types of fractures are rare (Brickley, 2006). The result of this break is two-fold. The first result was infection. There is a healed cloacae on the left clavicle (Figure 11), a sign of osteomyelitis. This infection could have occurred later than the break but resulted from the trauma that the rib endured.

**Figure 10.** Left first rib with healed break.

**Figure 11.** Healed osteomyelitis cloaca on left clavicle.

The second result of the break is a development of thoracic outlet syndrome (TOS). Thoracic outlet syndrome is a title given to many different conditions and traumas where the result is a compression of the thoracic outlet, or the lower area of the neck and the upper chest.

This compression puts pressure on the neurovascular structures such as blood vessels and nerves that need to pass through this area (Malaga and Makowski, 2019). This condition has been known to affect the ability to do daily activities. As the rib healed, it changed shape. The angle facing the vertebral column was greatly reduced. This led to a pinching of all of the arteries and nerves that pass through this area (Figure 12).

**Figure 12.** Comparison of normal right first rib (L) and left first rib angled after healing (R).

TOS of this type may lead to a few different outcomes. The child could have experienced reduced feeling in the left arm in the best situation and full paralysis in the worst. There is no real way to know just how much the child’s arm use was affected, as the available parts of the arms do not have strong indicators of use or lack of use. However, there would be an effect on the arm because of the pinching of the nerves and compromising of the blood flow. Most likely, the arm and fingers would have experienced numbness (Malaga and Makouski, 2019). There would also be an effect on the pulmonary functions of the child. The child may have had trouble breathing and catching their breath, given the stress in the area above the lungs. This trouble could have been worsened by the naturally high elevation in which Urcuquí sits. Having trouble catching their breath, or breathing in general, could have an impact on movement and how much could be done in a day without causing too much stress to the body. Though there is no indication of the cause of death for the child, as they seemed to have recovered from the injury and infection, maybe the lack of ability to breathe would have factored into their early demise. Not being able to breathe in stressful situations could lead to danger. As well as having lessened ability in a limb combined with trouble breathing could lead to a collapse that the child may not have recovered from.

While there is no way to know for sure, we do know that the child experienced stress throughout their life, and passed very young, potentially as a result of their past injuries and illnesses and the subsequent symptoms. Nevertheless, the signs of healing on the pathologies and trauma do show that the child was cared for over time. They would have needed assistance while they waited for the rib and clavicle to heal. As this individual was a child, there is some assumption that the family would have cared for the child until they healed. This child was cared for enough to heal from multiple injuries, but the conditions of their environment most likely did not allow for a long life.

*Individual 218*

This individual was an adult aged between 35-50 years old. They were also estimated to be a possible female, so I will be using the pronouns of she/her in this osteobiography. Though she most likely lived until middle aged, she did have some changes to her body that may have resulted in chronic pain. Firstly, she seemed to have been born with a lumbarization of the S1 of the sacrum (Figure 13). This means the first section of the sacrum never fully connected to the rest as she aged. Instead, the S1 will assume a lumbar appearance, this lumbarization has been noted in the Andes as being more common in females (Becker et al, 2023). This would have greatly diminished her capabilities in terms of what her lower back could take. There would have also been a great deal of pain associated with the lower back over her life, maybe even to the point that she could not sit in certain positions. She would have developed a reliance on her upper body since the lower body movements may have caused pain.

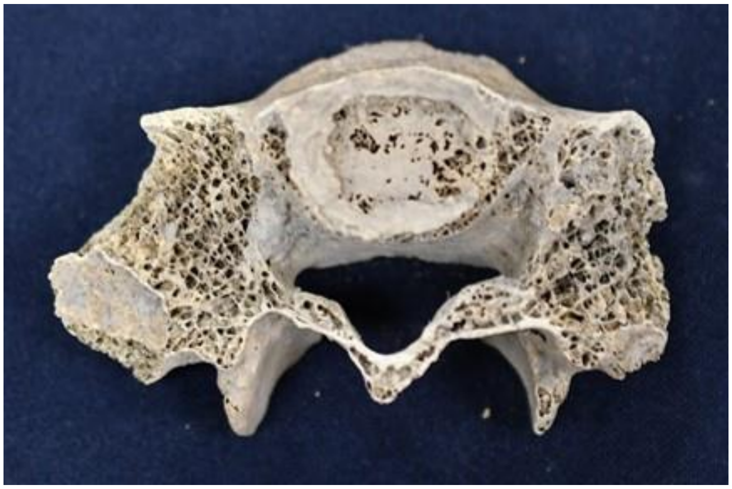

**Figure 13.** Inferior view of S1 to S2 ossification center that did not fuse over time.

Because of this congenital deformity, she may have specialized more in crafts, or jobs that she could complete with minimal movement and a reliance on her hands and arms. Since the main labor types for the area include agriculture, monumental architecture, long distance trade, and craftsmanship, it follows that she was most likely a craftsman. There are some slight signs of entheseal changes in a few phalanges that offer support to the idea of weaving or using her hands at a more constant rate than others. She also had osteoarthritis on the cervical (Figure 14), thoracic, and lumbar vertebrae that support the idea of spinal stress throughout her life.

**Figure 14.** Osteoarthritis on cervical vertebra.

The other major impact on her life is mandible subluxation (Figure 15). As shown by the dental wear patterns (Figure 16 and Figure 17), she was not using the left side of her mouth to chew nearly as much as the right side. The muscle attachment sites also show a distribution that the left side needed more work overtime to control the movement, and the right side was functioning more regularly. The temporal-mandibular junction of the left side shows evidence that the mandible was sliding in the joint more than it should have been.


**Figure 15.** Extended left temporal mandibular surface.

A subluxation like this could have many causes such as seizures, stroke, or trauma. However it was caused, the ligament holding the mandibular condyle in place was now lax and the jaw would slide while chewing. This led to the favoring of one side over the other. She would have to rely on softer foods, maybe even liquids, depending on the severity and the medical practices at the time. The diet at the time relied on leaner meats such as llama, alpaca, and guinea pig, as well as favoring vegetables such as maize and potatoes. These types of foods would not be very conducive to a soft diet, so she may have had to find new foods to eat, or just lived in pain while both eating and existing. While she did not have signs of many different pathologies, she does show through her body, a life of discomfort and pain.

**Figure 16.** Right side of mandible with high dental wear.

**Figure 17.** Left side of mandible with low dental wear.

*Individual 163A*

This individual was an adult between 25-50 years old. She was sexed to possible female, so I will use she/her pronouns in this osteobiography. She was included in a double burial with another adult. This adult was only four bones and was not able to be sexed. Along with both individuals, was an animal bone and a ceramic piece, which could have been intended for either, or both. She also had signs of insects burrowing across many bones of her body, which were not on the few bones of the other adult. Unlike the previous individuals, she did not have signs of life-long or crippling pathology on her bones. However, almost all available bones contained signs of labor. She had osteoarthritis mainly on or around joint surfaces, such as on both acetabulum (Figure 22), the humerus, the femur, and the tibia. She also had some osteoarthritis on the spine. None of the OA present was highly progressed and was scored lowly.


**Figure 22.** Right acetabulum with osteoarthritic lipping starting to develop.

For entheseal changes, they were present on all available long bones in at least one location and the hand and feet phalanges. They were also present in the joint surfaces alongside the osteoarthritis. Similar to OA, the entheseal changes were not scored very high. Since the signs of labor are equal across her body, there is a higher chance she partook in the communal labor in a more active way. Her labor signs are more in line with the Rhode (2006) farming EC. She was at least partaking in many repetitive motions. In her hands, the repetitive motions were enough to cause more dramatic EC on multiple phalanges (Figure 23). The phalange EC could have various causes, for instance weaving. However, for her upper and lower limbs, as seen in the ulna (Figure 24) and the femur (Figure 25), the labor is most likely more taxing to the full body.

**Figure 23.** Hand phalange with EC on both inferior edges.

**Figure 24.** Left ulna with entheseal changes.


**Figure 25.** Left femur with entheseal changes.

Any of the farming practices described previously would cause EC in the same areas (Rhode, 2006). The combination of the OA developing where the EC is already causing changes lends strength to the theory that the OA developed because of both labor and age combined. Over time, as she worked using the repetitive motions, her body reacted by forming the entheseal changes. As she aged, the stress to the surfaces began to cause deterioration, leading to the start of osteoarthritis forming in these joints (Myszka et al., 2019). She may have been feeling pain from these joints, but not in a way that would have affected day-to-day life for her. None of the OA was developed enough to be the cause of pain or disuse of the limb or joint. She was just beginning to show signs of a life of labor.

However, the end of her life may not have been pleasant or normal. She had perimortem trauma to the left parietal in the skull. An obsidian flake (Figure 26) that was included in her excavated materials fell out of her head. This flake perfectly matches the hole the injury left on the skull (Figure 27 and Figure 28). This injury shows no sign of healing, with beveling inside the skull. She was most likely buried with the obsidian still embedded in her skull. Since the injury occurred on the top of the skull, there are not many ways that it might have ended up there, but the reason will never be known.

**Figure 26.** Obsidian flake found in skull.


**Figure 27.** Skull with obsidian flake embedded in the injury.


**Figure 28.** Injury without the obsidian flake.

# CHAPTER 9: CONCLUSION

At Urcuquí, the data patterns revealed that while labor was taking place, no one individual from the sample was shouldering most of the burden. Entheseal changes were apparent in over half of the population, which supports the use of repetitive motion throughout life. However, the rates of osteoarthritis were so low that those with the disease most likely obtained it because of age or because of another pathology affecting their health. The EC affecting mainly the upper and lower limbs follows similar patterns seen in other farming communities, while the low levels of OA suggest that the communal aspect to labor was reducing the workload on the individual. Since all people helped with hard labor, the physical effects of the labor were not being felt until later in life, when the bones and joints begin to deteriorate naturally.

To better explain how the individuals would be affected by the other pathologies they endured more than the EC caused by repetitive movements, osteobiographies were done on a few of them. The osteobiographies examined the changes to the lives of these people and how they might have been cared for after injury, or from birth. They also examine how labor presents on the bodies of both those affected by congenital pathology, and those who seemed to be able bodied until death. The comparison of where the labor signs on the body where between these two groups of people can help us understand how labor was endured by both the healthy and the sick. These osteobiographies give some insight into the lives of individuals that supplements the research done into the rates of labor-related diseases.

There are many avenues for future research at this site. These include the continued inventory and study of the rest of the excavated human remains, the documentation of the burial goods as they relate to each burial, the pathological analysis of the congenital deformities seen across the site, and isotopic analysis to get a better picture of diet and health. A better understanding of the labor-related diseases as they affected the entire population buried at the site would help with comparisons to other sites of the same time period. Since researchers are just beginning to dive into the study of the human remains from the site, there is much to be done before the story is complete.

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# APPENDIX A: TABLE OF ALL INDIVIDUALS IN SAMPLE

| Unit | Sex | Age | OA | EC | Pathology |
|---|---|---|---|---|---|
| **2** | IND | adult | Y | N | N |
| **11** | M | 35-50 yrs | Y | Y | N |
| **21A** | IND | adult | N | Y | N |
| **21B** | IND | adult | N | N | N |
| **78** | IND | adult | Y | Y | N |
| **79** | IND | adult | N | N | Congenital deformation of I2 with the root of canine tooth and with a hook of enamel |
| **83** | IND | adult | N | Y | N |
| **85** | N/A | 2 yrs | N | N | Porotic hyperostosis on skull fragments |
| **86** | IND | adult | N | N | Molar with abscess |
| **88A** | N/A | 6-8 yrs | N | Y | L $1^{st}$ rib has healed fracture resulting in thoracic outlet syndrome. L clavicle has healed pustule lesion. LEH on two incisors. |
| **88B** | IND | adult | Y | Y | Scoliosis and Schmorls node |
| **89** | IND | 20-35 yrs | Y | Y | N |
| **97** | IND | 20-35 yrs | Y | Y | N |
| **125** | IND | adult | N | N | N |

| | | | | | |
|---|---|---|---|---|---|
| **158** | F | 35-50 yrs | Y | Y | Abscess on tooth. Osteomyelitis on femur. Porotic hyperostosis on R Parietal. |
| **160** | M | 35-50 yrs | Y | Y | N |
| **163A** | F | 25-50 yrs | Y | Y | N |
| **163B** | IND | adult | N | Y | N |
| **183** | IND | adult | N | N | N |
| **184** | IND | adult | N | N | Osteomyelitis on unidentified shaft fragment |
| **206** | IND | adult | N | Y | Osteomyelitis on both femurs and tibia shaft. Sinusitis in skull fragments. |
| **210** | IND | adult | N | Y | N |
| **212** | IND | adult | Y | Y | Osteomyelitis on both tibiae. |
| **215** | M | adult | N | Y | Sinusitis in skull fragments. |
| **218** | F | 35-50 yrs | Y | Y | Lumbarization of S1. Mandible subluxation. |
| **238** | IND | adult | N | Y | N |
| **246** | IND | adult | N | Y | Osteomyelitis on femur. |
| **250A** | N/A | subadult | N | N | N |
| **250B** | N/A | subadult | N | N | LEH on four teeth. |
| **251** | IND | adult | N | N | N |
| **266** | N/A | 1 yr | N | N | N |

| | | | | | |
|---|---|---|---|---|---|
| **269** | IND | adult | N | N | Osteomyelitis on unidentified shaft fragment |
| **270** | IND | adult | N | Y | N |

APPENDIX B: TABLE OF MUSCLE ATTACHMENT SITES

| **Body Area** | **Bone(s)** | **Attachment** |
|---|---|---|
| **Midline** | Vertebrae, ribs, mandible, sacrum, sternum | All |
| | Clavicle | Costoclavicular Ligament |
| **Shoulder** | Scapula | M. triceps brachii |
| | | Coracoid tendon |
| | | Pectoralis minor |
| | Clavicle | Conoid Ligament |
| | | Trapezoid ligament |
| | | M. pectoralis major |
| | | M. deltoideus |
| | | Subclavius |
| | Humerus | M. pectoralis major |
| | | M. lat.dorsii/ teres major |
| | | M. deltoideus |
| | | Subscapularis tendon |
| **Elbow** | Humerus | M. bracioradialis |
| | | Pronator teres |
| | Radius | M. biceps brachii |
| | | M. pronator teres |
| | | Brachioradialis |
| | Ulna | M. triceps brachii |
| | | M. brachialis |
| | | Anconeus |
| **Forearm** | Radius | Interosseuous membrane |

| | | |
|---|---|---|
| | Ulna | M. supinator |
| | | Pronator quadratus |
| **Wrist / Hand** | Radius | Flexor carpi radialis |
| | Ulna | Abductor pollicis longus |
| | | Flexor digitorum superficialis |
| | | Extensor carpi ulnaris |
| | Metacarpals | Tendons |
| **Hip** | Femur | M. gluteus maximus |
| | | M. iliopsas |
| | | acetabulum attachments |
| | Innominate | Adductor longus |
| | | Obturator internus |
| | | Gluteus maximus |
| **Knee** | Femur | M. vastus medialis |
| | Patella | Quadriceps tendon |
| | Tibia | Quadriceps tendon |
| | Fibula | Biceps femoris |
| **Ankle / Foot** | Tbia | M. soleus |
| | Fibula | fibularis longus |
| | | interosseous membrane |
| | | Extensor hallucis longus |
| | Calcaneus | Achilles tendon |
| | Metatarsals | tendons |
| | Talus | tendons |

# APPENDIX C: INVENTORIES OF AVAILABLE AND AFFECTED BONES WITH KEY

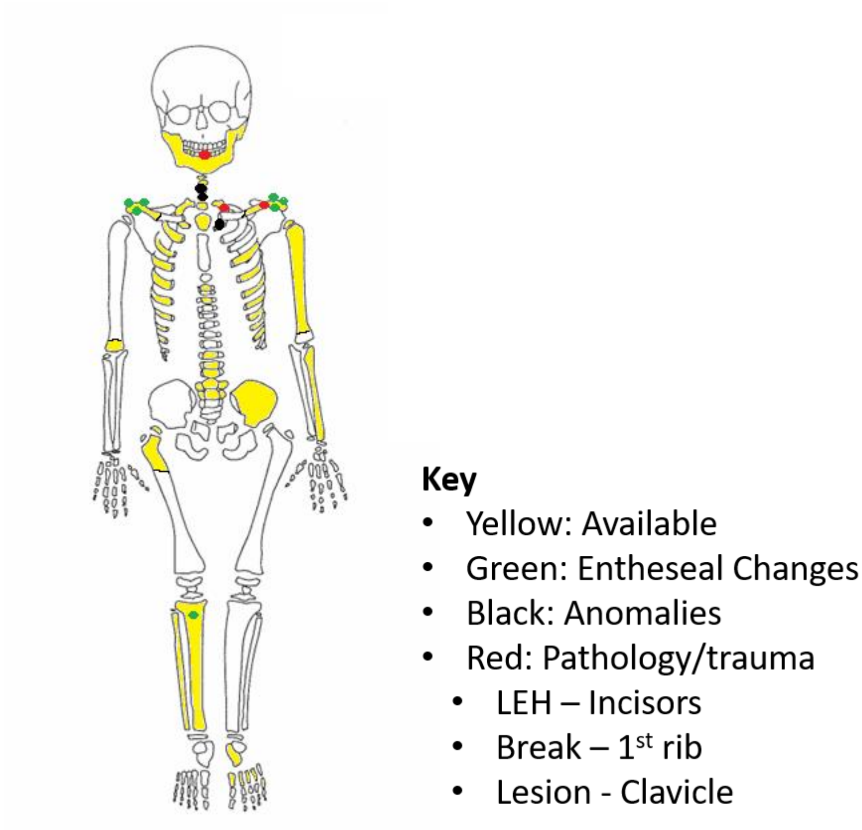
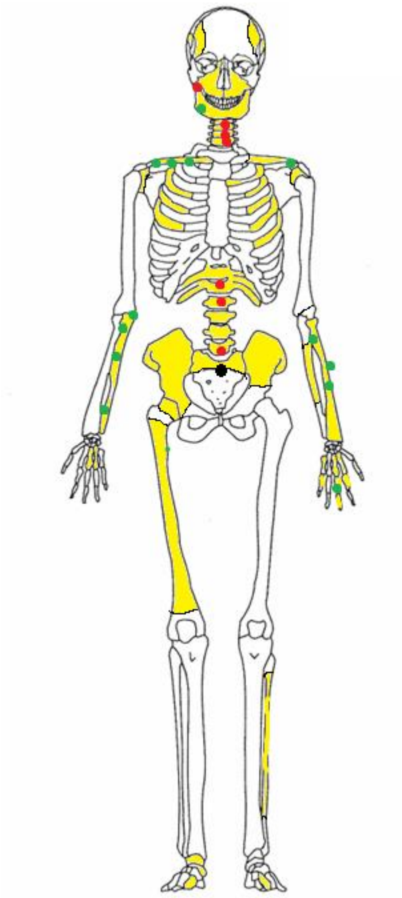



**Figure 29.** Individual 88A inventory with key.



**Key**

- Yellow: Available
- Green: Entheseal Changes
- Black: Anomalies
  - Lumbarization of S1
  - Subluxation of mandible
- Red: Pathology
  - Osteoarthritis

**Figure 30.** Individual 218 inventory with key.

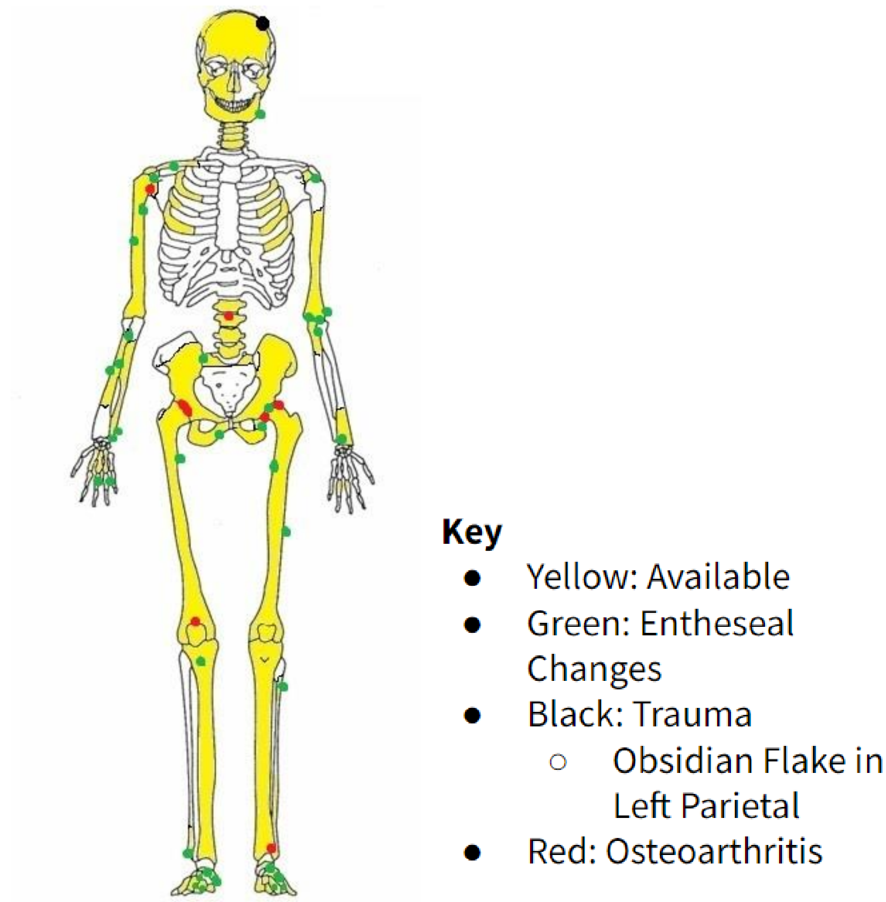



**Figure 31.** Individual 163A inventory with key.