

**SELECTED FOR DEATH: A BIOARCHAEOLOGICAL STUDY OF THE
BIOCULTURAL PROFILES OF HUMAN SACRIFICES AT EL POLLO, MOCHE
VALLEY, PERÚ**

**ELEGIDOS PARA MORIR: UN ESTUDIO BIOARQUEOLÓGICO DE LOS
PERFILES BIOCULTURALES DE LOS SACRIFICIOS HUMANOS EN EL
POLLO, VALLE DE MOCHE, PERÚ**

Rachel G. Witt

Abstract

Human sacrifice is a form of ritual violence used by empires to generate images of coercion and demonstrate the immutable power of those staging the event. Although lethal wounds provide physical evidence of sacrifice, a lifetime of experiences are inscribed on the sacrificed body. This chapter presents the results of a bioarchaeological analysis of human sacrifices from the site of El Pollo (AD 1300-1550) outside the Chimú capital city Chan Chan in the Moche valley, Huanchaco, on the north coast of Perú. The goal of this paper is to reconstruct the life histories of El Pollo sacrificial victims using biocultural data including health status, healed injuries, and cranial modifications. The results suggest that victim selection parameters involved targeting those who could be transformed into offerings of value, specifically young, healthy individuals from diverse communities throughout the north coast. Although adult victims show evidence of childhood illness and poor health, they too were selected from a variety of north coast communities. In addition to providing a window into the lived experiences of these victims, this study provides new perspectives

Rachel G. Witt. Department of Sociology and Anthropology, Marshall University, 1 John Marshall Dr., Huntington, WV 25701. (witttr@marshall.edu), <https://orcid.org/0009-0000-8989-276X>

on parameters for sacrificial inclusion and how Chimú imperial enterprises impacted the life histories of sacrificial victims at El Pollo.

Keywords: Bioarchaeology, sacrifice, health, cranial modification, Chimú Empire.

Resumen

El sacrificio humano es una forma de violencia ritual organizada por los imperios para demostrar el poder inmutable de los organizadores del evento del sacrificio. El daño corporal y la muerte de la víctima representan evidencia física del sacrificio, sin embargo, las experiencias vividas antes del sacrificio, son documentadas en el cuerpo de la víctima. Este capítulo presenta los resultados del análisis bioarqueológico de los restos óseos humanos del sitio de El Pollo (1300-1550 dC) ubicado en las afueras de la ciudad capital Chimú Chan Chan, Huanchaco, en el valle de Moche, Perú. Aquí, el objetivo de la investigación fue reconstruir las experiencias vividas antes de la muerte de las víctimas en el ritual de sacrificio. Datos bioculturales (estatus, salud, heridas reincidentes, y modificaciones artificiales del cráneo) representan las experiencias vividas. Los resultados muestran que las víctimas fueron ofrendas jóvenes y saludables provenientes de diversas comunidades de la costa norte del Perú. Por el contrario, los adultos hallados en El Pollo, fueron principalmente individuos enfermos en la infancia, pero también fueron elegidos de múltiples comunidades de la costa norte. Aquí, la investigación considera el efecto del desarrollo del Imperio Chimú en las experiencias vividas de las víctimas en el ritual de sacrificio. Este artículo demuestra las experiencias vividas antes muerte de las víctimas, proponiendo una perspectiva nueva de los métodos de la inclusión de las víctimas en el ritual del sacrificio y la función de estos actos de violencia ritual en el desarrollo del Imperio Chimú.

Palabras clave: Bioarqueología, sacrificio, salud, modificaciones artificiales del cráneo, Imperio Chimú.

Human sacrifice was a major component of political systems and religious practices in many ancient societies, especially for early states where authority is only tenuously established and leaders rely on rituals to legitimize and naturalize the new social order (Morris 2007). Effecting communion with the supernatural realm to acquire divine legitimation provides an opportunity to display and reinforce new identities, social differentiation, and political power through the inclusion of specific persons as officiants, observers, and victims, making the ritual of sacrifice itself a medium for transforming the power asymmetries into reality (Inomata and Coben 2006; Swenson 2014; Watts et al. 2016). Despite the diverse manifestations and motivations for sacrifice, the culmination of the event is the moment when victims are violently dispatched (Hubert and Mauss 1964[1898]). Bioarchaeological analyses of injury patterns on the skeletal remains of victims provides a logical starting point for investigating sacrificial methods and motivations for staging these ritual events.

Skeletal remains are not only static reflections of the victims at the time of death but are reservoirs of biocultural information representing a lifetime of cumulative lived experiences. In ancient state societies, political forces and economic structures directly shape elements of human biological realities over the life course (Agarwal 2016; Klaus 2012). Increased exposure to physical violence under nascent political regimes and economic policies altering access to varied dietary resources are circumstances that impact health and wellbeing, and in severe cases result in paleopathological conditions and injuries on the skeleton (Mant et al. 2020). The degree to which political structures and economic policies shape health outcomes is also influenced and constrained by local environments due to bioavailability of nutrients, exposure to infectious pathogens, and parasite loads (Blom et al. 2005; Larsen 2018). Contextualizing skeletal information allows bioarchaeologists to go beyond simply documenting injury patterns or health profiles on human remains as it provides a path for interpreting how the external world, including sociopolitical processes, cultural situations, and environmental circumstances, impact the wellbeing and lived experiences of ancient individuals.

This study redirects the focus of bioarchaeological inquiry of human sacrifice away from trauma analysis to reconstruct the biocultural profiles of individuals selected to be sacrificed at the site of El Pollo during the Chimú and Chimú-Inca periods (AD 1300-1500) in Huanchaco, in the Moche valley on the north coast of Perú. Previous studies at El Pollo and other Chimú sacrificial sites in the Moche valley have revealed that nonadults (children and adolescents) show lethal wounds to the chest. The shared pattern of injuries indicates that the Chimú Empire staged a highly systematic manner sacrificial program motivated by various imperial enterprises (Prieto et al. 2019; Prieto et al. 2024; Prieto and Verano 2023; Witt 2023; Witt et al. in review).

Reconstructions of the biocultural profiles of sacrificial victims enable us to investigate the impacts of Chimú sociopolitical conditions and local environmental circumstances on the lived experiences of these individuals prior to sacrifice. Given the methodical way in which victims were sacrificed, this paper considers if victim selection and inclusion in the ritual events was also conducted in a highly standardized manner. Furthermore, understanding who is selected for sacrifice informs the reconstruction of the historical and social significance underlying acts of sacrifice (Toyne 2016).

It is hypothesized that the skeletal assemblage at El Pollo consists of victims with similar biocultural profiles that reflect shared lived experiences. Demographic, paleopathological, and body modification data are used to reconstruct the biocultural profiles of these individuals over the life course. Biocultural data are then assessed together as a group and compared to other sacrificial contexts in the Moche valley and other contemporary assemblages to contextualize the biocultural profiles of El Pollo sacrificial victims within the sociopolitical and environmental context of the north coast. This work concludes by considering more broadly the sociopolitical motivations selecting these victims for sacrifice within the context of Chimú imperial development and territorial expansion.

Human Sacrifice in the Chimú Empire

The Chimú Empire emerged at the beginning of the Late Intermediate period (ca. AD 1050/1100) in the Moche valley and expanded throughout much of the north coast of Perú until conquered by the Inca Empire (ca. AD 1450/1470) (Moore and Mackey 2008). Between AD 1050-1300, the empire began sponsoring construction projects to intensify irrigation agriculture and expand arable land (Prieto 2023) and establishing rural administrative centers to ensure that tributes from surrounding communities were sent to Chan Chan (Billman et al. 2020; Keatinge 1974, 1975; Keatinge and Conrad 1983; Moseley and Day 1982). Fishing subsistence economy on the coast provided an abundance of marine resources, including shellfish, fish, and sea mammals (Pozorski 1982). These efforts led to the formation of an imperial heartland at the center of which Chan Chan developed into a large urban capital (Moore and Mackey 2008).

After consolidating their core territory, the Chimú shifted to an imperial strategy that involved the creation of new settlements and the incorporation of local nobles into Chimú administration. The Chimú were able to maintain control over compliant communities through the extraction of foreign resources, appropriation of land, and access to trade routes throughout the north coast (Mackey and Klymyshyn 1990; Moore and Mackey 2008). The Chimú Empire often used violence to consolidate newly conquered regions. Reprisal killings at Punta Lobos in the Huarmey valley (Verano and Toyne 2011, see also Verano, this volume, tomo 1) correspond to Chimú expansion south and human sacrifices unearthed at the sites of Chotuna-Chornancap and Túcume coincide with Chimú conquest of the northern Lambayeque (Sicán, AD 900-1300) region (Klaus et al. 2016; Toyne 2011).

Until recently, human sacrifice in the Chimú heartland was only known to the monumental palaces of the Chimú elite in Chan Chan. The immutable and unambiguous expression of Chimú power and authority materializes in the palaces with their imposing facades and restricted entry (Day 1982). Excavations of the burial platform known as Las Avispas documented hundreds of retainer sacrifices dispatched during ceremonies venerating the platform's deceased ruler (Conrad 1982; Day 1982; Moore 2004), which further emphasizes the unprecedented power of the Chimú ruling class.

For over a decade, members of the Programa Arqueológico Huanchaco (or PAHUAN) have uncovered evidence that human sacrifice was an integral part of Chimú imperial enterprises. Excavations in the region outside Chan Chan at the sites of Huanchaquito-Las Llamas (HLL), José Olaya-Iglesia Colonial (JO-IG), and Pampa La Cruz (PLC) indicate that the Chimú staged periodic ritual events that involved sacrificing hundreds of humans and camelids by administering lethal transverse wounds to the chests. The motivation for performing such large-scale events varied but generally functioned to fulfill the numerous needs of the Chimú Empire (Prieto et al. 2019; Prieto et al. 2024; Prieto and Verano 2023).

Recent excavations at the site of El Pollo, a large, rectangular structure located approximately 13 km north of Chan Chan, revealed an additional sacrificial context in which the Chimú staged periodic killing events (Witt 2023; Witt et al. in review). Excavations of the area west of the structure uncovered the remains of 49 humans and 78 juvenile camelids. Radiocarbon dates indicate that victims were deposited outside the rectangular structure during multiple ritual episodes spanning two centuries beginning in the Late Intermediate period and continuing into the Late Horizon following Inca conquest (AD 1300-1550) (Witt 2023; Witt et al. in review). Most victims show evidence of having their chests slit, cut open, or a combination of these activities (Witt 2023; Witt et al. in review). Wound patterns mirror the method of sacrifice documented at HLL and PLC, thereby supporting previous arguments that Chimú sacrifice in the Moche valley followed a set of standardized procedures (Prieto et al. 2019; Prieto et al. 2024).

The sacrificial program at El Pollo, however, differs in several notable ways. Adult men were incorporated into the sacrificial program as victims who sustain cuts to the chest. Cut marks to the chest provide physical evidence of bloodletting; together these are activities unique to El Pollo (Witt 2023; Witt et al. in preparation). Given these novel elements, it is crucial to consider if other aspects of the sacrificial program at El Pollo are also unique. Reconstructions of the victims' biocultural profiles will provide insight into the lived experiences of these individuals and provide the opportunity to consider what made them the ideal victims to target for sacrifice.

Reconstructing the Biocultural Profiles of Human Sacrifices

Bioarchaeological studies assess population-based morbidity patterns by compiling the aggregate characteristics of skeletal assemblages, an approach that has been shown to reveal how social phenomena and environmental circumstances shaped human biocultural realities in the past (Armelagos and Cohen 1984; Cohen and Crane-Kramer 2007). Several inherent issues in cemetery assemblages limit interpretative capacity when analyzing skeletal data from archaeological sites, including selective mortality, hidden heterogeneity in frailty and disease risk, and changes in fertility, mortality, and migration patterns (Wood et al. 1992). Skeletal data from individuals or small groups in non-cemetery mortuary contexts are insufficient for reconstructing population-level morbidity patterns but provide an opportunity to explore issues that population studies cannot. Skeletal remains of individuals or groups dispatched for ritual reasons, like sacrifice, typically share salient characteristics that account for their sacrificial inclusion (Schwartz 2017). Their collective biocultural profile is thus well suited to explore other elements of the sociopolitical context, including social organization, power asymmetries, and the role of the state.

The human body is a biological entity and a cultural artifact in which the bones reflect the cumulative lived experiences of the individual within a particular social and historical context (Sofaer 2006). Life histories are embodied in the skeleton (Knudson and Stojanowski 2008), and the body is the embodiment of larger cultural worldviews and

ideologies (Martin et al. 2013). For example, body modification, like cranial modification, is a process in which close kin inscribe a particular social identity onto infants by altering the shape of the head (Blom 2005; Torres-Rouff 2002). As a modified cranium is permanent and visible, the head shape represents the intentional construction of group membership, be it ethnic affiliation (Blom 2005; Torres-Rouff 2002; Velasco 2016, 2018) or geographic origins (Pechenkina and Delgado 2006).

Skeletal data may illuminate individual responses to social institutions and environmental conditions, especially in contexts in which the body is exposed to political forces that include coercive policies and harmful practices. Warfare, captive-taking, and sacrifice are types of violence periodically sanctioned by the state in support of territorial expansion, social dominance, and economic exploitation (Martin et al. 2013; Walker 2001). By placing certain individuals and groups at extreme risk for trauma and early death, these actions show disregard for the wellbeing of individuals and groups the state has marginalized and may be reflected in the skeletal data (Judd 2002; Martin et al. 2010).

Once it is embedded in long-standing social institutions, violence becomes less overt as it normalizes suffering (Klaus 2012). The wellbeing of ancient peoples may be impacted by unfair food distribution policies that provide inadequate access to varied nutritional staples (Tung 2012). Such circumstances may not directly result in lethal injuries but puts certain individuals at a greater risk for poorer health, nutritional problems, and early death. Environmental circumstances also impact biological patterning. Changes to settlement patterns may force individuals to exploit foods with higher risks for anemia-induced parasitism while aggregating populations increases exposure to infectious diseases (Klaus and Tam 2009; Walker 1986).

This work reconstructs the biocultural data to examine the lived experiences of the individuals prior to their selection and inclusion in the sacrificial rituals at El Pollo in the Moche valley. I address the hypothesis that biological profiles of victims sacrificed at El Pollo reflect shared health outcomes, exposure to violence, and geographic origins. This hypothesis is tested by reconstructing the biocultural profiles of these individuals using skeletal indicators of their cumulative life histories, including cranial lesions (porotic hyperostosis and *cribra orbitalia*), patterns of antemortem wounds, and cranial modification forms. Sacrificial victims from El Pollo are compared to contemporary assemblages of sacrificial and non-sacrificial contexts on the north coast. The biocultural profiles of the victims are combined with archaeological information to explore how imperial developments of the Chimú Empire shaped the lived experiences of these individuals prior to sacrifice.

Methods

A total of 49 individuals were documented during excavations at El Pollo, and most were complete or partial skeletons. Several methods were used to document biocultural profiles, including age-at-death, sex, skeletal health, trauma, and cranial modification forms during

a comprehensive laboratory study. Adult age-at-death and sex estimations were calculated based on accepted standards (Buikstra and Ubelaker 1994). Age-at-death for nonadults was estimated based on dental eruption rates, stage of epiphyseal fusion, and long bone lengths (Schaefer et al. 2009).

Porotic hyperostosis, *cribra orbitalia*, periosteal lesions, and linear enamel hypoplasia (LEH) are nonspecific indicators of physiological stress routinely used to assess general health and nutritional status in past populations. No examples of LEH or periosteal lesions were documented at El Pollo; this work relies on examples of porotic hyperostosis and *cribra orbitalia* to establish a general health profile for the victims. *Cribrar orbitalia* develops on the outer cortical table of the roof of the eye orbits, whereas porotic hyperostosis appears on the frontal, parietal, and/or occipital bones of the cranial vault. Both lesions are understood to be an expansion of the diploë coupled with an irregular remodeling of the outer cranial table in response to marrow hypertrophy (Ortner 2003; Brickley 2018). Remains were evaluated for presence, degree of severity, and healing status of porotic hyperostosis and *cribra orbitalia* following established standards (Buikstra and Ubelaker 1994).

Porotic hyperostosis and *cribra orbitalia* are porous cranial lesions that represent short or chronic periods of physical stress associated with a deviation from the body's homeostasis (Temple and Goodman 2014). Porotic hyperostosis is the result of periods of systemic stress due to iron deficiency anemia (Ortner 2003; Oxenham and Cavill 2010) or megaloblastic anemia stemming from B-vitamin deficiency (Walker et al. 2009). Other suggested etiologies include infectious diseases, parasitism (Stuart-Macadam 1991), gastrointestinal conditions (Blom et al. 2005); and metabolic disorders (Brickley et al. 2020).

Cribrar orbitalia may share a similar etiology with porotic hyperostosis, including anemias (Stuart-Macadam 1987), pathogen load, infectious diseases (O'Donnell et al. 2020; Stuart-Macadam 1991), and metabolic disorders (Brickley et al. 2020). Other studies suggest that orbital lesions may result from different disease processes, including renal failure (Rivera and Mirazon Lahr 2017), congenital heart conditions (Brickley 2018; O'Donnell et al. 2020), and scurvy (Walker et al. 2009).

Porotic hyperostosis and *cribra orbitalia* form during the growth of the cranium in infancy and childhood (between 6 months to 12 years of age) (Blom et al 2005; DeWitte and Slavin 2013; Watts 2013). Lesions observed on adults indicate that the individual experienced marrow hyperplasia in infancy or childhood (Blom et al. 2005; Mays 2018:1107; Stuart-Macadam 1985). Sex-based differences in the biological processes involved in the formation of *cribra orbitalia* and porotic hyperostosis have shown that heightened osteoblastic activity in males may account for a higher preponderance of these lesions among them (O'Donnell et al. 2021).

Reconstructions of the frequency and morphology of healed (antemortem) wounds provide a cumulative record of an individual's exposure to violence throughout their life including nonlethal accidents and daily hazards (Jurmain et al. 2009; Walker

2001). Injuries to the skeleton were observed macroscopically using the naked eye and/or a 10x hand lens. Multiple reference materials were consulted to assist with recording and interpreting wound morphology, patterning, and locations (Galloway 1999a, 1999b; Lewis 2018; Redfern and Roberts 2019). Systematic recording of trauma involved: (1) describing the morphology of trauma; (2) documenting time at which the trauma occurred (antemortem, perimortem, or postmortem); (3) documenting the location of the wound; (4) calculating the number of individuals with trauma; and (5) illustrating the anatomical location of trauma. Results reported here focus exclusively on antemortem wounds as these wounds serve as a proxy for the degree to which victims were exposed to violence throughout the life course. Results and discussion of trauma analysis perimortem wounds associated with sacrifice are found elsewhere (Witt 2023, Witt et al. in preparation).

Cranial modification is the intentional or unintentional shaping of the pliable infant crania from the application of a device or apparatus. The steady pressure applied to the growing cranial bones results in an altered cranial shape (Blom 2005; Imbelloni 1933). In the ancient Andes Mountains, cranial modification is a permanent social marker that reflects social identities of ancient populations (Torres-Rouff 2020). Two types of modified crania are known to the north coast of Perú: occipital flattening (fronto-occipital flattening) and annular modification. Fronto-occipital flattening is the unintentional result of cradleboarding during infancy (Verano 1997a). Fronto-occipital flattening has been documented on skeletal assemblages belonging to various cultures, social classes, and ethnic groups in the Lambayeque region on the north coast (Klaus 2008; Shimada et al. 2004). Outside the Lambayeque region, fronto-occipital modification has been documented in numerous north coast skeletal assemblages (Toyne 2016; Verano 1997b; Verano and Toyne 2011) and is often argued to represent the presence of nonlocal individuals from the Lambayeque region (Mackey and Nelson 2020; Prieto et al. 2024). Annular modification is common among skeletal assemblages from the Andean highlands but is rare on the north coast (Antón 1989; MacCurdy 1923). Fronto-occipital modification and annular modification are understood to represent coastal or highland geographic origins, respectively. For this analysis, only crania that were at least 75% complete and fused were included. Cranial modification was observed as present or absent and by the type of flattening (fronto-occipital or annular).

Fisher's exact tests were conducted to identify possible relationships and patterns by comparing different combinations of variables. The null hypothesis states that there is no relationship or correlation between the two variables. If the null hypothesis is rejected ($p \leq 0.05$), it suggests that there is a relationship between the two variables.

Results

The sample from El Pollo consists primarily of nonadults (37/49, 76%), although several adults are represented (12/49, 24%). The sample consists of one infant (1/49, 2%), children (18/49, 38%), adolescents (18/49, 38%), young adults (6/12, 50%), middle adults (5/12,

42%), and one undetermined adult (1/49, 2%). The majority of adults were estimated to be male (11/12, 92%) and one female is represented (1/12, 8%) (**Table 1**).

Table 1.
Age-at-death and sex estimations, El Pollo.

Age and sex (years)	n=
Infant (1-4 yrs)	1
Child (5-11 yrs)	18
Adolescent (12-18 yrs)	18
Nonadult Total	37
Young Adult Male (18/21-35 yrs)	6
Young Adult Female (18/21-35 yrs)	0
Middle Adult Male (35-50 yrs)	4
Middle Adult Female (35-50 yrs)	1
Old Adult Male (50 yrs +)	0
Old Adult Female (50 yrs +)	0
Undetermined Adult	1
Adult Total	12
Sample Total	49

A total of 43 crania were observed for porotic hyperostosis or *cribra orbitalia*; 36 crania were complete and thus examined for both conditions (**Table 2**) and described based on the degree of healing and severity of lesions. Overall, few crania show porotic hyperostosis (6/43, 14.0%) and *cribra orbitalia* (8/37, 21.6%). Among nonadults, one adolescent shows a mild case of porotic hyperostosis with a mix of active and healed lesions (n=1/34, 2.9%). *Cribr orbitalia* is slightly more common among nonadults (n=5/28, 17.9%), including one child (n=1/12, 8.3%) with barely discernable healed lesions. Four adolescents (n=4/16, 25%) exhibit *cribra orbitalia*, with three adolescents showing a mix of active and healed lesions, while the fourth shows severe lesions that were active at the time of death.

Comparisons were made between the frequency of nonspecific indicators of physiological stress and other north coast samples (**Table 2**). The frequency of porotic hyperostosis among nonadults from El Pollo is lower compared to nonadults from Túcume (sacrificed 21.5%, $p = 0.0232$; non-sacrificed 20.4%, $p = 0.0367$), Farfán (41.3%, $p = 0.0003$), and Pacatnamú (27.5%, $p = 0.0044$); a statistically significant relationship. There is no significant relationship in the frequency of porotic hyperostosis among nonadults between El Pollo and Punto Lobos (11.1%, $p = 0.3131$) or the Chimú-Inca burials from JO-IG (33.3%, $p = 0.1577$).

Cribr orbitalia among nonadults is slightly more common at El Pollo (5/28, 17.8%) compared to porotic hyperostosis. The rate at El Pollo is not significantly different when compared to frequencies of *cribra orbitalia* among nonadults from Túcume (sacrificed: 20%, $p = 1$; non-sacrificed: 5.4%, $p = 0.224$), Farfán (26.1%, $p = 0.5137$), Pacatnamú (32.6%, $p = 0.2725$), Punto Lobos (11.1%, $p = 0.7049$), and the Chimú Inca burials from JO-IG (0%, $p = 1$).

Table 2.
Summary of non-specific indicators of physiological stress and cranial modification
forms of El Pollo and other regional samples.

		Sacrifice			Non-sacrifice				
		El Pollo	Huanchaquito Las Llamas ^a	Túcume ^b	Túcume ^b	Farfán ^c	Pacatnamú ^d	Punta Lobos ^e	Jose Olaya – Iglesia Colonial de Huanchaco ^f
Cribra Orbitalia # of cases/# in sample	Nonadult	5/28 (17.9%)	17%	10/50 (20%)	2/37 (5.4%)	6/23 (26.1%)	14/43 (32.6%)	3/27 (11.1%)	0/3
	Adult	3/9 (33.3%)		4/61 (6.5%)	1/19 (5.2%)	3/11 (27.2%)	17/35 (48.5%)	11/89 (12.3%)	0/12
Porotic Hyperostosis # of cases/# in sample	Nonadult	1/34 (2.9%)	14%	11/51 (21.5%)	9/44 (20.4%)	12/29 (41.3%)	11/40 (27.5%)	3/27 (11.1%)	1/3 (33.3%)
	Adult	5/9 (55.6%)		24/81 (29.6)	3/21 (14.2%)	3/11 (27.2%)	12/96 (12.5%)	44/122 (36.1%)	4/12 (33.3%)
Cranial Modification # of cases/# in sample	Nonadult	15/26 (57.7%)	19/111 (17.1%)	9/45 (20%)	16/51 (31.3%)	12/25 (48.0%)	0%	14/39 (35.9%)	2/2 (100.0%)
	Adult	4/8 (50%)	3/3 (100%)	19/75 (25%)	32/105 (30.4%)	8/16 (50%)	38/134 (28.3%)	47/122 (38.5%)	9/11 (81.8%)

^a Prieto et al. (2019)

^b Toyne (2016)

^c Toyne (2006)

^d Verano (1997b)

^e Verano and Toyne (2011)

^f Tschinkel (2022)

^g sample consists of Chimú-Inca burials

Among adults, half of the males and the one female show porotic hyperostosis (n=5/9, 55.6%). Porotic hyperostosis is more common among young adult males (n=2/4, 50%) compared to middle adult males (n=1/3, 33.3%). All healed lesions documented on adults were scored as mild to moderate.

One-third of adults show advanced *cribra orbitalia* (n=3/9, 33.3%) including one young adult male, one middle adult male, and the only female from El Pollo. Only three individuals in the assemblage from El Pollo show both porotic hyperostosis and *cribra orbitalia* (n=3/37, 8.1%), including one young adult male, one middle adult male, and the only adult female (**Figure 1**).

The rate of porotic hyperostosis and *cribra orbitalia* among all males at El Pollo, both those sacrificed by chest opening and those dispatched by other means, is generally higher compared to non-sacrificial, cemetery assemblages on the north coast (**Table 2**). The rate of porotic hyperostosis among adults from El Pollo is higher compared to the non-sacrificial context at Túcume (14.2%, $p = 0.0272$) and Pacatnamú (12.5%, $p = 0.0053$), which are both statistically significant relationships. Fishers exact test comparing *cribra orbitalia* rates between El Pollo adults and adults sacrificed at Túcume is statistically significant ($p = 0.0405$). There is no significant relationship in the adult *cribra orbitalia* rates between El Pollo and non-sacrificed adults from Túcume ($p = 0.0841$), Farfán ($p = 1$), Pacatnamú ($p = 0.4771$), Punto Lobos ($p = 0.1163$), or the Chimú-Inca burials from JO-IG ($p = 1$).



Figure 1. *Cribrā orbitalia* in left and right orbits of middle adult female (EP 119).

Non-sacrificial trauma is rare at El Pollo; only two individuals show antemortem blunt force trauma wounds (2/49, 4%). Among nonadults, one adolescent shows antemortem cranial trauma in the form of a small, circular depression on the right superior frontal bone of the cranial vault. The depression measures 2.0cm x 3.5cm and exhibits blunted, rounded edges. No fractures, perimortem or healed, radiate from the compression site. The circumference of the compressed bone exhibits pin-point porosity, which is perhaps a bony reaction and evidence of healing (**Figure 2**). The second antemortem wound is located on the right hand of a young adult male, specifically on the 4th proximal phalanx. This individual is the only adult to show an antemortem wound in the sample.

In the sample, 34 crania had adequate preservation to document cranial modification (**Tables 2 and 3**). Nonadults (11/26, 42.3%) and adults (4/8, 50%) exhibit unmodified crania (15/34, 44.1%). More than half the crania showed a form of modification (19/34, 55.8%), including both nonadults (15/26, 57.7%) and adults (4/8, 50%). The most common form of cranial modification is fronto-occipital (18/34, 52.9%) and is present in both nonadults (n=14/26, 53.8%) and adults (4/8, 50%). Annular modification is present in only one individual, an adolescent (**Figure 3**). There is no statistically significant relationship in the presence of cranial modification between nonadults and adults ($p = 0.7086$).

Comparisons between El Pollo, HLL, and PLC reveal several patterns. At HLL, nonadults show fronto-occipital (11/130, 8.5%) and annular modification (8/130, 6.2%), although unmodified crania dominate the assemblage (111/130, 85.4%). Fronto-occipital and annular modification forms are represented among nonadults during every sacrificial event at PLC. None of the adults sacrificed at El Pollo, HLL, or PLC

show annular modification. All adults sacrificed at HLL and during Events 3 and 4 at PLC show fronto-occipital modification compared to half of the adults sacrificed at El Pollo. Only one adult from the first sacrificial event at Pampa la Cruz has an unmodified cranium (**Table 3**).



Figure 2. Antemortem wound on the right side of the frontal bone of an adolescent (EP 104).



Figure 3. Annular modification on adolescent (EP 115, 15 years +/- 36) and fronto-occipital flattening on adolescent (EP 116, 15 years +/- 36 months).

Comparisons with other north coast skeletal assemblages (**Table 2**) show that there is a statistically significant relationship between the frequency of cranial modifications between El Pollo nonadults and nonadults from HLL ($p = 0.0001$) and nonadults from the sacrificial ($p = 0.0018$) and non-sacrificial contexts at Túcume ($p = 0.0304$). There was no statistically significant relationship in nonadult cranial modification between El Pollo and Punta Lobos ($p = 0.1262$) or the Chimú-Inca burials from the JO-IG ($p = 0.5053$). Comparisons between adult cranial modification forms from El Pollo and HLL ($p = 0.2364$), Túcume (sacrificial: $p = 0.2085$; nonsacrificial: $p = 0.2632$), Farfán ($p = 1$), Pacatnamú ($p = 0.2359$), Punta Lobos ($p = 0.711$), and the Chimú-Inca burials from the JO-IG ($p = 0.3563$) revealed no statistically significant relationships.

Table 3.
Cranial modification frequencies in Chimú sacrificial sites, Moche valley.

	Unmodified		Fronto-Occipital		Annular	
	Nonadult	Adult	Nonadult	Adult	Nonadult	Adult
El Pollo (n=34)	11/26 (42.3%)	4/8 (50.0%)	14/26 (53.8%)	4/8 (50.0%)	1/26 (3.8%)	0/8
Huanchaquito Las Llamas (n=133)	111/130 (85.4%)	0/3	11/130 (8.5%)	3/3 (100.0%)	8/130 (6.2%)	0/3
Pampa la Cruz (n=186)						
Event 1	10/12 (83.3%)	1/1 (100.0%)	1/12 (8.3%)	0/1	1/12 (8.3%)	0/1
Event 2	11/16 (68.8%)	0/0	4/16 (25.0%)	0/0	1/16 (6.3%)	0/0
Event 3	52/70 (74.3%)	1/11 (9.1%)	13/70 (18.6%)	10/11 (91.0%)	5/70 (7.1%)	0/11
Event 4	27/29 (93.1%)	0/1	1/29 (3.4%)	1/1 (100%)	1/29 (0.03%)	0/1
Event 5	18/20 (90.0%)	0/0	1/20 (5.0%)	0/0	1/20 (5.0%)	0/0
Event 6	26/27 (96.3%)	0/0	0/27	0/0	1/27 (3.7%)	0/0

^a Prieto et al. (2019)

^b Prieto et al. (2023)

Given the small size of the El Pollo assemblage, only limited comparisons may be made to investigate the relationship between nonspecific indicators of physiological stress, antemortem wounds, and cranial modification forms. Among nonadults, one child and three adolescents show both fronto-occipital modification and either *cribra orbitalia* or porotic hyperostosis (4/26, 15.3%). Specifically, one adolescent shows both porotic hyperostosis and fronto-occipital modification (1/26, 3.8%). One child (1/11, 9%) and two adolescents (2/15, 13.3%) exhibit *cribra orbitalia* and fronto-occipital modification. Among the four adults with modified crania, three show porotic hyperostosis, including one young adult male, one middle adult male, and one middle adult female. The middle adult male and female with fronto-occipital modification crania and porotic hyperostosis also show *cribra orbitalia*. Scalp infections resulting from the cranial modification process may mimic porotic hyperostosis (Blom et al. 2005, Farnum 2002, Guillén 1992); this scenario seems unlikely given that majority of individuals with modified crania do not show evidence of porotic hyperostosis.

The only adolescent to show blunt force trauma has an unmodified cranium and shows no nonspecific indicators of physiological stress. The one young adult male with a blunt force injury to the hand has an unmodified cranium but exhibits both porotic hyperostosis and *cribra orbitalia*.

Discussion

Biocultural Profiles

All skeletal assemblages consist of individuals who vary in their underlying morbidity and risk of mortality. Individuals who show healed cranial lesions may represent a healthier group who had a strong immune response, while those without lesions may lack an immune system strong enough to mount a response to an insult (Wood et al. 1992). Thus, the low frequency of El Pollo nonadult cranial lesions and high frequency of El Pollo adult cranial lesions does not necessarily indicate that nonadults selected for sacrifice were healthy or healthier compared to El Pollo adults or the other north coast nonadults at the time of death. Individuals with active cranial lesions may have lower survivorship and greater mortality risks compared to individuals with healed or absent lesions (O'Donnell 2019). This would indicate that skeletal assemblages with a low frequency of active cranial lesions alongside few lesions in mixed stages of healing or absent lesions may represent a group with a lower mortality risk and thus are presumably healthy.

Individuals who develop *cribra orbitalia* may have higher mortality risks and decreased longevity compared to those who only show porotic hyperostosis; *cribra orbitalia* may also represent a more severe illness or physiological disturbance (O'Donnell 2019). Although nonadults with *cribra orbitalia* may be experiencing acute stress, none show multiple nonspecific indicators of physiological stress or lesions pathognomonic for a specific metabolic or infectious disease. The small number of El Pollo adults may account for any statistically significant differences, but it is possible that adults, especially those who show both cranial lesions and who developed *cribra orbitalia*, may have experienced more severe health burdens during infancy and childhood along with an increased mortality risk compared to that experienced by El Pollo nonadults.

Antemortem injuries are rare at El Pollo. Depressed cranial injuries may reflect lethal intent because targeting the head with a blunt weapon serves to inflict damage and disable the victim (Kroman and Symes 2013; Knüsel and Smith 2014; Walker 2001). Nonlethal antemortem wounds typically reflect attempts to render the victim unconscious rather than kill if the goal was to terrorize or capture the individual (Martin et al. 2010). Nonadult cranial injuries, however, cannot be assumed to be the result of interpersonal violence. Children typically land on their head rather than break their fall with an outstretch hand (Wilber and Thompson 1998). A wound sustained during a fall is more likely to depress inward rather than fracture on infant crania (Pudenz et al. 1961), which mirrors the wound on this adolescent.

The wound on the phalanx of the young adult male may similarly be an accidental injury. The shaft of the phalanx exhibits a bulbous callous, with the palmar surface exhibiting a rounded, smooth surface. It appears that the wound was sustained from a direct blow to the dorsum of the digit. Injuries to the hand like the one on this adult male may have been sustained during sporting events, accidental fall, or combat (Galloway 1999b). Excluding the sharp force trauma to the chest, both individuals show no other wounds.

Neither nonadults nor adults show evidence of having endured circumstances conducive to endemic violence prior to being selected for sacrifice. The very low rate of antemortem injuries among the sacrificed nonadults indicates that in addition to being relatively healthy they were unburdened by the risk of violence or other hazards. The general lack of antemortem injuries indicates that these individuals were not part of communities or marginalized groups exposed to endemic violence. Rather, these victims were spared from physical violence until they were selected to be sacrificed.

The presence of modified and unmodified crania documented among nonadults and adults at El Pollo and among other sacrificial contexts in the Moche valley indicate that no group of individuals with a specific modification form were targeted for sacrifice. There is only one case of annular modification, while fronto-occipital modification dominates the assemblage. Statistically, cranial modification appears to be more frequent among El Pollo nonadults compared to HLL and both Túcume contexts; the frequency of El Pollo adult cranial modification forms is similar among all north coast adults. This indicates that El Pollo nonadults generally represent a more heterogeneous group of individuals compared to these other contexts, perhaps consisting of both local and nonadult victims from the distant Lambayeque region. It is possible that the victims selected to be sacrificed at El Pollo, nonadults in particular, were purposefully drawn from multiple communities that had been recently conquered by the Chimú. Stable isotope analysis tentatively supports the view that the sample consists of a mix of individuals drawn from multiple geographic regions (Witt 2023) and will be explored in a future work.

Interpretations of Biocultural Profiles and the Chimú Empire

Combining the biocultural data with archaeological information detailing the nature of Chimú imperial developments provides an avenue for interpreting how the policies and practices of the Chimú Empire shaped the lived experiences of these individuals selected for sacrifice.

Human sacrifice corresponds to a period when Chimú ruling elites were aggressively expanding their territory. Chimú conquest and consolidation involved varying degrees of alternations to agricultural production, irrigation management, and settlement patterns to produce and redirect resources to satisfy the demands of the growing capital city and to maintain

the wealth of its rulers (Billman et al. 2020; Cutright 2015; Keatinge and Conrad 1983). Imperial practices and regulations may prejudicially alter morbidity profiles among communities by impacting access to resources and changing settlements patterns, which may ultimately result in poor health conditions (Tung 2012). The imposition of what was an extractive, and perhaps exploitive, economy may have negatively impacted the availability of food staples or altered the local subsistence patterns, creating circumstances in which nutritionally inadequate diets, infections, parasitism, or a combination thereof, may account for the cranial lesions observed at El Pollo.

In addition to these transformations in socioeconomic policies, environmental factors may have impacted and even exacerbated the health issues observed among several El Pollo sacrificial victims. Studies of marine-dependent populations have cited pathogen burden in contaminated water sources, inadequate sanitation in agricultural settlements, and marine-borne parasites found in dietary staples including shellfish and other marine resources as the possible explanations for cranial lesions (Bathurst 2004; Blom et al. 2005; Walker 1986). Changes to agricultural policy altering access to various resources may force communities to intensify exploitation of marine foods, like shellfish. Shellfish consumption has a high risk of anemia-induced parasitism that may cause chronic gastrointestinal conditions including abdominal bleeding and diarrhea resulting in biological stress (Blom et al. 2005; Farnum 2002; Klaus and Tam 2009). It is possible that the adult victims sacrificed at El Pollo were drawn from such communities that had been incorporated in the Chimú extractive economy where a shift in food availability altered subsistence patterns thereby impacting their overall health.

Preliminary analysis of the dental diseases at El Pollo confirm that many victims relied heavily on shellfish as evidenced by a high frequency tooth crown damage, including dental attrition and chipping (Witt 2023), which is a pattern consistent with consuming shellfish with abrasive elements like sea salt, sand, and broken shell pieces (Watson et al. 2013). Similarly, results of stable isotopes analysis of sacrificial victims from El Pollo and PLC reported by Witt (2023) revealed that individual diets vary in the contributions of marine and terrestrial food items. Correlations between cranial lesions and reliance on specific dietary items as revealed through stable isotope analysis will be discussed in a future work.

Imperial policies may contribute to improved lived experiences among community members by curtaining internecine violence (D'Altroy 1992). While tensions between rural communities, local administrators, and elites in Chan Chan may have certainly existed, trauma analysis indicates that these tensions did not necessarily manifest as violence. The imposition of Chimú imperial rule and installation of local administrators may have curtailed internecine violence between communities. It appears that for the Chimú Empire violence was reserved for other events commemorating the conquest of foreign communities.

Chimú sacrifice appears to have generally targeted young, healthy individuals from multiple communities. According to ethnohistoric accounts, the Inca Empire also

coordinated a ritual program known as the *qhapaq hucha* (*capacocha*, or *capac huacha*) ceremony (Cobo 1990[1653]). Victim selection parameters targeted young, healthy individuals from multiple geographic locales (de la Fuente Castro et al. 2024; Previgliano et al. 2003; Socha et al. 2021). The ritual functioned to amplify the victims' status as valued offerings while simultaneously articulating the political authority of the Inca ruler who could remind provincial nobles of their compliant status by calling upon them to provide sacrificial victims (Besom 2013).

Both the Chimú and Inca Empires appear to prefer dispatching young, healthy people from diverse geographic locales. Inca *qhapaq hucha* ceremony, however, is not analogous to sacrifice in Chimú Empire given the distinct political structures and social organization of these empires. Despite these differences, they shared similar imperial enterprises, including interest in territorial expansion and consolidation. Perhaps like the Inca, the Chimú Empire viewed the El Pollo nonadults as offerings of value whose death could best articulate imperial efforts to expand and consolidate a large region consisting of diverse communities. Selecting victims from multiple communities recently brought into the Chimú imperial sphere would symbolically articulate these new power relations between Chimú ruling elite and the subservient communities who must provide the victims.

Conclusions

This approach sheds light on the lived experiences of the individuals selected for sacrifice. Comparing the profiles of the sacrificed and non-sacrificed individuals provides an opportunity to explore how biocultural profiles varied in relation to social factors as reflected in their sacrificial inclusion or exclusion. Individuals sharing social roles, like those selected for sacrifice, tend to have access to similar resources, quantities of socioeconomic capital, and cultural identities that create shared patterns of biological health status (Toyne 2016). Although numerous studies have shown that demographic features and poor health may account for sacrificial inclusion (Blevins et al. 2023; Klaus et al. 2016; Toyne 2016), the health profiles between sacrificial and non-sacrificial victims is not always this straightforward (Buzon and Judd 2008).

The results of this study indicate that nonadult victims generally shared similar lived experiences in that most suffered few illnesses or physiological disturbances resulting in cranial lesions. Adults likely experienced more severe childhood illnesses or physiological disturbances, but their healthy immune response ensured that they survived despite having lived in circumstances conducive to nutrition inaccessibility, parasitism, or infection. Victims studied here perished from sacrificial death rather than natural causes which limits interpretations of the overall risk of poor health and death among north coast populations.

These results tentatively support the hypothesis that sacrificial inclusion may have targeted primarily healthy individuals from multiple geographic locales who experienced few physical risks throughout their life course.

By contextualizing the biocultural data within the early phases of Chimú imperial developments, it is possible to understand how the policies and practices of the Chimú Empire shaped the lived experiences of the individuals selected for sacrifice. This perspective is crucial for understanding why certain individuals are deemed appropriate victims and, through inference, the desired outcomes of sacrifice. This work contributes to a growing body of literature that aims to illuminate how the dynamics of state power directly impact the lives of those individuals who lived and eventually died for the empire.

Acknowledgements. Funding was provided by the Rust Family Foundation (RFF-2019-110), the Lambda Alpha National Honors Society, Tulane University School of Liberal Arts Summer Merit Fellowship, and the Stone Center Summer Field Research Grants. We thank members of the Programa Arqueológico Huanchaco and students from Universidad Nacional de Trujillo for field and laboratory assistance. Excavations at El Pollo and permission to analyze human skeletal remains were approved under the Ministerio de Cultura R.D. N° 287-2019/DGPA/VMPCIC/MC de fecha 16 de julio de 2019.

REFERENCE CITED

Agarwal, Sabrina

- 2016 Bone morphologies and histories: Life course approaches in bioarchaeology. *American Journal of Physical Anthropology* 159(61):130-149.

Antón, Susan

- 1989 Intentional cranial vault deformation and induced changes of the cranial base and face. *American Journal of Physical Anthropology* 79(2):253-267.

Armstrong, George and Marl Cohen

- 1984 *Paleopathology and the origins of agriculture*. Academic Press, Orlando.

Bathurst, Rhonda

- 2005 Archaeological evidence of intestinal parasites from coastal shell middens. *Journal of Archaeological Science* 32(1):115-123.

Besom, Thomas

- 2013 *Inka Human Sacrifice and Mountain Worship*. University of New Mexico Press, Albuquerque.

Billman, Brian, Dana Bardolph, Jean Hudson, and Jesus Briceño

- 2020 Fisherman, Farmer, Rich Man, Poor Man, Weaver, Partialidad Chief? Household Archaeology at Cerro la Virgen, a Chimú town within the hinterland of Chan Chan. In *Maritime Communities of the Ancient Andes*, edited by Gabriel Prieto, and Daniel Sandweiss. University Press of Florida, Gainesville.

Blevins, Kelly, Madeline McGrane, Josefina Lory, Salvador Guilliem Arroyo, and Jane Buikstra

- 2023 Structural Violence and Physical Death at Tlatelolco: Selecting the Chronically Malnourished for Sacrifice at a Late Postclassic Mesoamerican City (1300-1521 CE). *Bioarchaeology International* 7(1):1-31.

Brickley, Megan

- 2018 Cribra orbitalia and porotic hyperostosis: A biological approach to diagnosis. *American Journal of Physical Anthropology* 167(4):896-902.

Brickley, Megan, Rachel Ives, and Simon Mays

2020 *The bioarchaeology of metabolic bone disease*. Academic Press, London.

Blom, Deborah

2005 Embodying borders: human body modification and diversity in Tiwanaku society. *Journal of Anthropological Archaeology* 24(1):1-24.

Blom, Deborah E., Jane Buikstra, Linda Keng, Paula Tomczak, Eleanor Shoreman, and Debbie Stevens-Tuttle

2005 Anemia and childhood mortality: Latitudinal patterning along the coast of pre-Columbian Perú. *American Journal of Physical Anthropology* 127(2):152-169.

Buikstra, Jane and Douglas Ubelaker

1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archaeological Survey, Fayetteville.

Buzon, Michele and Margaret Judd

2008 Investigating health at Kerma: sacrificial versus nonsacrificial individuals. *American Journal of Physical Anthropology* 136(1):93-99.

Cobo, Bernabé

1990[1653] *Inca Religion and Customs*. Translated and edited by Roland Hamilton. University of Texas Press, Austin.

Cohen, Mark and Gillian Crane-Kramer

2007 *Ancient health: skeletal indicators of agriculture and economic intensification*. University Press of Florida, Gainesville.

Conrad, Geoffrey

1982 The burial platforms of Chan Chan: some social and political implications. In *Chan Chan: Andean Desert City*, edited by Michael Moseley and Kent Day, pp. 87-117, University of New Mexico, Albuquerque.

Cutright, Robyn

2015 Eating Empire in the Jequetepeque: A Local View of Chimú Expansion on the

North Coast of Perú. *Latin American Antiquity* 26(1):64-86.

D'Altroy, Terence 1992

1992 *Provincial Power in the Inca Empire*. Smithsonian Institution Press, Washington, D.C.

Day, Kent

1982 Ciudadelas: Their form and function. In *Chan Chan: Andean Desert City*, edited by Michael Moseley and Kent Day, pp. 55-66. University of New Mexico, Albuquerque.

De la Fuente Castro, Constanza Cortés, Maanasa Raghaven, Daniela Castillo, Mario Castro, Ricardo Verdugo, Mauricio Morgana

2024 The genomic and cultural diversity of the Inka Qhapaq hucha ceremony in Chile and Argentina. *Genome Biology and Evolution* 16(9):evae196.

DeWitte, Sharon, and Philip Slavin

2013 Between famine and death: England on the eve of the Black Death—evidence from paleoepidemiology and manorial accounts. *Journal of Interdisciplinary History* 44(1):37-60.

Farnum, Julie

2002 Biological consequences of social inequalities in prehistoric Perú. University of Missouri-Columbia, 2002. Unpublished Ph.D. Dissertation, University of Missouri, Colombia.

Galloway, Alison

1999a *Broken Bones: Anthropological Analysis of Blunt Force Trauma*. CC Thomson, Springfield, Illinois.

1999b Fracture patterns and skeletal morphology: the upper extremity. In *Broken bones: anthropological analysis of blunt force trauma*, edited by Alison Galloway, pp. 113-159. CC Thomas, Springfield.

Guillén, Sonia Elizabeth

1992 The chinchorro culture: mummies and crania in the reconstruction of preceramic coastal adaptation in the South-Central Andes. Unpublished Ph.D. Dissertation University of Michigan, Ann Arbor.

Hubert, Henri and Marcel Mauss

1964[1898] *Sacrifice: Its nature and function*. Chicago University Press, Chicago, Illinois.

Imbelloni, José

1933 Los pueblos deformadores de los Andes. La deformación intencional de la cabeza como arte y como elemento diagnóstico de las culturas. *Anales del Museo Argentino de Ciencias Naturales* 37(75):209-253.

Inomata, Takeshi and Lawrence Coben

2006 *Archaeology of performance: theaters of power, community, and politics*. Rowman Altamira, Lanham.

Keatinge, Richard W.

1975 Urban Settlement Systems and Rural Sustaining Communities: An Example from Chan Chan's Hinterland. *Journal of Field Archaeology* 2(3):215-227.

1974 Chimú Rural Administrative Centers in the Moche Valley, Perú. *World Archaeology* 6(1):66-82.

Keatinge, Richard and Geoffry Conrad

1983 Imperialist Expansion in Peruvian Prehistory: Chimú Administration of a Conquered Territory. *Journal of Field Archaeology* 10(3):255-283

Keatinge, Richard and Kent Day

1974 Chan Chan: A Study of Precolumbian Urbanism and the Management of Land and Water Resources in Perú. *Archaeology* 27(4):228-235.

Klaus, Haagen

2014 Frontiers in the Bioarchaeology of Stress and Disease: Cross-Disciplinary Perspectives from Pathophysiology, Human Biology, and Epidemiology. *American Journal of Physical Anthropology* 155(2):294-308.

2012 The Bioarchaeology of Structural Violence: A Theoretical Model and a Case Study. In *The Bioarchaeology of Violence*, edited by Debra L. Martin, Ryan P. Harrod, and Ventura R. Perez, pp. 29-62. University Press of Florida, Gainesville.

- 2008 Out of Light Came Darkness: Bioarchaeology of Mortuary Ritual, Health, and Ethnogenesis in the Lambayeque Valley Complex, North Coast Perú, A.D. 900-1750. Unpublished PhD dissertation, Department of Anthropology, The Ohio State University, Columbus.

Klaus, Haagen and Manuel Tam

- 2009 Contact in the Andes: Bioarchaeology of systemic stress in colonial Mórrope, Perú. *American Journal of Physical Anthropology* 138(3):356-368

Klaus, Haagen and Marla Toyne

- 2016 *Ritual Violence in the Ancient Andes*. University of Texas Press, Austin.

Klaus, Haagen, Bethany Turner, Fausto Saldaña, Samuel Castillo, and Carlos Wester

- 2016 Human Sacrifice at the Chotuna-Chornancap Archaeological Complex: Traditions and Transformations of Ritual Violence Under Chimú and Inka Rule. In *Ritual Violence in the Ancient Andes*, edited by Haagen Klaus and Marla Toyne, pp. 178-210. University of Texas Press, Austin.

Knudson, Kelly and Christopher Stojanowski.

- 2008 New directions in bioarchaeology: Recent contributions to the study of human social identities. *Journal of Archaeological Research* 16(4):397-432.

Knüsel, Christopher and Martin Smith

- 2014 *The Routledge Handbook of the Bioarchaeology of Human Conflict*. Routledge, Abingdon.

Kroman, Anne and Steven Symes

- 2013 Investigation of Skeletal Trauma. In *Research Methods in Human Skeletal Biology*, edited by Elizabeth DiGangi and Megan Moore, pp. 219-239. Elsevier, New York.

Judd, Margaret

- 2002 Ancient injury recidivism: an example from the Kerma period of ancient Nubia. *International Journal of Osteoarchaeology* 12(2):89-106.

Jurmain, Robert, Eric Bartelink, Alan Leventhal, Viviana Bellifemine, Irina Nechayec, Melynda Atwood and Diane DiGiuseppe

- 2009 Paleoepidemiological patterns of interpersonal aggression in a prehistoric central California population from CA-ALA-329. *American Journal of Physical Anthropology* 139(4):462-473.

Larsen, Clark

- 2018 The bioarchaeology of health crisis: Infectious disease in the past. *Annual Review of Anthropology* 47(1):295-313.

Lewis, Mary

- 2018 *Paleopathology of Children: Identification of Pathological Conditions in the Human Skeletal Remains of Non-Adults*. Elsevier Academic Press, London.

Mackey, Carol and Alexandra M. Ulana Klymyshyn

- 1990 The southern frontier of the Chimú empire. In *Northern Dynasties: Kingship and Statecraft in Chimor*, edited by Michael Moseley and Alana Cordy-Collins, pp. 195-226. Dumbarton Oaks, Washington, D.C.

MacCurdy, George

- 1923 Human skeletal remains from the highlands of Perú. *American Journal of Physical Anthropology* 6(3):217-329.

Mackey, Carol and Andrew Nelson

- 2020 *Life, Death and Burial Practices during the Inca Occupation of Farfán on Peru's North Coast*. Andean Past Special Publications, New York.

Mant, Madeleine, Carlina de la Cova, and Megan Brickley

- 2020 Intersectionality and trauma analysis in bioarchaeology. *Journal of Physical Anthropology: Theory and Synthesis* 174(4):583-594.

Martin, Debra, Ryan Harrod, and Ventura Pérez

- 2013 *Bioarchaeology: An integrated approach to working with human remains*. Springer Science & Business Media, New York.

Martin, Debra, Ryan Harrod, and Misty Fields

- 2010 Beaten down and worked to the bone: Bioarchaeological investigations of women and violence in the ancient Southwest. *Landscapes of Violence* 1(1):1-19.

Mays, Simon

- 2018 Micronutrient deficiency diseases: Anemia, scurvy, and rickets. In *The international encyclopedia of biological anthropology*, edited by Wenda Trevathan, pp. 1-5, Wiley-Blackwell, Hoboken, NJ.

Moore, Jerry

- 2004 The Social Basis of Sacred Spaces in the Prehispanic Andes: Ritual Landscapes of the Dead in Chimú and Inka Societies. *Journal of Archaeological Method and Theory* 11(1):83-124.

Moore, Jerry, and Carol Mackey

- 2008 The Chimú Empire. In *Handbook of South American Archaeology*, edited by Helaine Silverman and William Isbell, pp. 783-807. Springer, New York.

Morris, Ellen

- 2007 Sacrifice for the State: First Dynasty Royal Funerals and the Rites at Macramallah's Rectangle. In *Performing Death: Social Analyses of Funerary Traditions in the Ancient Near East and Mediterranean*, edited by N. Laneri, pp. 15-38. Oriental Institute, Chicago.

Moseley, Michael and Kent Day

- 1982 Chan Chan: Andean Desert City. University of New Mexico Press, Albuquerque.

O'Donnell, Lexi

- 2019 Indicators of stress and their association with frailty in the precontact southwestern United States. *American Journal of Physical Anthropology* 170(3):404-417.

O'Donnell, Lexi, Eric Hill, Amy Anderson, and Heather Edgar

- 2021 A biological approach to adult sex differences in skeletal indicators of childhood stress. *American Journal of Biological Anthropology* 177:381-401

O'Donnell, Lexi, Eric Hill, Amy Anderson, and Heather Edgar

- 2020 Cribra orbitalia and porotic hyperostosis are associated with respiratory infections in a contemporary mortality sample from New Mexico. *American Journal of Physical Anthropology* 173(4):721-733.

Ortner, Donald

- 2003 *Identification of pathological conditions in human skeletal remains*. Academic Press an Imprint Elsevier, London.

Oxenham, Marc Fredrick and Ivor Cavill

- 2010 Porotic hyperostosis and cribra orbitalia: the erythropoietic response to iron-deficiency anaemia. *Anthropological Science* 118(3):199-200.

Pechenkina, Ekaterina and Mercedes Delgado

- 2006 Dimensions of health and social structure in the Early Intermediate Period cemetery at Villa El Salvador, Perú. *American Journal of Physical Anthropology* 131(2):218-235.

Pozorski, Shelia

- 1982 Subsistence Systems in the Chimú State. In *Chan Chan: Andean Desert City*, edited by Michael Moseley and Kent Day, pp. 177-196 M, University of New Mexico Press, Albuquerque.

Previgliano, Carlos, Constanza Ceruti, Johan Reinhard, Dacundo Arias Araoz, and Josefina Gonzales Diez

- 2003 Radiologic evaluation of the Llullaillaco mummies. *American Journal of Roentgenology* 181(6):1473-1479.

Prieto, Gabriel

- 2023 Creando el Valle de Chimor: Reconsideraciones y Estudios Preliminares de la Mega Infraestructura Chimú en los Alrededores de Chan Chan (Siglos XI y XV DC). *Chungara* 55(3):435-461.

Prieto, Gabriel, John Verano, Nicolas Goepfert, Douglas Kennett, Jeffery Quilter, Steven LeBlanc, Lars Fehren-Schmitz et al.

- 2019 A mass sacrifice of children and camelids at the Huanchaquito-Las Llamas site, Moche Valley, Perú. *PLoS ONE* 14(3):e0211691.

Prieto, Gabriel, John Verano, Ann Pollard Rowe, Feren Castillo, Luis Flores, Julio Asencio, Alan Chachapoyas et al.

- 2024 Pampa La Cruz: A New Mass Sacrificial Burial Ground during the Chimú Occupation in Huanchaco, North Coast of Perú. *Nawpa Pacha* 44(1):69-154.

Prieto, Gabriel, and John Verano

- 2023 From brave warriors to innocent children: Understanding the foundations of ritual violence in the Moche Valley, North Coast of Perú, AD 200-1450. In *Human Sacrifice and Value*, edited by Matthew Walsh, Sean O'Neill, Mariana Moen, and Svein Gullbekk, pp. 219-257. Routledge, London.

Pudenz, Robert, Edwin Todd, and C. Hunter Shelden

- 1961 Head injuries in infants and young children. *California Medicine* 94(2):6-71.

Redfern, Rebecca and Charlotte Roberts

- 2019 Trauma. In *Ortner's identification of pathological conditions in human skeletal remains*, edited by Jane Buikstra, pp. 211-284, Academic Press an Imprint Elsevier, London.

Rivera, Feances and Marta Mirazón Lahr

- 2017 New evidence suggesting a dissociated etiology for cribra orbitalia and porotic hyperostosis. *American journal of physical anthropology* 164(1):76-96.

Schaefer, Maureen, Sue Black, and Louise Scheuer

- 2009 *Juvenile Osteology*. Elseiver, New York.

Schwartz, Glenn

- 2017 The Archaeological Study of Sacrifice. *Annual Review of Anthropology* 46(1):223-240.

Shimada, Izumi, Kenichi Shinoda, Julie Farnum, Robert Corruccini, and Hirokatsu Watanabe

- 2004 An Integrated Analysis of Pre-Hispanic Mortuary Practices: A Middle Sicán Case Study. *Current Anthropology* 45(3):369-402.

Socha, Dagmara, Johan Reinhard, and Ruddy Chávez Perea

- 2021 Inca human sacrifices from the Ampato and Pichu Pichu volcanoes, Perú: new results from a bio-anthropological analysis. *Archaeological and Anthropological Sciences* 13(94):1-14.

Sofaer, Joanna

- 2006 *The Body as Material Culture: a theoretical osteoarchaeology*. Cambridge University Press, London.

Stuart-Macadam, Patricia

- 1992 Anemia in past human populations, In *Diet, Demography, and Disease: Changing Perspectives on Anemia*, edited by Patricia Stuart-Macadam and Susan Kent, pp. 151-170, New York, Aldine de Gruyter.
- 1991 Anaemia in Roman Britain: Poundbury Camp. In *Health in past societies: Biocultural interpretations of human skeletal remains in archaeological contexts*, edited by Helen Bush and Marek Zvelebil. pp. 101-113, University of Michigan, Ann Arbor.
- 1987 A radiographic study of porotic hyperostosis. *American Journal of Physical Anthropology* 74(4):511-520.
- 1985 Porotic hyperostosis: Representative of a childhood condition. *American Journal of Physical Anthropology* 66(4):391-398.

Swenson, Edward

- 2014 Dramas of the dialectic: sacrifice and power in ancient polities, In *Violence and Civilization*, edited by Robert Campbell, pp. 28-60, Oxford University Press, Oxford.

Temple, Daniel and Alan Goodman

- 2014 Bioarcheology Has a “Health” Problem: Conceptualizing “Stress” and “Health” in Bioarcheological Research. *American Journal of Physical Anthropology* 155(2):186-191.

Torres-Rouff, Christina

- 2002 Cranial vault modification and ethnicity in Middle Horizon San Pedro de Atacama, Chile. *Current Anthropology* 43(1):163-171.

Toyne, Marla

- 2016 Life Before Death: A Paleopathological Examination of Human Sacrifice at the Templo de la Piedra Sagrada, Túcume, Perú. In *Ritual Violence in the Ancient Andes*, edited by Haagen Klaus and Marla Toyne, pp. 215-243, University of Texas Press, Austin.
- 2011 Interpretations of *Pre-Hispanic Ritual Violence at Túcume, Perú, from Cut Mark Analysis*. *Latin American Antiquity* 22(4):505-524.
- 2006 Analysis of Human Skeletal Remains from the Late Intermediate Period Occupation of Farfán, Perú. Technical report on file with author.

Tschinkel, Khrystyne

- 2022 The Biological and Cultural Impacts of European Colonialism in Early Colonial Perú: A Bioarchaeological Study of Late Pre-Contact and Circum-Contact Period Cemetery in Northern Coastal Perú. Unpublished PhD dissertation, Department of Anthropology, Tulane University, New Orleans.

Tung, Tiffany

- 2012 *Violence, Ritual, and the Wari Empire*. University of Florida Press, Gainesville.

Velasco, Matthew

- 2018 Ethnogenesis and social difference in the Andean Late Intermediate Period (AD 1100–1450): a bioarchaeological study of cranial modification in the Colca Valley, Perú. *Current Anthropology* 59(1):98-106.
- 2016 Mortuary tradition and social transformation during the Late Intermediate Period (AD 1100–1450): a bioarchaeological analysis of aboveground burials in the Colca Valley, Perú. PhD dissertation, Vanderbilt University, Nashville.

Verano, John

- 1997a Advances in paleopathology in Andean South America. *Journal of World Prehistory* 11(2):237-268.
- 1997b Physical Characteristics and Skeletal Biology of the Moche Population at Pacatnamú. In *The Pacatnamú Papers*, Volume 2: The Moche Occupation, edited by Christopher B. Donnan and Guillermo Cock, pp. 189-214. Fowler Museum of Cultural History, University of California, Los Angeles.
- 2001 The Physical Evidence of Human Sacrifice in Ancient Perú. In *Ritual Sacrifice in Ancient Perú*, edited by Elizabeth Benson and Anita Cook, pp. 165-184. University of Texas Press, Austin.

Verano, John and Marla Toyne

- 2011 Estudio bioantropológico de los restos humanos del Sector II, Punta Lobos, valle de Huarmey. In *Arqueología de la Costa de Ancash. Boletín Del Centro de Estudios Precolombinos de La Universidad de Varsovia, Vol. 8*, edited by G. Milosz, pp. 421-446. l'Institut Français D'études Andines, Varsovia.

Walker, Philip

- 2001 A bioarchaeological perspective on the history of violence. *Annual Review of Anthropology* 30(1):573-596
- 1986 Porotic hyperostosis in a marine-dependent California Indian population. *American Journal of Physical Anthropology* 69(3):345-354.

Walker, Phillip, Rhonda Bathurst, Rebecca Richman, Thor Gjerdrum, and Valerie Andrushko

- 2009 The causes of porotic hyperostosis and cribra orbitalia: A reappraisal of the iron deficiency-anemia hypothesis. *American Journal of Physical Anthropology* 139(2):109-125.

Watson, James, Bernado Arriaza, B. Standen, and Iván Muñoz Ovalle

- 2013 Tooth Wear Related to Marine Foraging, Agro-Pastoralism and the Formative Transition on the Northern Chilean Coast, *International Journal of Osteoarchaeology* 23(3):287-302.

Watts, Joseph, Oliver Sheehan, Quentin Atkinson, Joseph Bulbulia, and Russell Gray

- 2016 Ritual human sacrifice promoted and sustained the evolution of stratified societies. *Nature* 532(7598):228-231.

Watts, Rebecca

- 2013 Childhood development and adult longevity in an archaeological population from Barton-upon-Humber, Lincolnshire, England. *International Journal of Paleopathology* 3(2):95-104.

Wilber, John and George Thompson

- 1998 The multiply injured child, In *Skeletal Trauma in Children*, edited by Neil Green and Marc Swiontkowski, pp. 71-102, WB Saunders Company, Philadelphia.

Witt, Rachel

- 2023 Death that Endures: A Bioarchaeological and Biogeochemical Study of Human Sacrifices from the Late Intermediate Period and Late Horizon, Moche Valley, Perú. Unpublished Ph.D. Dissertation, Department of Anthropology, Tulane University, New Orleans.

Witt, Rachel, Gabriel Prieto, Alan Chachapoyas, John Verano, Luis Flores de la Oliva, and Feren Castillo

In review The Purposes Death Serves: Bioarchaeological Interpretations of Sacrifice at El Pollo, Moche Valley, Perú.

Wood, James, George Milner, Henry Harpending, Kenneth Weiss, Mark Cohen, Leslie Eisenberg, Dale Hutchinson, et al.

1992 The osteological paradox: problems of inferring prehistoric health from skeletal samples. *Current Anthropology* 33(4):343-370.