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Health at the Edge of the Wari Empire: An Analysis of Skeletal Remains from Hatun Cotuyoc, Huaro, Peru

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HEALTH AT THE EDGE OF THE WARI EMPIRE: AN ANALYSIS OF SKELETAL REMAINS FROM HATUN COTUYOC, HUARO, PERU

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INTRODUCTION

The expansion of states and empires affects more than politics and power relations across a broad area. This process also restructures human/environment interaction, bringing once-distinct populations into contact, introducing social hierarchies to new regions, putting under-utilized labor and land to use, and altering the scope of staple and exotic resources that people consume and cultivate (Bray 2003; Dietler 2010; Klaus *et al*. 2009; Tung 2003). All of these factors can impact individual and population health in a variety of ways. For example, strictly imposed social hierarchies may limit access to dietary resources, putting certain segments of a population at greater risk for nutritional deficiencies, while diversified labor patterns may change workloads, affecting overall wear and tear and stress levels. However, in situations of loose political control, relative peace and cooperation with neighbors, and ability to manage subsistence needs, populations may feel little impact on their lives and maintain patterns of health and disease considered "normal". A population's experience of political circumstances can be thus reflected (at least partially) by the human skeleton, making bio-archaeological investigations a valuable avenue of inquiry into the impact of statecraft.

This paper investigates the impact of the expansion of the Wari state, on the health of people living at Hatun Cotuyoc, a Wari colony in the Huaro Valley of the Cusco Region. This site was occupied by agriculturalist and possibly low-level elite populations (discussed below) circa A.D. 700-1000. Based on the excavation and analysis of forty-one individuals from six tombs and several domestic contexts at Hatun Cotuyoc, we asked if Wari colonists living in the valley experienced health issues or violent trauma related to state expansion. Our results suggest that health was adversely affected in several ways, particularly considering dental health, infectious disease, and late childhood mortality. However, violent interactions for this population were infrequent overall.

WARI BACKGROUND

The Wari state formed in the Ayacucho Valley of the Central Andes of Peru in the sixth century A.D. (Isbell and Schreiber 1978). Shortly following this (ca. A.D. 600-1000), the Wari spread out from Ayacucho to colonize diverse and distant regions of Peru (Jennings 2011:108-111; Schreiber 2004:241; Skidmore 2014) (Figure 1). In some of these regions the Wari state installed administrative centers and exerted political control over a local area (*e.g.* McEwan 1987, 1991; Nash 2002; Schreiber 1992, 1999, 2004; Williams 2001). There is

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evidence that the Wari incorporated some peoples and regions coercively (*e.g.* Schreiber 1992), taking land away from local groups and reorganizing them so that they fell under Wari administration. However, the Wari did not exact the same amount of control over all regions and peoples of Peru (*e.g.* Schreiber 1999; Topic and Topic 2000). Many regions were never occupied by the Wari, or were occupied less intensely, but the adoption of Wari styles of material culture indicate their regular interaction with Wari people (*e.g.* Castillo 2012; Jennings 2006; Lau 2010). Wari hegemony may be partially responsible for this phenomenon, but local groups also strove to attach themselves in meaningful ways to the culture spread by the state and its people (Jennings 2006). The Wari trajectory was a dynamic one; various lines of evidence indicate that administrative foci changed and sometimes went unfulfilled (Jennings 2011:99-120; Schreiber 2001) and that not all Wari colonization carried out across Peru may have been directly related to expanding state administration (*e.g.* Owen 2010; Skidmore 2014:321-325).

Some of the best evidence of administrative control implemented by the Wari in a colony setting comes from the Cusco Region of Peru. Two of the largest Wari settlements abroad were established there ca. A.D. 650, at Huaro and Pikillacta (Figure 2) (Glowacki 2005:117; Skidmore 2014:158, 330-331). Each site was amplified substantially over the 300-400 years that it was occupied. Though these sites grew to be large, and likely incorporated other local settlements in their vicinity, creating a powerful and perhaps metropolitan Wari outpost in the region (McEwan 1987:59-61), it is important to keep in mind that the Wari occupation of Cusco was constructed over a long period of time. For example, it has been estimated that the massive compound of Pikillacta was only one quarter of its extant size for at least the first century (and perhaps two) of its occupation (McEwan 2005: 72; Skidmore 2014:176-178). Recent research within Wari the settlement in Huaro has similarly highlighted how colonists settled in gradually, taking time to establish resource bases and organize community life (Skidmore 2014).

Of Wari settlements in the region, Pikillacta is especially well-known, as it was the largest and among the most impressive Wari administrative complexes outside the heartland and was built to follow a rigidly gridded architectural layout with walls towering two or three stories (McEwan 1987). This complex accom-modated Wari elite and ceremonial activity (Glowacki 1996; McEwan 1991:118, 1996), and may have also provided space for housing and storage (McEwan 1987:51-54, 1996:177). Few, if any, formal tombs have been identified at Pikillacta (*cf.* Bauer and Bauer 1987; McEwan 1991:108-109; Verano 2005).

Huaro exhibits lesser degrees of settlement planning, but also hosts ceremonial architecture and patio groups that probably served as elite residences, and perhaps had administrative functions (Glowacki 2002). Cemetery and residential components of settlement are also present in Huaro (*ibid*; Skidmore 2014; Zapata 1997), offering an important opportunity to investigate the lifeways of Wari populations that settled in the region. Recent evaluation of the archaeological record at Huaro indicates that this settlement does not follow Wari canons as closely as the site of Pikillacta, with much of its material culture assuming localized, though still Wari-derived, styles (Skidmore 2014:184-202; 280-312).

Settlements at Pikillacta and Huaro may have been important to the Wari for a variety of reasons: to connect them to trading partners and trade routes that brought important resources from the south (*e.g.* minerals, camelids, coca, and other exotics) (Bauer 2004:66; Bélisle 2011), to maintain a southern frontier with the Tiwanaku (McEwan 1987:68), to intensify production (agricultural and otherwise) for the Wari state (Schreiber 2001), and to provide opportunities for expanding populations to meet subsistence needs and create new civic arrangements (Covey *et al.* 2013:550; Skidmore 2014:331-317). Through time, Wari settlements in the Cusco region took on many of the characteristics of those in the heartland in terms of establishing similar modes of living, practices of daily life, agriculture and other production, and ritual and mortuary behavior (Glowacki 2002; Skidmore 2014:280-309; Zapata 1997; *cf*. Leoni 2009; Milliken 2006). Production of maize, a resource regularly consumed by Wari populations and one that may have served a special role in the production of beer (Finucane 2009), was intensified in the region (Bauer 2004:68), but at a smaller scale than at other Wari colonies (*cf*. agricultural terraces described by Schreiber 1992:149-152; Zegarra 2005).

We expect that as in other colony settings (e.g. Blanton 2003; Dietler 2010:157-182; Larsen *et al*. 1995), the people who established new Wari settlements in the region encountered some difficulties as they adapted to new environments, managed incipient and imperfect risk-avoidance strategies, and navigated sometimes hostile circumstances far beyond the safety net offered by the heartland. Given the strong administrative agenda of the Wari in the Cusco region, people living in colonies there also would have dealt with state demands for resources and labor. This paper investigates human skeletal remains from Hatun Cotuyoc, a sector of the broader settlement in the Huaro Valley, to evaluate how health of colony populations was affected by such factors. Also of particular interest for the Wari are considerations of how a proposed focus on maize agriculture (*e.g.* Finucane 2009; Schreiber 2001) may have impacted local health. Recent research at Hatun Cotuyoc yielded a number of tombs with human remains which were evaluated for information regarding the health of colony residents.

SITE BACKGROUND

Hatun Cotuyoc is located on the floor of the Huaro Valley, approximately 800 meters west of the center of the modern town (Figure 3). Calibrated radiocarbon dates place its occupation from circa A.D. 700-1000 (Skidmore 2014:330-332). Excavations at the site in the 1990s by Mary Glowacki and Julinho Zapata identified rustic architecture, utilitarian pottery, food refuse and artifacts used in its preparation and consumption, agricultural tools, and other prosaic features. Glowacki (2002) posited that the site housed populations of Huaro who worked in agriculture. One author of this paper, Skidmore, began additional research in 2010 to further elucidate the nature of settlement and to look into the shape and experiences of daily life of the people who came to settle in the colony. Excavation and analysis of resultant material culture by Skidmore have largely confirmed the preliminary conclusions of Glowacki and Zapata and provide additional data on the domestic life of Wari agriculturalist populations in the Cusco region (see below). The study of the daily life of people of different socioeconomic stations complements previous studies that have highlighted Wari administration, ceremonialism, and the elite.

Excavations at Hatun Cotuyoc recovered material culture that is generally consistent with that utilized in the Wari heartland. Residential architecture consists of agglutinated multi-room structures associated with patio spaces, furniture (*e.g.* benches), and activity areas, especially those related to cooking and food processing. Artifacts associated with these contexts include large quantities of undecorated or crudely decorated pottery, agricultural and hunting tools, and implements used in textile/garment manufacture. Wari pottery was excavated at the site, in addition to various local and foreign styles (the latter in limited quantities). Floral and faunal remains, mostly food refuse, are ubiquitous and include maize, beans, quinoa, and camelid and guinea pig remains. Several tombs and domestic contexts yielded the remains of at least forty-one individuals; their bones were analyzed by Juengst using standards described below.

The character of the tombs and the nearby houses provides a relative measure of expected social status for the individuals interred. The tombs at Hatun Cotuyoc are not exceptionally elaborate when compared to contemporaneous ones in the valley (*cf*. Glowacki 2002; Zapata 1997), but variation in the embellishment of graves across the sample may indicate some status differences between individuals interred at the site (see below). However, structures and associated toolkits and residues of activity in the vicinity of the tombs indicate that the people who lived at Hatun Cotuyoc maintained relatively modest means overall. Residents likely engaged in agriculture, complemented by periodic craft production (Skidmore 2014:23-237).

BURIAL SAMPLE

The skeletal sample in this paper is a total of forty-one individuals excavated from six tombs and from architectural fill and trash contexts. Three tombs were relatively simple in preparation, while another three showed more elaboration in terms of construction, grave good association, and number of interred individuals. The simple tombs were characterized by burials in dug-out holes or in earthen fill, sometimes with rocks lining or marking part of the grave. Two of these each contained the remains of a solitary and articulated individual, while the third simple tomb was a secondary interment of two individuals. Some artifacts were found in association with the three simple tombs, but none were especially fine and they may have been part of the burial fill rather than items intentionally left as grave goods. All of the simple burials were located below the floors of rooms, or were in passageways.

The remaining tombs were more elaborate in terms of construction (Figure 4), the number of individuals included, and the items accompanying the deceased (Figure 5). These tombs were located within a small round structure. Two tombs were small, semi-subterranean, rectilinear chambers (with one to two square meters of floor space in each, their heights are unknown) built of stone and mud mortar, while the third was a circular subterranean stone-lined cist (approximately 0.85 meters in diameter and one meter deep). All of these tombs had been disturbed in antiquity, and at least one of them had been disturbed more recently (discussed below).

Each of the more elaborate tombs contained bones of at least ten individuals. Because of the number of people in each tomb and the disturbed nature of the remains, bodies may have been placed in the tombs over time, as opposed to during one burial event. In the Wari heartland, people frequently re-opened tombs to inter additional human remains, add and manipulate offerings, or paint the bones of the dead in cinnabar (Cook 2004:159; Isbell 2004; Milliken 2006; Tung and Cook 2006). Evidence for similar application of pigment to human remains was identified within the elaborate tombs at Hatun Cotuyoc. However, disturbance of these tombs in antiquity and recent times prevents the reconstruction of the precise sequence of deposition for most individuals. Only one individual was found in primary context within the round structure. This individual was fully articulated and buried within one of the rectilinear chambers within a matrix that included the disarticulated remains of several other people (Skidmore 2014).

The rectilinear chamber adjacent to the primary burial and the cist tomb, also contained disarticulated remains of numerous people. It is possible that all of these tombs were disturbed around the same time in antiquity (perhaps around the time that the primary burial was interred), causing the co-mingled remains. However, because the small chambers are consistent with Wari tombs from other parts of Peru that contain multiple burials (*cf*. Isbell 2004; Milliken 2006), Skidmore suggests that each tomb (or perhaps other chambers nearby yet to be excavated) would have contained multiple individuals prior to their disturbance.

In comparisons of the burials excavated at Hatun Cotuyoc, it is clear that more of an investment was made in the three tombs built within the circular structure; not only are they associated with the construction of formal tomb architecture, but they are also associated with a few exotic materials. This may indicate that individuals found within the more elaborate tombs maintained a higher socioeconomic status than individuals buried in simpler tombs. However, because of disturbance of all of the most elaborate tombs, it is difficult to parse out status distinctions between the individuals represented in the sample discussed below. Even so, tomb architecture and associated finds are comparatively modest if we consider them in the spectrum of tombs represented across the valley and at Wari sites in general (Skidmore 2014:303-307, 344-351; *cf*. Isbell 2004; Zapata 1997). This indicates that the individuals evaluated in this study may represent a range of status categories, but these probably do not include the highest elite of the local setting or broader Wari society.

Bioarchaeological Methods

Because activity, disease, and diet can leave indelible marks on the human skeleton, studying burial remains is one important way to investigate daily life and health in the past (Buikstra 1977; Larsen 1995; Sofaer 2006). Lesions included in this study include porotic hyperostosis, cribra orbitalia, periosteal reactions, and osteomyelitis. Dentition was observed for evidence of dental cavities and abscesses. This selection of lesions allows for investigation of diet, infectious disease prevalence, and nutritional deficiencies in childhood. Additionally, Juengst noted skeletal trauma and osteoarthritis in order to investigate experiences of violence and labor over the life course.

It is important to note that in order for many skeletal lesions to form, the infection or nutritional problems must have been chronic, as bony reactions form fairly slowly. Acute infections or extreme nutritional stress may cause death prior to formation of diagnostic lesions, leaving them invisible in the bio-archaeological record (Wood *et al*. 1992). Acknowledging this, we recognize that our interpretations are limited in scope and miss some of the variety of health experiences at Hatun Cotuyoc. We present evidence for systemic stress, traumatic events, and patterns of labor as a preliminary step in identifying overall health status for this population.

Age and Sex

When possible, age was determined for each individual based on a number of dental and skeletal traits. Juengst scored dental eruption and wear following methods in Buikstra and Ubelaker (1994:49-53). When dentition was not available, Juengst estimated age based on cranial suture closure, the appearance of the pubic symphysis and fusion of the epiphyses of long bones, all of which progressively change as individuals get older (Brooks and Suchey 1990; Meindl and Lovejoy 1985; Suchey and Katz 1986; Todd 1920, 1921).

The age categories used included fetus (prenatal), infant (0-2 years), young juvenile (3-6 years), older juvenile (7-15 years), young adult (16-23 years), middle adult (24-40 years), and older adult (40+). When an age range could not be estimated or groups were lumped for analysis, Juengst used adult (over 15 years) and subadult (15 years and under). When an individual's age estimate crossed categories (*i.e.* an individual estimated to be 13-16 years old), they were included in the younger age group for consistency. These age categories were selected because they represent moments of significant biological change over the life course which often have social consequences, such as weaning and puberty. Biological processes like weaning and puberty are often cross-culturally important to social status as they reflect new periods of independence and a significant shift in relationships between people (Halcrow and Tayles 2011:336; Sofaer 2006, 2011).

Sex was estimated for each adult individual when cranial and pelvic elements were present. Juengst did not estimate sex for infant or juvenile individuals as most reliable indicators of sex develop during puberty. Pelvic and cranial traits indicating sex were scored according to standards in Buikstra and Ubelaker (1994:16-21) following methods developed by Bass (1987), Buikstra and Meilke (1985), and Phenice (1969). Sex categories used included indeterminate, probable female, female, probable male, and male (Buikstra and Ubelaker 1994:21).

Dental Cavities and Abscesses

These dental indicators are generally linked to diet. By assessing carious lesions (cavities) and abscesses, it is possible to determine the amount of "stickiness" and grit present in the food consumed. These factors can help determine what was being processed and eaten. "Sticky" foods, such as maize, often adhere to the enamel of teeth and lead to massive carious lesions (Cucina et *al*. 2011; Hillson 2008:278; Larsen 1995). Chewing non-food items, such as coca leaves, can also predispose dentition to cavities along the gumline (Indriati and Buikstra 2001). If the pulp cavity of a tooth is exposed (either by caries or other pathological processes), bacteria can infiltrate the surrounding bone and create an abscess (Hillson 2008:284-285; Roberts and Manchester 2007: 70). Importantly, neither of these processes (caries or abscess formation) is directly reflective of diet; both caries and abscess formation are affected by a number of factors including oral micro-flora and fauna, acidity, rate of saliva flow, and hormone levels (see Hillson 2008; Lukacs 2011; Lukacs and Largaespada 2006; Temple 2011). However, combining these data with archaeological botanical remains and other lines of evidence can help build a general picture of diet at the population level (Berryman 2010; Hillson 2008:276-284; Larsen 1995; White *et al*. 2011:455).

Dental caries were recorded when dentin was visible. Darkened spots of enamel were not considered cavities until the dentin was exposed (Cucina *et al*. 2011). Dental caries were scored by location on tooth or tooth root, size of lesion, and depth of lesion (Buikstra and Ubelaker 1994:55). Dental abscesses were recorded separately from cavities, unless the edges of the cavity were still visible and obvious. Juengst noted teeth lost antemortem in association with abscesses and cavities, but made no correction factors or assumptions about why teeth had been lost (*i.e.* attributed tooth loss to caries) (Cucina *et al*. 2011). Aveolar resorbtion and healing of abscesses and tooth loss were also recorded.

Periosteal Reaction and Osteomyelitis

These nonspecific disease indicators allow insight into adult health. Periosteal reactions (inflammation of the outer layer [periosteum] of long bones) and osteomyelitis (infection and inflammation of the medullary cavity) signal the presence of an infection or traumatic event (Roberts and Manchester 2007:172-174; White *et al.* 2011:445-446). Relative healing, or lack thereof, can indicate the ability of the person to recover from these stressful events, thereby providing a commentary upon overall individual health.

Juengst recorded periosteal reactions and osteomyelitis by skeletal element, location on element, and extent of the lesion. Healing was recorded as fully healed (woven bone was remodeled although defect was still notable), some healing (woven bone was partially smoothed but active areas were still observable), and active (no evidence for healing) (Buiskstra and Ubelaker 1994:118). Juengst additionally recorded osteomyelitis by obstruction of the marrow cavity (if observable) and the presence of draining sinuses (*ibid.*:119).

Cribra Orbitalia and Porotic Hyperostosis

Periods of stress and nutrient deficiency in childhood can have effects on the skeleton that persist into adulthood. Cribra orbitalia (CO) and porotic hyperostosis (PH) are lesions in the eye orbits and on the cranium, respectively, and can co-occur or occur independently of one another. They are both generally considered to be indicative of anemia or other nutritional deficiencies in childhood (Larsen 2002; Stuart-Macadam 1985, 1992; Walker *et al.* 2009; White *et al.* 2011:449) (although see Peckman 2003 who found links between smallpox and PH). CO and PH can be caused by limited nutrition as well as by parasitic load, as anemic conditions can be brought on by either insufficient diet or high levels of bodily parasites (Blom *et al.* 2005; Holland and O'Brien 1997; Kent 1986; Roberts and Manchester 2007:222-234; Stuart-Macadam 1992; Walker 1986). Evidence for healing of these lesions gives some indication of whether the dietary or parasitic stresses were relieved.

Porotic hyperostosis (PH) and cribra orbitalia (CO) were recorded by Juengst according to location and size of the defect following standard methods in Buikstra and Ubelaker (1994:120-121). Additionally, these lesions were observed for signs of healing, recorded as fully healed (smoothed bony surface without remaining pits and remodeled diploic expansion), some healing (some pits visible, diploie expanded), or active (no evidence for remodeling).

Osteoarthritis

Osteoarthritis (OA) is a complex disorder involving the accretion of bone surrounding skeletal joints and margins associated with loss of synovial cartilage on joint surfaces (Chamberlain 1994; Jurmain 1999; Larsen 1995, 2002; White *et al.* 2011:441-443). Traditionally, these bony changes have been interpreted as markers of activity and occupation; recently, this has come under scrutiny as medical studies show that many variables impact this patho-physiological process. Human joints are amazingly efficient and often bear loads throughout the course of a lifetime without change in friction. Individuals can also be genetically predisposed to OA, unrelated to the stress or repetition of their activities (Jurmain 1999; Waldron 1994). However, observing OA on a population level eliminates some of these individual level factors and it is generally accepted that behavior and activity patterns contribute to the distribution and severity of joint disease, at least at the population level (Jurmain 1999; Larsen 1995, 2002; Roberts and

Manchester 2007:132-135, 143-144; White *et al*. 2011:441-443). Specifically, eburnation, caused by two bones coming into direct contact once protective cartilage has been worn away, is highly indicative of behavior, especially of repetitive motions (Chamberlain 1994; Jurmain 1999). These degenerative changes can result from repeated movements and physical bodily stresses over one's lifetime. If the distribution of OA is patterned across a population, it is possible that this degenerative change is related to repetitive activity and workloads (Larsen 2002; Roberts and Manchester 2007:143-144).

OA was recorded by joint surface and by degree and extent of bony deformation. In particular, Juengst recorded lipping (bony spur development) as barely discernible, sharp, extensive, or full ankyloses or fusion of joint (especially on vertebrae). Eburnation was recorded by degree and extent of the polishing and labeled as barely discernible, polish only, or polish with grooves (Buikstra and Ubelaker 1994:122-123).

Trauma

Pre- or perimortem trauma represents injuries that individuals sustained during life from which they recovered or succumbed. Injuries can result from a variety of causes, such as accidents, sporadic inter-personal conflict, or regular and routinized violence (Arkush and Tung 2013; Martin and Frayer 1997; Tung 2007; Walker 1997). Distinguishing between accidental and intentional injury is important because they reflect different experiences of individuals and populations. Intentional injuries may be caused by a range of behaviors, including socially sanctioned brutality (*e.g.* corporal punishment, domestic assault, or ritual violence) and those that are unwelcome and come from outside sources (*e.g.* violence associated with warfare or raiding) (Arkush and Tung 2013; Berryman and Haun 1996; Stone 2012; Walker 1997, 2001; Wheeler *et al*. 2013). A large sample of individuals that experience trauma can indicate intentionality in their delivery (Arkush and Tung 2013; Tung 2007; Walker 1997).

Location of trauma can indicate the type of interaction preceding the injury. Face-to-face violent conflicts are often reflected by trauma on the facial or frontal bones. Conversely, injuries sustained while fleeing or avoiding an attacker may more commonly occur on the posterior portion of the skull (Berryman and Haun 1996; Tung 2007; Walker 1997). Fractures of the distal ulna are often considered to be defensive, as they can result from throwing up an arm to ward off a blow. Rib fractures are considered to result from interpersonal conflict as blows more commonly fall on the torso during conflict. Finally, fractures of the hand bones often result from violence as hands are often used as weapons or defenses. While injuries sustained during violent conflict can be varied, this pattern of injuries on the cranium, ulnae, ribs, and hands have been shown to reliably reflect incidents of interpersonal violence (Arkush and Tung 2013; Berryman and Haun 1996; Martin and Frayer 1997; Tung 2007; Walker 1997, 2001).

Juengst observed the remains for evidence of antemortem or perimortem trauma following methods described by Berryman and Haun (1996), Buikstra and Ubelaker (1994:119-120), and Walker (1997, 2001). Any trauma present on cranial or postcranial elements was recorded and photographed. Fractures were described as complete or incomplete and any bony remodeling was recorded as indicative of healing and timing of the injury. Healing was recorded as none (sharp fracture edges, no bone remodeling), partial (some new bone growth evident), or fully healed (extensive remodeling).

RESULTS

Age

Twenty-three (56.1%) of forty-one individuals of the population were subadults, and the remaining eighteen individuals (43.9%) were adults. Amongst the subadults, there was one fetus, six infants (0-2 years), seven young juveniles (3-6 years), and nine older juveniles (7-15 years). Amongst the adults, five were recorded as young adults (16-23 years), eleven as middle adults (24-40 years), and two as older adults (above forty years) (Table 1).

Age Category	Total Observed	Caries/ Abscess	PH/CO	Perio/ Osteo	OA	Trauma
Fetus	1	0	0	0	0	0
Infant	6	0	2 (33.3%)	1 (16.7%)	0	0
Young Juvenile	7	2 (28.6%)	0	1 (14.3%)	0	0
Older Juvenile	9	0	0	2 (22.2%)	0	0
Young Adult	5	3 (60%)	0	2 (40%)	0	1 (20%)
Middle Adult	11	7 (62.7%)	0	4 (36%)	2 (18%)	0
Older Adult	2	0	0	0	2 (100%)	0
Totals	**41**	**12 (29.3%)**	**2 (4.9%)**	**10 (24.4%)**	**4 (9.8%)**	**1 (2.5%)**

Table 1. Frequency and percent of age groups with pathology at Hatun Cotuyoc

Sex

Sex was estimated for 55.6 percent (10/18) of the adult remains (Figure 6). There were two females, two probable females, one male, and five probable males. There were eight adults of indeterminate sex. Although sex could only be estimated with certainty for about half of the population, a fairly even sex distribution was noted.

Pathology

This skeletal sample included many individuals with pathology (Table 1). Dental cavities were most common, with twelve individuals (29.3% of observable individuals) presenting at least one cavity (Figure 8) and a total of eighteen (10.1%) of 179 teeth affected. Seven of these individuals had more than one carious lesion, although this is not especially surprising given that having a cavity will predispose the surrounding teeth to caries (Gagnon and Weisen 2013; Hillson 2008:269). Notably, two individuals with cavities on first molars were around seven years of age. The first adult molar erupts around age six, indicating these teeth must have been aggressively exposed to factors leading to cavity formation. All of the carious lesions noted were on the occlusal (chewing) surfaces of premolars and molars. Two cavities were associated with severe dental abscesses as well (Figure 9).

Thirty-two (78%) of forty-one individuals were observable for periosteal reactions and osteomyelitis. Of these, nine (28.1%) had periosteal reactions and one (3.1%) had osteomyelitis (Table 1). Three affected individuals were under the age of ten, three were between 14 and 23 years old, and four affected adults aged 24-40 years. Femora were the most commonly affected bones (21.9% or 7/32 femora), followed by tibiae (15.6% or 5/32) and humeri (6.3% or 3/32) (Figure 10). Most infections (77.8% or 7/9) were active at the time of death. Commingling of remains made it difficult to observe if these lesions were bilateral or systemic for most individuals; however, two well-preserved individuals both presented bilateral periosteal lesions.

Twenty-four individuals had sufficiently preserved crania and eye orbits to observe for PH and CO. Two (8.3%) of these twenty-four presented lesions (Figure 11). One infant around three months old had active PH lesions on the cranial vault, while another infant, between six months and one year old, had active PH and CO lesions, on the parietals and eye orbits respectively. No adults showed evidence for healed lesions from childhood, although mild cases may have become invisible over time.

The eighteen adult individuals included in this sample were observable for osteoarthritis; adults are most likely to accurately reflect OA, given that juvenile bones actively grow and continually remodel. Four (22%) of eighteen adults experienced OA (Figure 12). Two of the individuals with severe OA were likely over 40 years old, which is a somewhat normal result of a lifetime of activity. However, the other two afflicted individuals were in a younger age category (24-40 years) and thus the OA here may represent patterns of labor. The most commonly affected areas were bodies of lower thoracic and lumbar vertebrae and joint surfaces surrounding hips and knees.

Trauma

Evidence for trauma was limited in this skeletal sample. One male individual had two antemortem wounds on the cranium (Figure 13). One sharp force trauma on the right parietal was almost entirely healed, with remodeling (Figure 14). The other blunt force trauma was also in the process of healing, higher on the right parietal (Figure 15). This wound had not completely healed, either indicating a later time of injury or a higher severity of injury. Likely these injuries happened within months prior to death. This individual was buried face-down within the fill of the disturbed rectilinear burial chamber (described above), a pattern that is not typical for the Wari, or for people indigenous to the region. This suggests the circumstances surrounding his death were abnormal and/or that he may have been buried hastily and/or have been considered an outsider by those who interred his body. As with indices of pathologies, a lack of complete skeletons may limit our ability to observe skeletal trauma in other individuals whose remains were excavated at Hatun Cotuyoc.

DISCUSSION

From these results, we identify a few key patterns. First, childhood seems to have been a difficult time. The largest age group represented in this sample was adults ages twenty-four to forty, but was closely followed by children aged nine to fourteen years old. Young children and infants often compose a large portion of burial populations as they struggle to combat malnutrition after weaning and early childhood diseases. Older children tend to be heartier and more resilient. While the dearth of infant and young juvenile remains may reflect issues of preservation and taphonomy, it is interesting that the older juvenile age category is so well-represented. Perhaps late childhood was a time of higher exposure to pathogens or labor demands, resulting in increased death rates. Alternatively, it is possible that this reflects higher birth rates for this age cohort; environmental or social factors may have allowed for high fertility for their mothers (Buikstra *et al.* 1986; Klaus and Tam 2010; Wood *et al.* 1992). However, given that some juvenile individuals did have skeletal stress markers, it seems likely that mortality from pathogens or systemic stress played an important role.

Indicators of systemic infection were present in an active state on several children. This suggests two things: first, some children were able to combat disease long enough to develop skeletal lesions and second, recovery from these disease episodes (as shown by evidence of healing or lack thereof) was not common. Individuals without skeletal lesions may have succumbed to acute infection before lesions could be formed and thus cannot be identified by this study. However, the low numbers of healed lesions overall indicates that few individuals fully recovered from chronic infections, especially during childhood.

Young and middle-aged adults also dealt with infectious disease regularly. In fact, thirty percent (6/18) of adults had periosteal reactions on at least one long bone. Only one of these infections seemed to be trauma-related. Like the lesions noted on juvenile remains, adult lesions reflect chronic illness or extended exposure to pathogens, in order to create prolonged periosteal reactions, both active and healed. Also like the juvenile populations, most adults did not fully recover from their infections, with only two individuals showing evidence of healing.

Nutritional insults were relatively rare for the entire population. Only two individuals (8.3% of the observable population) had lesions associated with nutritional deficiency. Both of these individuals were infants. Studies at other Wari sites have found generally higher rates of CO and PH: forty percent of juveniles and twenty-three percent of adults at Beringia and twenty-two percent of adults at La Real exhibited these lesions (Tung and Del Castillo 2005). Because these lesions form during childhood, it is not surprising that more juveniles would present observable lesions because lesions may heal entirely or be masked by taphonomic changes to adult crania. However, even just comparing juvenile remains, the rates of CO/PH at Hatun Cotuyoc were lower than at other Wari sites.

At Hatun Cotuyoc, 24.4% of individuals and 10.1% of teeth were affected by caries. While dental cavities result from a variety of causes, there is supporting evidence for dietary causes at this site. First, young children developed severe cavities in newly erupted teeth. This means that whatever was causing caries was present in the oral environment early in life and was not caused by age, hormonal changes of puberty or pregnancy, or activity. Secondly, cavities developed primarily on the occlusal surface of teeth, rather than close to the root or gum line. This indicates a dietary cause, rather than coca chewing, a common factor for caries in the Andes. Coca use tends to cause cavities on the buccal side of teeth near the gum line where the wad of coca is usually held (Indriati and Buikstra 2001). However, because Huaro cavities are located on the chewing surfaces of teeth, coca is probably not the cause here. Finally, all age and sex categories were impacted by caries, indicating that other factors like hormones or saliva flow may not have been a driving force. Consumption of a cariogenic food, such as maize, is a better explanation for cavities amongst the Huaro burial population.

Studies from other sites under Wari control or influence have found variable caries rates linked to maize consumption. Buzon *et al.* (2012) found evidence for caries and dental abscesses in the Nazca area and, combined with stable isotope analysis, interpreted these results as indicative of at least slightly increased maize consumption under Wari influence. In the Majes Valley of southern Peru, Tung and Del Castillo (2005) found extremely elevated rates of caries with 56% of juveniles and 44% of adults displaying carious lesions at one Wari site, Beringia. In the same valley, at the site La Real, Tung and Del Castillo (*ibid.*) found a comparatively low rate of caries with 10.5% of individuals affected. These different caries rates have several implications. First, the extremely high rate of caries at Beringia is likely linked to the Wari emphasis on maize production. The lower status individuals cultivating maize at this site may have been consuming a lot of this cariogenic food, resulting in their high rate of carious lesions (*ibid.*). Comparatively, the lower rate of caries at La Real and only slight increase of caries at Nazca may reflect a more diversified diet associated with upper class individuals (Buzon *et al.* 2012; Tung and Del Castillo 2005).

Stable isotope analysis from Nazca by Kellner and Schoeninger (2008) support this interpretation: Wari presence in Nazca was focused on status rather than maize extraction, resulting in relatively diverse diets for local Wari and native populations.

Caries at Hatun Cotuyoc fall between these other Wari sites, with 24.4% of people and 10% of teeth affected. Perhaps this reflects a mixed status population, as suggested by the diverse tomb types. Some individuals may have been protected from carious lesions by having more diverse diets while others relied more heavily on maize, resulting in more lesions. Unfortunately, because so many remains were commingled within and between tombs, it is difficult to say whether caries and tomb status were directly related.

Osteoarthritis in this population was not extremely severe, affecting only four individuals. Preservation may be an issue here. While long bone shafts were commonly preserved, epiphyses and joint surfaces (where OA most commonly occurs) were not well-preserved and often not present. The OA that was observable suggests a pattern of labor focused on the lower back, hip, and knee joints. Lower back arthritis is common amongst pre-industrial populations (and modern ones) due to progressive degeneration of the intervertebral cartilaginous discs (Bridges 1992; White *et al.* 2011:441-443). This degeneration can be exacerbated by carrying heavy loads and activities that include repeated bending at the waist. Hip and knee arthritis indicates a laboring adult population, possibly in the realm of agricultural production, although many explanations are certainly possible. Becker (2013) notes that maize agriculturalists in the Moguequa Valley, laboring under the influence of the Tiwanaku states, had greatly increased OA on the sacroiliac joint as well as high rates on the knee. This is similar to the pattern of OA at Hatun Cotuyoc, despite our minimal sample.

The relative lack of trauma at Hatun Cotuyoc contrasts with Tung's findings in both the Wari heartland and in the Arequipa region, where trauma (especially to crania) was frequently observed for both males and females (Arkush and Tung 2013; Kurin 2013; Tung 2003, 2007, 2012). At least some of this trauma was interpreted as the result of inter-personal violence. It is possible that the one instance of cranial trauma from Hatun Cotuyoc was sustained by accident or by socially sanctioned violence; however, the location and severity of the injuries are also consistent with receiving blows from an attacker. One wound had not completely healed at the time of death, either indicating a later time of injury or a higher severity of injury. Given the unorthodox burial position of this individual and his injuries, it is tempting to say that this person represented some sort of community outcast or warfare captive who was eventually killed. However, no evidence of perimortem trauma was found. It may be more likely that this individual died of complications from his cranial injuries.

CONCLUSION

Overall, the population at Hatun Cotuyoc struggled with infectious disease while they maintained relatively good nutrition, managed strenuous labor, and experienced little violence. Unlike other areas of the Wari state that were highly maize-focused, diet at Hatun Cotuyoc was varied, protecting some individuals from carious lesions and maintaining good nutrition for all age groups. Wari colonists and local people living at Huaro may have grown maize for export to the state capital and likely consumed maize on a semi-regular basis. However, they were not reliant on this resource; the lushness of the Huaro Valley seems to have allowed for dietary diversity that insulated this population from the nutritional stress and high rates of caries noted at other colonial Wari sites.

Pathogens were an issue for the population, with many individuals, young and old, suffering from, and succumbing to, infectious disease. Circulation of pathogens is often associated with high population densities and population nucleation (Barrett *et al.* 1998). Perhaps Wari influence in the Huaro Valley drew people into large, centralized communities, promoting and sustaining the transmission of disease. If people had previously lived in dispersed hamlets, living in the Wari state's colony may have decreased the health of these individuals.

Exactly how Hatun Cotuyoc people interacted with those of other local Wari sites such as Pikillacta and the Wari heartland remains unclear. Exchange with these other populations may have been central to maintaining a healthy diet; Wari colonists and other people living at Hatun Cotuyoc could trade locally grown maize for other foodstuffs either imported to the administrative center Pikillacta or produced there. Interaction with Pikillacta and the heartland may have also exposed the Hatun Cotuyoc populations to disease, and vice versa, as people moved themselves and their pathogens across the landscape.

Overall, people living at Hatun Cotuyoc shared many aspects of their lives with other people living throughout the Wari state. Extractive colony strategies, which created nucleated settlements and promoted maize consumption, impacted these populations in several notable ways: maintenance of circulating diseases, predictable patterns of labor and osteoarthritis, and regular presence of dental cavities, even in very young individuals. This pattern is reflected at other Wari sites throughout the state, to varying degrees. While we cannot say that people living in the Huaro Valley prior to Wari influence did not experience these issues as well, it is clear the Wari food values were shared and maintained at Hatun Cotuyoc. Future research in the form of stable isotope studies of diet and mobility and continued excavation will help identify the extent of maize consumption, social inequalities between individuals, and whether this population was composed of relocated Wari citizens or local residents.

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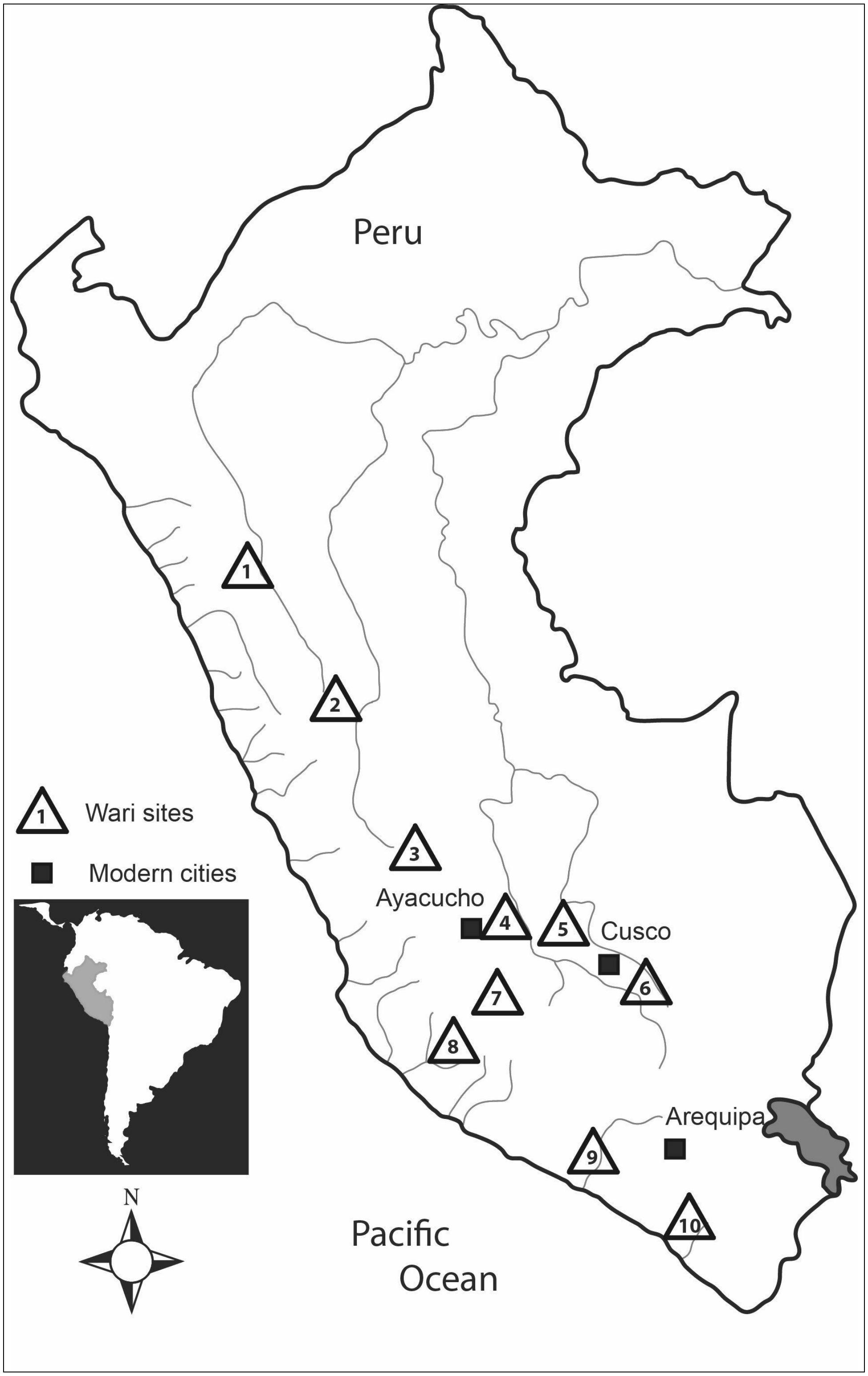

Figure 1. Wari sites established throughout Peru: (1) Viracocha Pampa; (2) Honcopampa; (3) Wari Wilka; (4) various heartland settlements including Huari, Conchopata, and Azángaro; (5) Espiritu Pampa; (6) Huaro and Pikillacta; (7) Jincamocco; (8) Pacheco and Pataraya; (9) Sonay; (10) Cerro Baúl and Cerro Mejia.

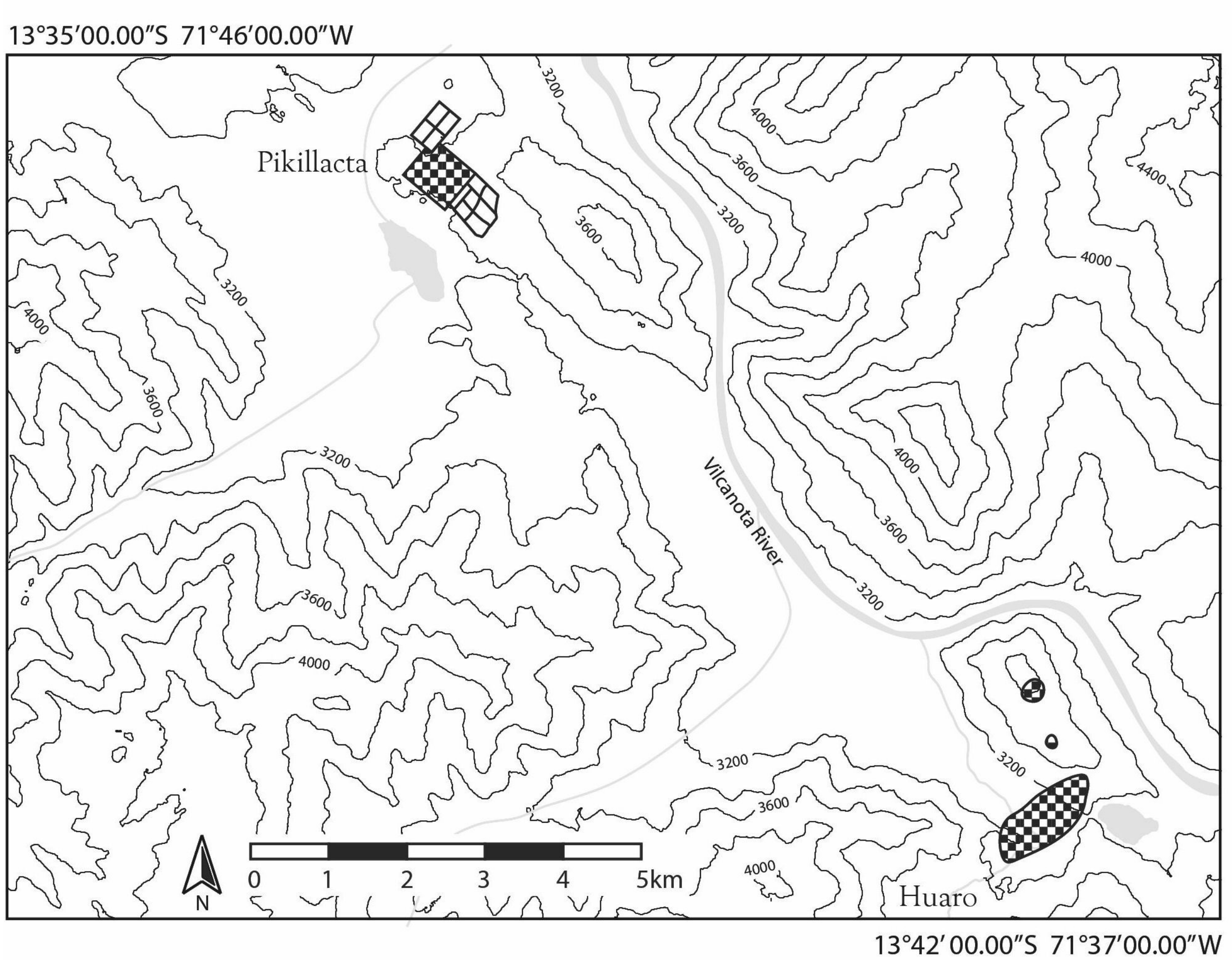

Figure 2. The sites of Pikillacta and Huaro in relation to one another.

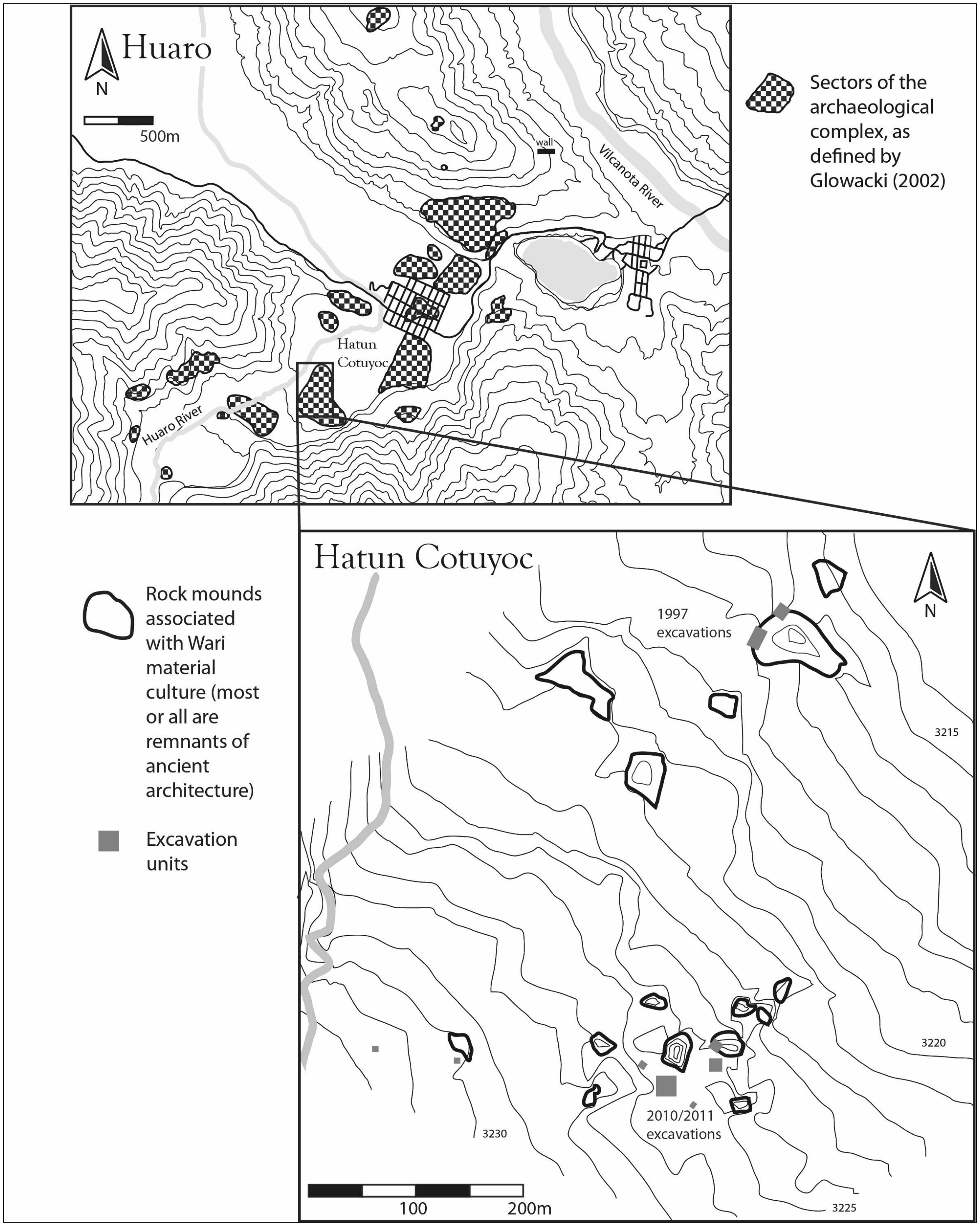

Figure 3. Position of Hatun Cotuyoc in the Huaro Valley and excavation units at the site. The grid near the right margin of the top map represents the present town of Huaro. The grid near the center of the top map represents agricultural fields.

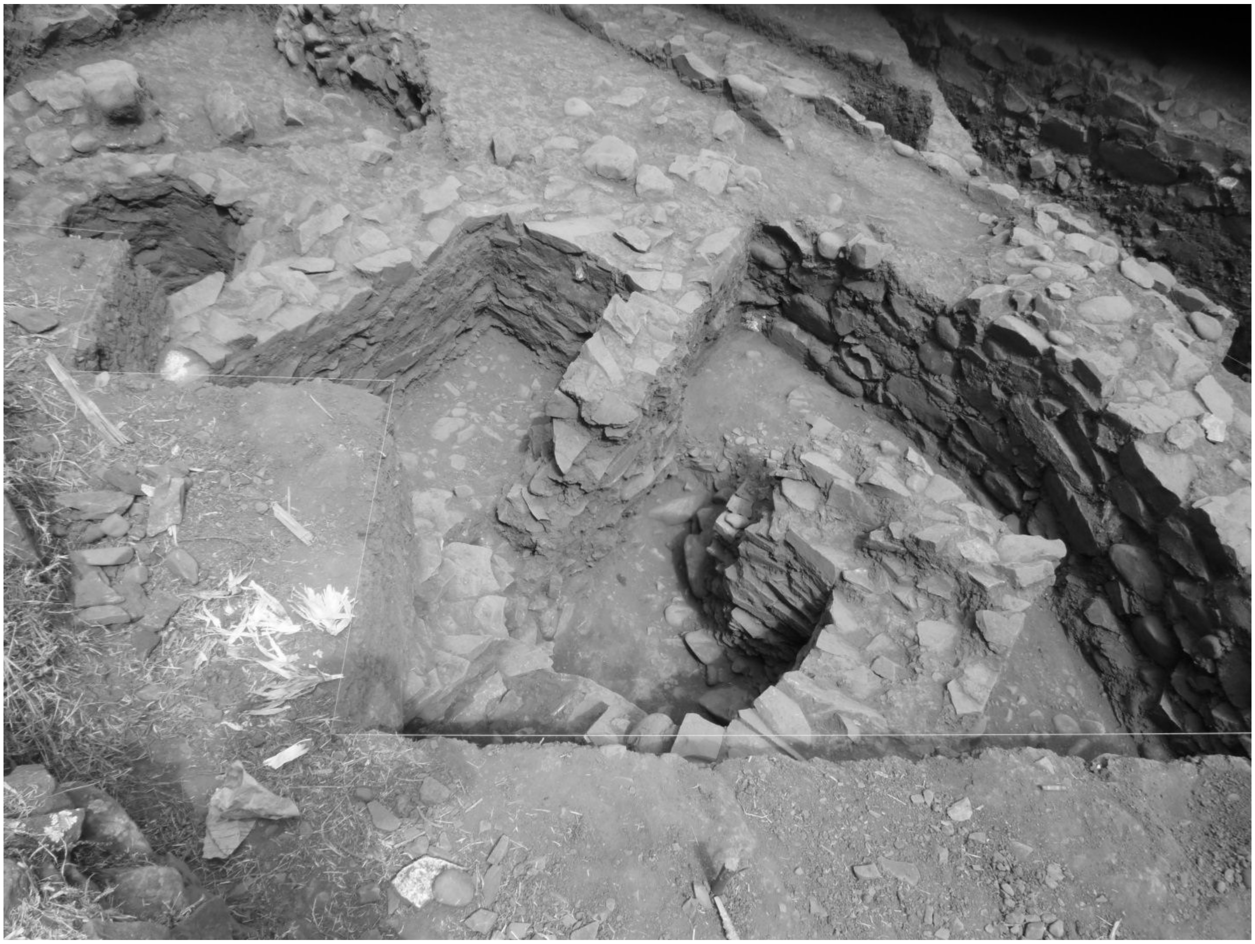

Figure 4. Architecture of the three tombs within a round structure.

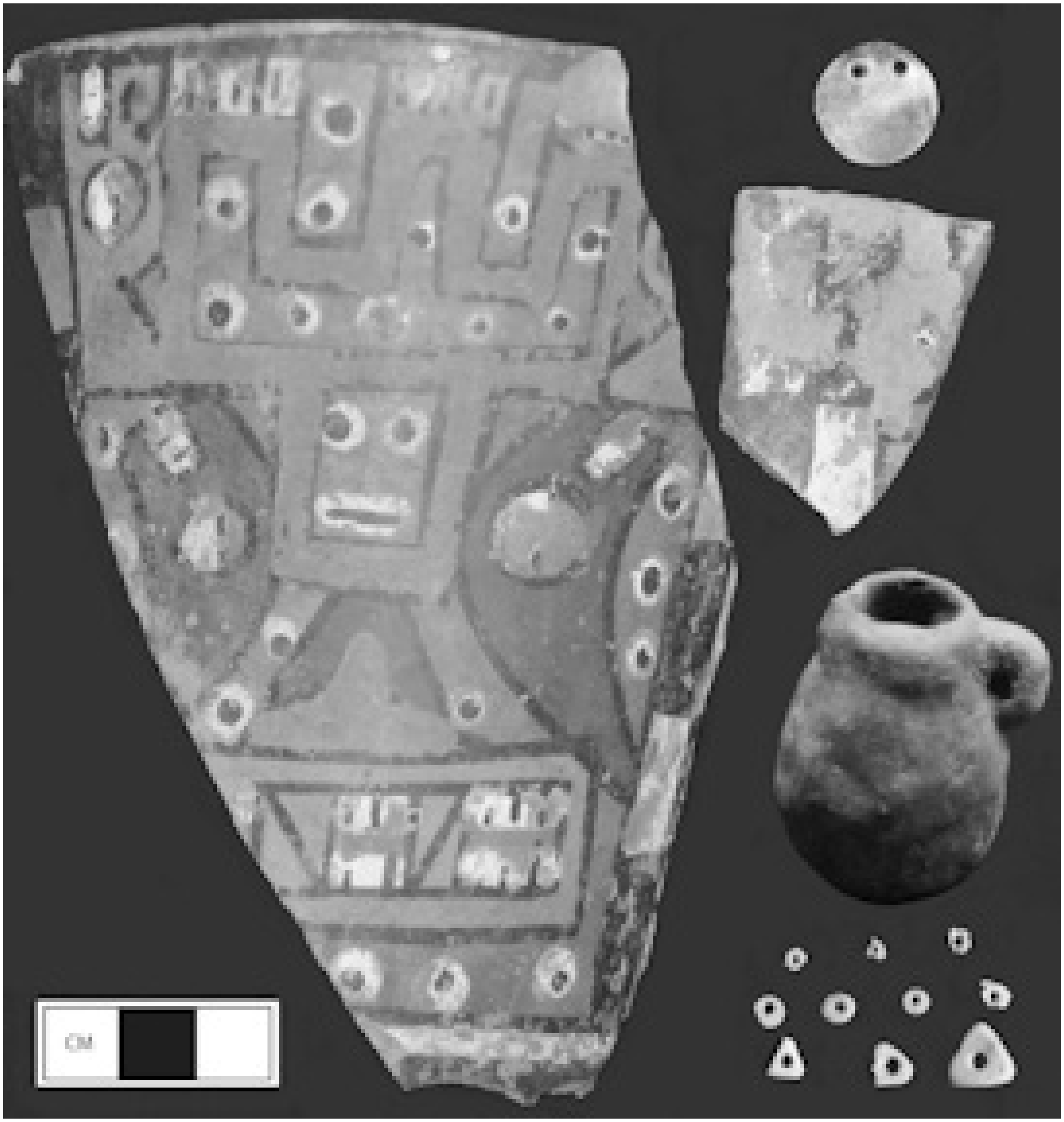

Figure 5. Sample of artifacts from rectilinear mortuary chambers, including fragments of a polychrome drinking vessel, turquoise beads, a miniature jar, and a silver adornment.

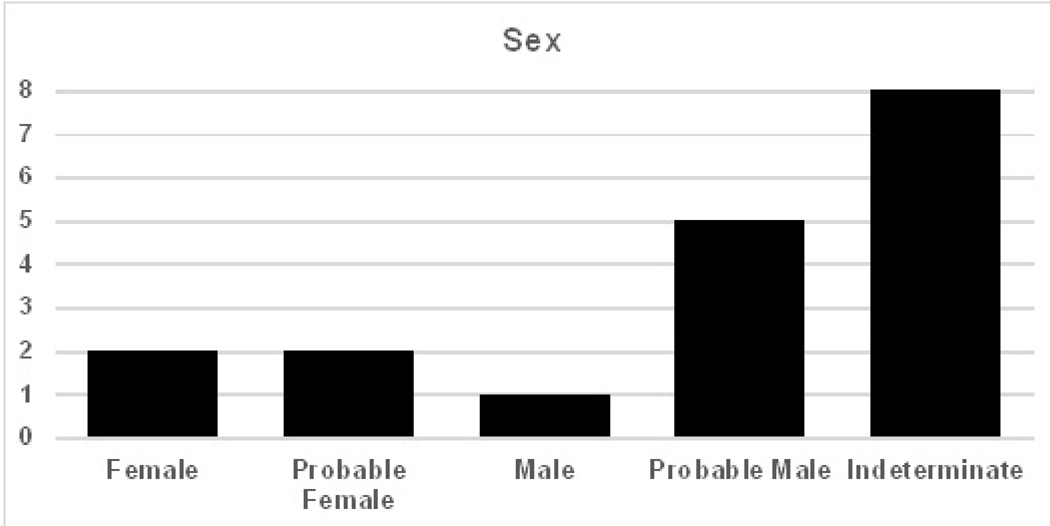

Figure 6. Sex Distribution of the Adult Population at Hatun Cotuyoc.

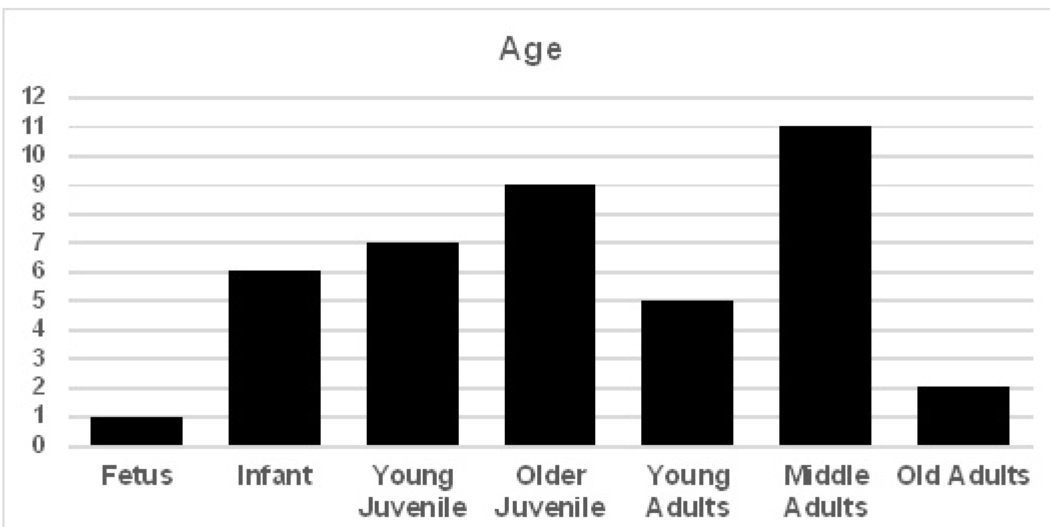

Figure 7. Number of individuals in each age category.

Figure 8. Cavity on mandibular third molar from Hatun Cotuyoc.

Figure 9. Mandibular dental abscess on second molar from Hatun Cotuyoc.

Figure 10. Periosteal reaction on right tibia from Hatun Cotuyoc.

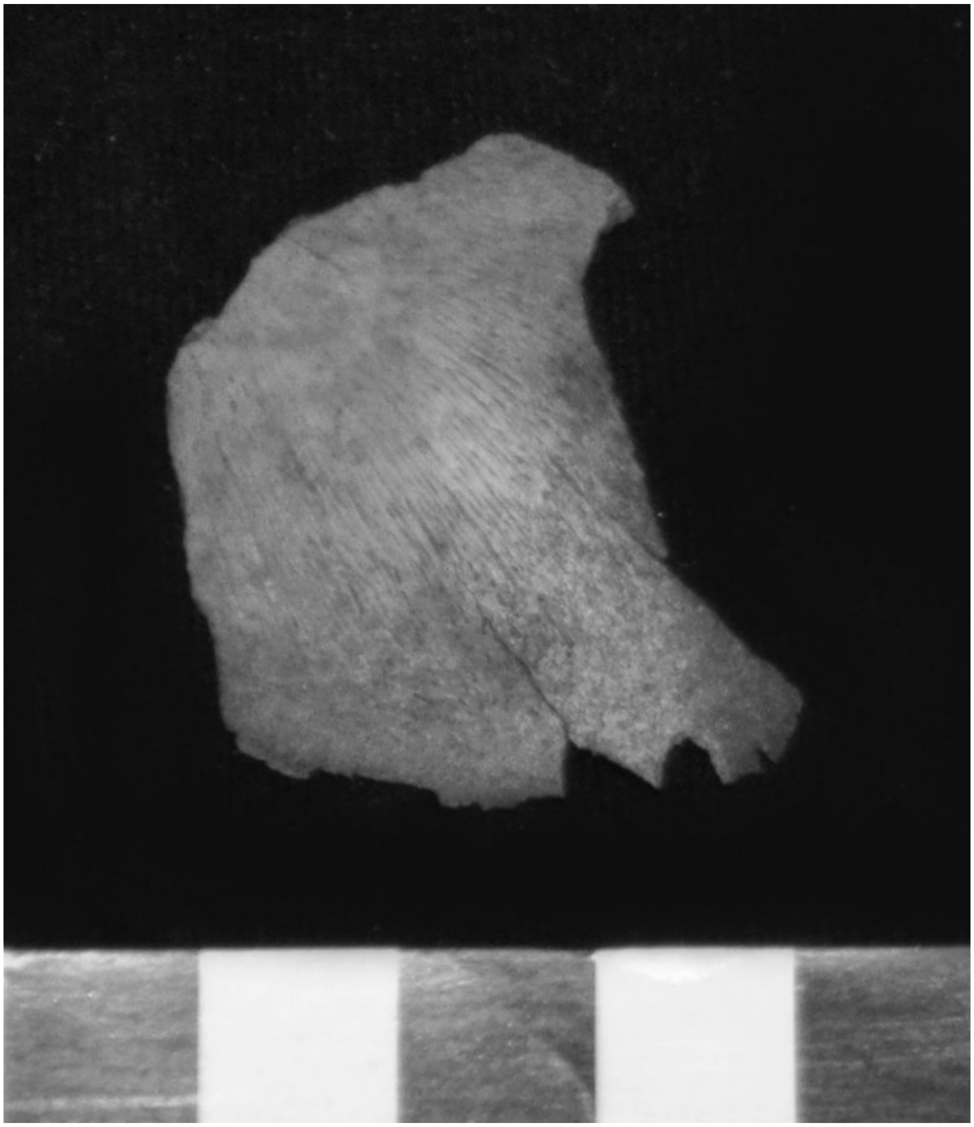

Figure 11. Porotic hyperostosis on infant parietal fragment from Hatun Cotuyoc.

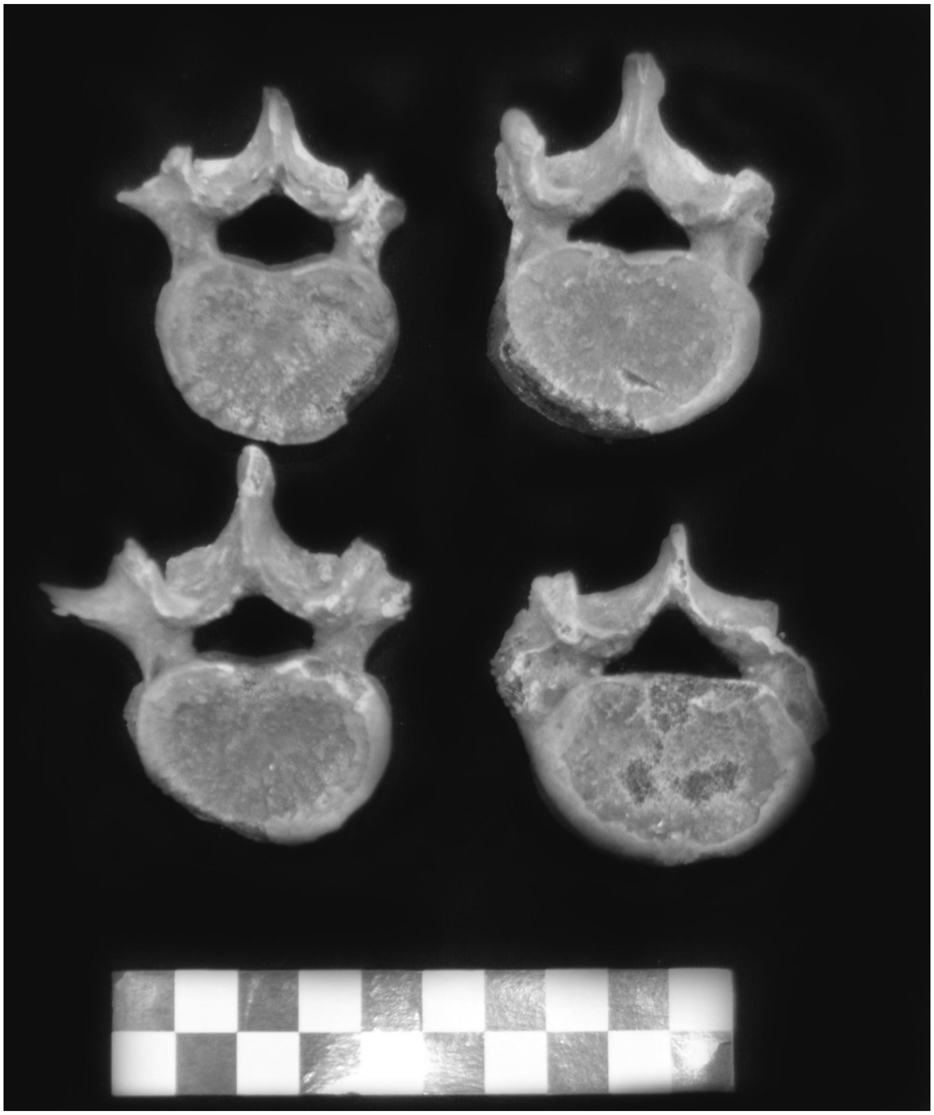

Figure 12. Osteoarthritis of lumbar vertebrae from Hatun Cotuyoc.

Figure 13. Relationship of two cranial wounds on right parietal.

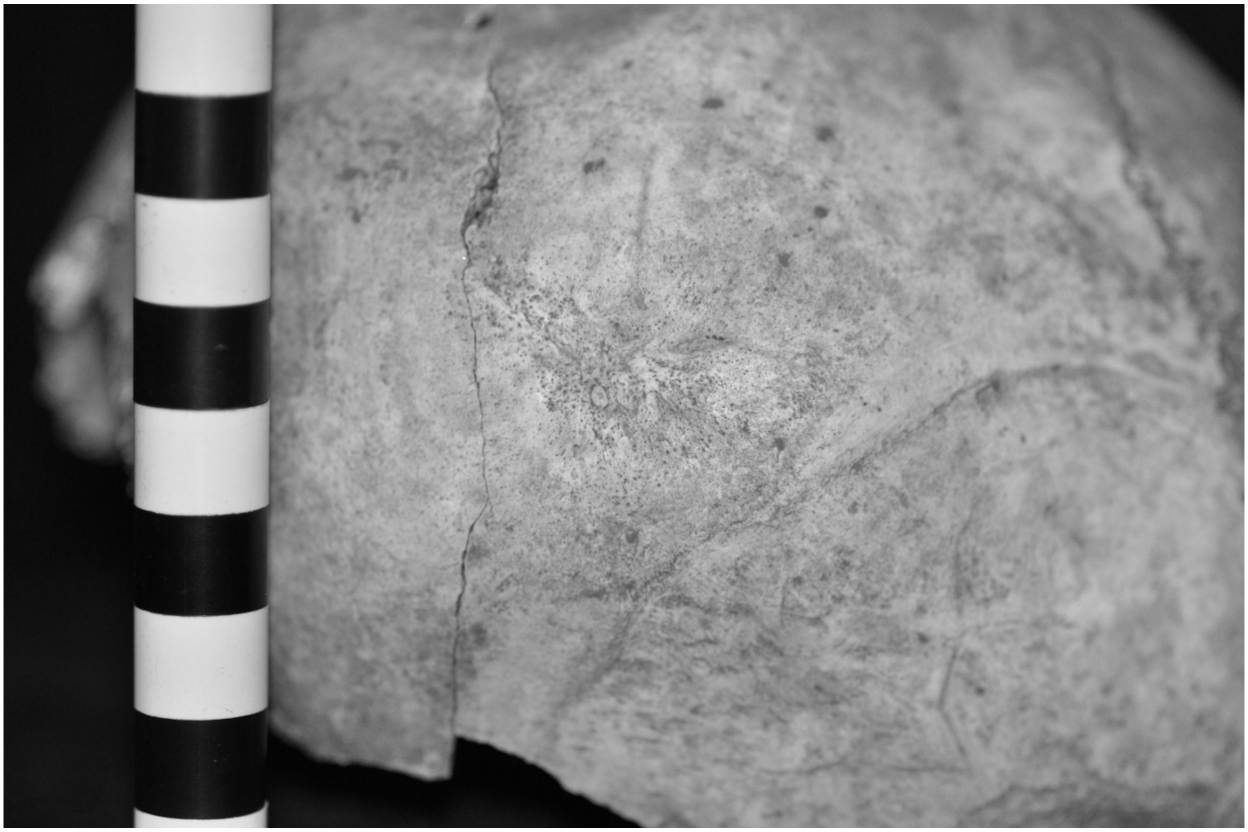

Figure 14. Healed sharp force trauma on right parietal.

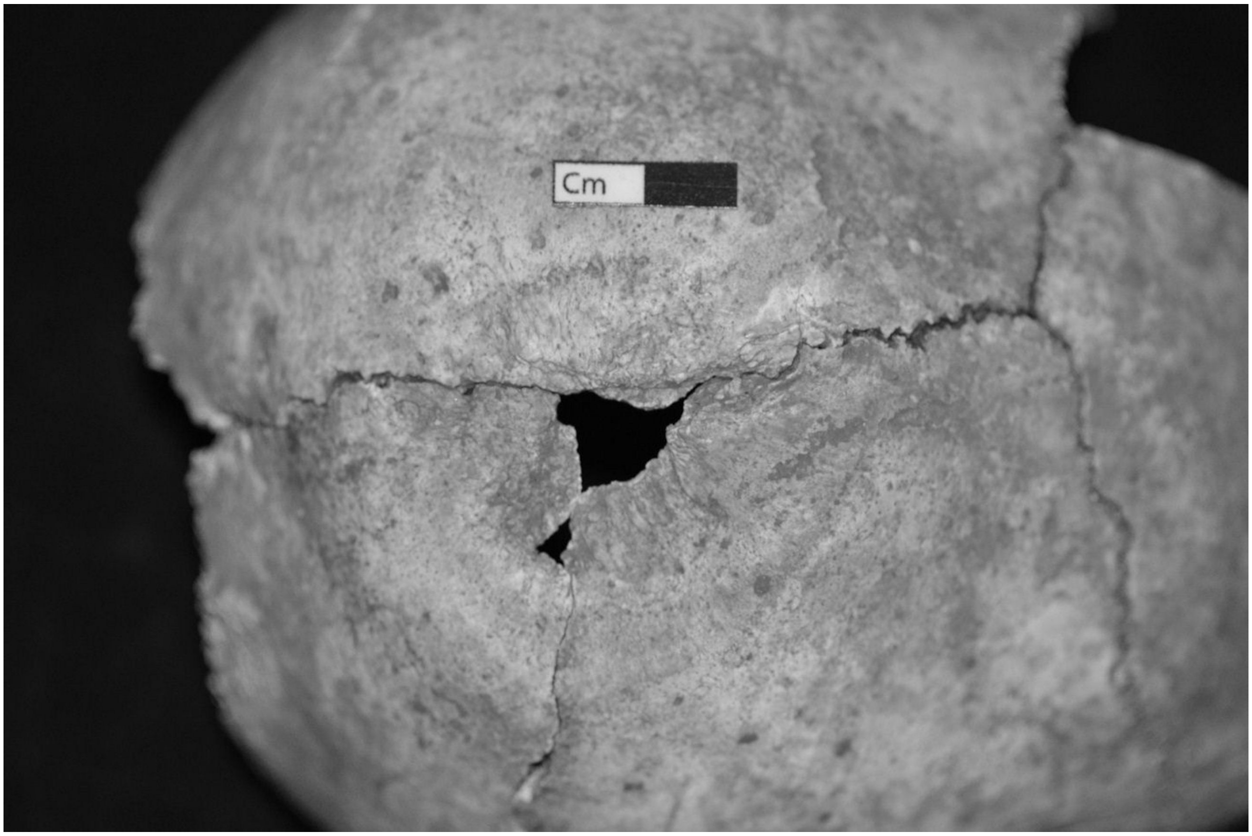

Figure 15. Blunt force trauma on the superior portion of the right parietal.