

ARTICLE

# Bioarchaeological Evidence of Violence between the Middle and Late Formative (500–400 BC) in the Peruvian North-Central Coast

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## Abstract

In this study, we address interpersonal violence during the transition between the Middle and the Late Formative periods in the Central Andes, a critical period of political disintegration, hypothesized population pressure, and reorganization of the belief systems that is poorly known from a bioarchaeological viewpoint. Our objective is to understand the nature of the violence and associated factors in this context based on a detailed description of skeletal trauma in 67 well-preserved individuals (20 adolescents and adults and 47 subadults) recovered from Quebrada Chupacigarro cemetery (500–400 BC); this site is located in the middle valley of Supe on the Peruvian north-central coast. To detect patterns and potential causes, we registered the prevalence of traumatic injury according to age, sex, anatomic location, mechanisms (blunt, sharp, mixed, etc.), timing (antemortem or perimortem), and manner (inflicted or accidental). The results show a high prevalence of fractures in the whole population, but especially in adolescents and adults. Eighty percent of the adolescents and adults perished due to the intentional trauma and show patterns that suggest repetitive episodes of interpersonal violence. Perimortem injuries in the skull, face, and thorax are compatible with lethal interpersonal violence. The findings support a probable scenario of intercommunity violence in the middle valley of Supe around 500–400 BC.

## Resumen

Este estudio aborda la violencia durante la transición entre el Formativo Medio y el Formativo Tardío en los Andes Centrales, periodo crítico de desintegración política a nivel regional, de hipotética presión poblacional y reorganización de los sistemas de creencias, pobremente conocidos desde el punto de vista bioarqueológico. Nuestro objetivo es entender la naturaleza de la violencia y sus factores asociados, con base en un detallado análisis de traumatismos esqueléticos en 67 individuos bien preservados (20 adolescentes y adultos y 47 subadultos) recuperados del cementerio Quebrada Chupacigarro (500–400 aC, valle medio de Supe, Costa Norcentral del Perú). La prevalencia de traumatismos fue registrada según sexo, edad, localización anatómica, mecanismo (contuso, cortante, mixto, etc.), temporalidad (*antemortem* y *perimortem*) y manera (infligido o accidental), para detectar patrones y causas potenciales. Los resultados muestran una alta prevalencia de traumatismos, aproximadamente el 80% de los adolescentes y adultos (16/20) pereció como resultado de traumatismo infligido, con patrones de lesión que sugieren eventos repetitivos de violencia interpersonal. Las lesiones *perimortem* en los huesos del cráneo, la cara y el tórax son compatibles con violencia interpersonal de carácter letal y sugieren un escenario probable de violencia intercomunitaria en el valle medio de Supe alrededor del 500–400 aC.

**Keywords:** bone fractures; intentional violent trauma; perimortem trauma; Andean Formative period

**Palabras clave:** fracturas óseas; traumatismos infligidos; trauma perimortem; Período Formativo andino

Based on settlement patterns data from the Central Andes, field archaeologists have proposed a scenario of political disintegration, overcrowding, and violence linked to the shift of political regimes from theocracies to new forms of government during the last half of the first millennium BC (Billman 1996; Ghezzi 2006; Ikehara 2016, 2021; Ikehara and Chicoine 2011; Pozorski and Pozorski 2018; Willey 1953; Wilson 1995). Although violence-related injuries (Martin and Harrod 2015) are crucial for the validation of the archaeological hypotheses under discussion, there is a near-absence of data about interpersonal violence in this period, characterized by the fall of the Chavin religious tradition around 450 BC. Considering a hypothetical context of population pressure in a relatively poor environment like the Peruvian coast, the possible occurrence of interpersonal violence in contexts from this period should be investigated, documented, and discussed.

Bioarchaeology is a discipline focused on the reconstruction of past lifeways from population-based and context-driven analyses of human remains. In this field, traumas are particularly informative about violent behaviors and, from a more general perspective, about living conditions, economic constraints, and processes of sociopolitical shifts (Lovell 1997; Redfern and Roberts 2019). However, because the expression of violence is modulated by the complex interplay of several local-specific factors, such as environmental change, cultural behavior, and historical trigger events (Harrod and Martin 2014; Murphy and Juengst 2020), the osteological approach is of utmost importance to understanding the nature of violence suffered by individuals (Martin and Harrod 2015).

In this article we evaluate the impact of interpersonal violence on the individuals buried at Quebrada Chupacigarro cemetery in Supe Valley on the Peruvian north-central coast; this archaeological site is dated to the Middle to Late Formative transition (500–400 BC). Through a detailed description and analysis of trauma patterns found in subadult and adult individuals, we evaluate the level of violence perpetrated on the individuals to understand the nature of intra- and intergroup interactions and related factors (i.e., environmental, socioeconomic, and historical) during this hypothesized period of sociopolitical restructuring.

### The Middle to Late Formative Transition (500–400 BC) in the Central Andes

From the Initial Formative (about 3000–1800 BC) until the Middle Formative (1200–400 BC), ceremonial centers linked to powerful belief systems were noticeable throughout the Central Andes (Kaulicke 1994; Morales 1993; Seki 2014). The sovereigns of these religious institutions controlled labor, surplus, and trade networks, renewing their power through dissuasive discourses, periodic architectonic renovations, and feasting (Burger 2008; Rick 2005; Vega-Centeno 2007).

During the last phase of the Middle Formative (800–400 BC), most Andean ceremonial centers shared roughly the same Cupisnique/Chavin iconography and U-shaped architectonic design under the influence of Chavin de Huantar, the most powerful ceremonial center of the period (Burger 1992; Rick 2005). However, during the transition from the Middle to Late Formative (500–400 BC), that system reached exhaustion, and the features of ritual spaces changed. Several ceremonial centers, including Chavin de Huantar, were desacralized and abandoned (Ikehara 2021; Rick 2013). Theocratic systems seemed to shift to secular governments. This political transition is more clearly perceived in the north, north-central, and central coasts of Peru (Billman 1996; Ghezzi 2006; Ikehara Tsukayama 2015; Ikehara and Chicoine 2011; Kaulicke 1992; Pozorski and Pozorski 1987; Willey 1953; Wilson 1995); it has been attributed to the fall of the Chavin cult and the disintegration of political formations organized around the Chavin sphere of interaction (Burger 1992, 2008; Rick 2005; Rick et al. 2009).

The Late Formative period (400–1 BC) is characterized by noticeable population growth (Billman 1996; Ikehara 2016; Ikehara Tsukayama 2015), changes in sociopolitical conditions, intercommunity tensions, and armed conflict (Chamussy and Goepfert 2019; Wilson 1995). High-scale monumental architecture disappears during this period, and there is evidence of the reallocation of the population to clustered settlements (villages and towns), defensive settings on hilltops, fortresses, and buffer zones (Billman 1996; Ghezzi 2006; Ikehara and Chicoine 2011; Mujica 1984; Pozorski and Pozorski 1987; Willey 1953).

These changes occurred at the same time as the intrusion of the White-on-Red ceramic style. On the north coast, this period is known as the Salinar phase, an archaeological culture first described by Larco

(1944) and Willey (1953) in the Chicama and Viru Valleys, respectively. Later studies confirmed the phenomenon in other valleys south of Viru (Ghezzi 2006; Ikehara and Chicoine 2011; Pozorski and Pozorski 1987; Wilson 1988, 1995); currently, the White-on-Red tradition includes other pottery styles distributed along the Central Andes; for example, Vicus, Cajamarca, Layzon, Puerto Moorin, Patatza, Huaraz, Huachipa-Jicamarca, San Blas, and San Juan Pata (Kaulicke 1992; Morales 1993:327). In addition to ceramics, metallurgy and new burial patterns, architectural styles, and iconography were introduced in this period (Elera 1998; Ikehara and Chicoine 2011).

The nature of the relations between the populations at that time is a matter of discussion (Ikehara and Chicoine 2011), although increasing coastal–highlands interactions seem to characterize the period. The model of demic diffusion is plausible in several valleys, and some scholars suggested “*serano* invasions” (Chamussy and Goepfert 2019; Mujica 1984; Pozorski and Pozorski 1987, 2018) or intervalley migrations throughout the coast, with a population decline in some valleys and an increase in others at approximately 400 BC (Billman 1996; Ghezzi 2006; Ikehara 2021; Ikehara and Chicoine 2011; Willey 1953; Wilson 1995). For some scholars, these hypothesized migrations were part of a scenario of “institutionalized war” spreading from the northeast through the Marañón basin (Chamussy and Goepfert 2019).

The available bioarchaeological evidence that is compatible with population growth, high population density, and poor living conditions during the Late Formative is limited, but it includes high frequencies of nonspecific stress markers and infectious diseases (Pechenkina et al. 2007; Pezo-Lanfranco and Eggers 2013). Bioarchaeological markers of intergroup violence around 400 BC have also been reported and interpreted as evidence of political reorganization and factional competition (Arkush and Tung 2013; Pechenkina et al. 2007; Pezo-Lanfranco and Eggers 2013; Vega Dulanto 2016). However, the underlying factors—for example, environmental fluctuations or demographic expansion—of this scenario of population pressure and hypothesized intergroup violence remain unclear.

### The Quebrada Chupacigarro Cemetery

The Quebrada Chupacigarro cemetery (QCC) is located at coordinates WGS84 10°54'17" S, 77°31'31" W (Figure 1), at the left margin of the middle valley of Supe, in the north-central coast of Peru, on the southwestern slopes of a middle-size hill called Cerro Mulato, less than 1.5 km from Caral, the most representative site of the earliest sociopolitical development of the third millennium BC.

The QCC was discovered and completely excavated in 2011 by the Caral Archaeological Project (Zona Arqueológica Caral, Unidad Ejecutora 003, Ministerio de Cultura del Perú). A total of 67 burials organized in clusters were identified over an area of 3,500 m<sup>2</sup>. Given that QCC is the first formal cemetery detected in the Supe Valley and Formative cemeteries are rarely found, this discovery has great importance to understanding the sociopolitical regional processes of the first millennium BC.

The burial pattern for adults and subadults is characterized by primary individual contexts excavated in sand matrix and covered by sand layers. The matrix shape is oval or rounded. According to field data, 65 of 67 individuals presented data about their body position. Among them, 64 were buried in a hyperflexed or fetal position, of whom 12 were in hyperflexed dorsal decubitus, 4 in hyperflexed ventral decubitus, 7 in hyperflexed-left lateral decubitus, and 41 in hyperflexed-right lateral decubitus. Only one infant was found in an extended position. The more common body orientations in the matrix are SE–NW and NW–SE, but there is also evidence of other orientations.

A total of 48 individuals were associated with a piece of covering of plain cotton fabric or vegetal mat. The funerary assemblage is poor, and in most cases, no offerings were detected. Some individuals show few offerings: one or more *mates* or gourds (*Lagenaria* sp.) containing botanic remains of pumpkin (*Cucurbita* sp.), cotton seeds (*Gossypium barbadense*), and some roots of undetermined species (16 individuals), basketry (two individuals), beaded necklaces (two individuals), and pottery fragments (two individuals). Stable isotope studies revealed that farming staples were the basis of subsistence (Pezo-Lanfranco et al. 2021).

The AMS radiocarbon dates suggest that QCC was formed by the accumulation of funerary areas between 2545 ± 28 and 2380 ± 30 BP, or 790–204 cal BC (2σ; Supplemental Tables 1 and 2). Because QCC dates are plotted into the Hallstatt plateau (around 750–400 cal BC; Burger 2014; Kembel and

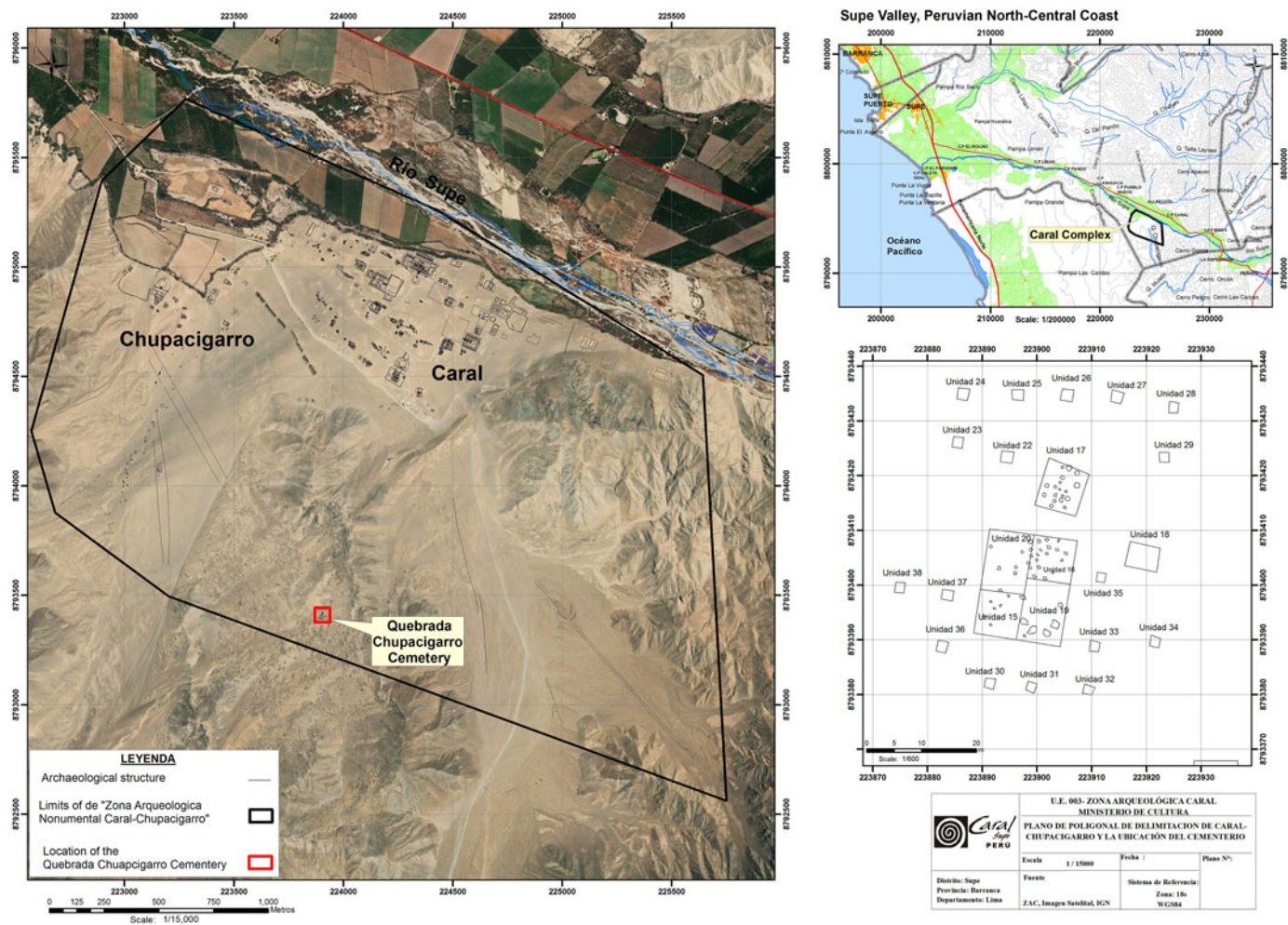


Figure 1. Location of Quebrada Chupacigarro cemetery.



Hass 2015) in the calibration curve, it was necessary to examine the stratigraphy, associated artifacts, and contextual data to validate the dates. The dataset indicates that QCC burials correspond to the transition between the Middle and Late Formative periods (500–400 BC), a poorly documented period of the Central Andes.

Although no settlements directly associated with QCC were detected in the area, there is an occupation from the Late Formative located in the northeast sector of Caral (Sector F) that includes two public ceremonial buildings with sunken squares and architectonic design similar to that observed in the Plaza Mayor of Chavin de Huantar; there was also evidence of Janabarriu-style pottery (Shady et al. 2014:148–150).

### Study Aims and Bioarchaeological Expectations

This study addresses three questions: Is there any evidence of violence in the QCC individuals? If so, what was the nature of this violence (i.e., intra- or intercommunity)? And what is the significance of this “local expression” of violence in the context of the hypothesized regional sociopolitical reorganization and population pressure?

Current archaeological evidence from the Middle to Late Formative transition on the coast of the Central Andes suggests, at a regional level, a context of crisis characterized by changes in settlement patterns, dense settlements, population growth, and conflict. The limited access to and competition over scant resources—two expected conditions in contexts of population pressure—may have influenced the expression of violence. Thus, if these conditions were present, we would expect to find bioarchaeological markers of trauma linked to interpersonal violence in QCC individuals.

From a comparative perspective, several categories of trauma, described and explained by contemporary medicine and forensic anthropology, can be associated with accidents or interpersonal violence and allow inferences about the etiology of the injuries observed in human skeletons (Lovell 1997; Passalacqua and Fenton 2012; Ubelaker 2019). Although most traumatic situations are not identifiable in dry bones, the observable cases provide much information about social violence situations and offer robust evidence about interindividual relationships, coercive or exploitive sociopolitical systems, and some historical events that were particularly violent. Traumas are also informative about the difficulty of navigation over the terrain—for instance, bumpy or dangerous topography—and the type and degree of physical activity deployed by individuals, such as risk activities (Campillo 2001; Lovell 1997).

Theoretically, the bioarchaeological assessment of trauma enables a differentiation between intra- and intercommunity patterns of violence. Intercommunity violence is commonly linked to conflict between organized groups (warfare and raids). Intracommunity violence may involve interpersonal violence between neighbors or relatives (spouses, sons, siblings, etc.) and include fights between males motivated by competition for females, prestige or resources, gender violence, and child abuse (Martin and Harrod 2015). Whereas intracommunity violence corresponds to nonlethal lesions because of the domestic or interdomestic nature of the conflicts, inflicted-lethal lesions are often related to intercommunity violence (Arkush and Tung 2013; Campillo 2001).

If intercommunity violence did exist in QCC, we would expect high relative frequencies of perimortem and antemortem fractures in the skull (e.g., depressed or penetrating fractures) and the thorax—often multiple fractures—and some specific types of traumas in the postcranium (e.g., perimortem parry fractures), especially when combined with cranial trauma. Usually, intercommunity violence is intentional-lethal trauma that shows signs of sharp or blunt weapons, has a side pattern of occurrence—it is more common in the left side of the individual, produced by a right-handed opponent in a face-to-face combat—and has a gender profile (i.e., more males and older adolescents). In the case of ritualized violence, another possibility in the Central Andes, multiple healed fractures corresponding to repetitive nonlethal injuries (Nagaoka et al. 2017) or to contexts of the execution of captives, mainly young males, can be expected (Verano 2001). In the case of massacres and mass graves, the presence of children, females, and males—with a significant frequency of perimortem trauma on the head, thorax, and arms—would be expected (Martin and Harrod 2015; Valdez 2009; Verano and Toyne 2011).

Environmental stress and changing sociopolitical conditions may have contributed to increasing levels of intracommunity violence in QCC, including increasing amounts of violence against children

and gender abuse (Martin and Harrod 2015). Among the patterns of trauma that characterize child abuse are multiple injuries suggesting recurring and repetitive episodes of violence, especially in the head (i.e., perimortem or healed, and periosteal reactions in the inner surface of cranial bones compatible with subdural hemorrhages), thorax (i.e., ribs, scapula, the spinous process of the vertebrae, and the sternum), and long bones (Gaither 2012). Gender abuse can show similar patterns, and the violence is mainly nonlethal, but any lethal trauma should be considered as a possible effect of violence against women (Martin and Harrod 2015).

Of course, a reasonable range of variability in the expression of the violence is possible. Thus, to avoid misinterpretations on interpersonal violence, the cautious evaluation of the individual in context is mandatory (Lovell 1997; Lovell and Grauer 2019; Martin and Harrod 2015).

## Materials and Methods

For this study, we analyzed 67 individuals from the QCC. Although there was some degree of bone fragmentation linked to both taphonomic factors and the antiquity of the burials, all the individuals presented well-preserved bones for detailed morphological examinations and accurate bioarchaeological recording.

### *Estimation of Sex and Age-at-Death*

Adult sex was estimated using morphological features of the skull and pelvis (Buikstra and Ubelaker 1994). Due to the difficulties of sex determination, all the subadults were classified as “undetermined” (Scheuer and Black 2000). The age-at-death in adults was determined using several standardized morphologic markers: pubic symphysis, the sternal end of the fourth rib, and the auricular surface of the innominate bone (all the methods in Buikstra and Ubelaker 1994). Age-at-death in subadults was based on the chronology of dental eruption (Gaither 2004), epiphyseal union (Buikstra and Ubelaker 1994), and vertebral development (Scheuer and Black 2000). The individuals were classified into broad categories: neonate (Neo): 0–1 year; infant (Inf): >1–5 years; child (CH): >5–>12 years; adolescent (Ad): 12–20 years; young adult (YA): >20–35 years; middle adult (MA): >35–50 years; and old adult (OA): >50 years.

### *Trauma Recording*

Trauma is conventionally defined as “an injury to living tissue that is caused by a force or mechanism extrinsic to the body” (Lovell 1997:139). Bioarchaeological markers of trauma include fractures, defined as any break (complete or incomplete) in the continuity of a bone; dislocation, defined as the displacement of one or more bones at a joint; and cut marks of various types, as well as their intermediate processes of healing (Campillo 2001; Lovell 1997; Lovell and Grauer 2019).

In this study trauma was registered as present/absent in each individual, and the group prevalence was then calculated (observed trauma / total observable cases). The traumatic injuries were recorded considering the affected bone, magnitude and features of the lesion, healing stage, timing (antemortem/healed, perimortem/nonhealed, or both [Berryman and Symes 1998; Galloway et al. 2014; Maat 2008:Table 5.8; Passalacqua and Fenton 2012]), lethality, manner, the mechanism (direct and indirect trauma, stress, and pathological fractures [Lovell 1997]), and related weapons. This recording was made so they could be classified as accidental or intentional, with the aim of approximating their cause (Gaither 2012; Lovell 1997; Martin and Harrod 2015). For consistency and to make them comparable with other studies, trauma descriptions and interpretations follow the classification and criteria of Lovell (1997).

To examine the differences in the prevalence of conditions between groups (male vs. female, adult vs. subadults, etc.), we did a  $2 \times 2$  chi-square test of independence with Yates’s correction at  $p < 0.05$ . The statistical analyses were conducted with SPSS 21.0 (IBM).

## Results

In Quebrada Chupacigarro Cemetery (QCC) the age-at-death structure shows a high proportion of subadult individuals (70.1%; 47/67) relative to adults and adolescents (29.9%; 20/67). The distribution

**Table 1.** Prevalence of Trauma in Quebrada Chupacigarro Cemetery ( $n = 67$ ).<sup>a</sup>

Categories	Trauma	
	$n^a$	%
<b>By age category</b>		
Neonate (0–1 year)	2 (29)	6.8
Infant (>1–5 years)	3 (17)	17.6
Child (>5– <12 years)	1 (1)	100.0
Adolescent (12–20 years)	2 (3)	66.7
Young Adult (>20–35 years)	2 (4)	50.0
Middle Adult (>35–50 years)	9 (10)	90.0
Old Adult (>50 years)	3 (3)	100.0
<b>By age group</b>		
Subadults (<12 years)	6 (47)	12.8
Adolescents + Adults	16 (20)	80.0
<b>By sex</b>		
Males	9 (12)	75.0
Females	7 (8)	87.5
Undetermined <sup>b</sup>	6 (47)	12.8
Total (whole sample)	22 (67)	32.8

<sup>a</sup> Considering all the observable trauma (antemortem and perimortem). Observed cases of trauma (observable individuals).

<sup>b</sup> In this case Undetermined corresponds to juveniles <12 years.

of adult individuals by sex shows more males (60%; 12/20, who were predominantly young and middle adults) than females (40%; 8/20, predominantly middle adults). Thus, regardless of the small size, this sample is asymmetric (Supplemental Table 3).

### *Traumatic Injuries in QCC Individuals*

The prevalence of traumatic injuries detected in the whole QCC sample was 32.8% (22/67). To address the nature of the observed injuries, we sorted and compared them according to their age/sex distribution (Table 1; see also Supplemental Table 4 for statistical comparisons between groups). Evidence of traumatic injuries appears in 80% (16/20) of adolescents and adults. The count of lesions by sex shows that 75% (9/12) of males and 87.5% (7/8) of females suffered trauma. Among subadults (<15 years old), 12.8% (6/47) of individuals show trauma, mainly perimortem injuries (Table 2; see also Supplemental Table 5 for individual injuries' description and additional documentation). The proportion of adults and adolescents with traumatic injuries is significantly higher than in subadults ( $p < 0.001$ ).

The inferred timing of the traumatic injuries suggests interpersonal violence: 7.4% (5/67) of individuals exhibit only antemortem trauma, and 14.9% only perimortem trauma, whereas 10.4% of individuals show both antemortem and perimortem trauma, resulting from two or more traumatic events.

The analysis of antemortem and perimortem traumatic injuries by anatomic region (Table 3) does not show significant differences between males and females in any comparison, but it refines our understanding of the mechanisms involved. Among the affected individuals, craniofacial perimortem injuries affected 56% of males, 71% of females, and 67% of subadults. Among postcranial perimortem injuries, most were thoracic (rib fractures, scapular fractures, vertebral fractures) and fractures of the middle or distal third of the ulnae and radius, which always appear linked to perimortem cranial injuries.

**Table 2.** Prevalence of Trauma among the Affected Individuals according to Inferred Timing, Manner, Number of Injuries, and Side in Quebrada Chupacigarro Cemetery.

Trauma	Males (N = 12)		Females (N = 8)		Subadults <sup>a</sup> (N = 47)		Total (N = 67)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<b>Affected by trauma</b>	9	75.0	7	87.5	6	12.8	22	32.8
<b>Inferred timing</b>								
Antemortem trauma	2	22.2	2	28.6	1	16.6	5	7.5
Perimortem trauma	3	33.3	2	28.6	5	83.3	10	14.9
Antemortem and perimortem (both)	4	44.4	3	42.9	0	0.0	7	10.4
<b>Inferred manner</b>								
Accidental / other causes	3	33.3	3	42.9	0	0.0	6	9.0
Intentional	8	88.9	5	71.4	4	66.7	17	<b>25.4<sup>c</sup></b>
Ambiguous	0	0.0	1	14.3	2	33.3	3	4.5
<b>Number of injuries</b>								
One injury	1	22.2	0	0.0	4	66.7	5	7.5
Multiple injuries	8	88.9	7	100.0	2	<b>33.3<sup>b</sup></b>	17	<b>25.4<sup>d</sup></b>
<b>Side of injuries</b>								
Right side	4	44.4	0	0.0	2	33.3	6	9.0
Left side	0	0.0	7	100.0	3	50.0	10	14.9
Both sides	5	55.6	0	0.0	1	16.6	6	9.0

Notes: N = total number of evaluated individuals; n = number of affected individuals. Significant differences in bold.

<sup>a</sup> All subadults <12 years, classified as undetermined sex.

<sup>b</sup> Females vs. subadults (Yates's correction  $\chi^2 = 3.974$ ;  $p = 0.046$ ).

<sup>c</sup> Intentional trauma vs. accidental (Yates's correction  $\chi^2 = 9.110$ ;  $p = 0.003$ ) and vs. ambiguous (Yates's correction  $\chi^2 = 15.492$ ;  $p < 0.001$ ).

<sup>d</sup> One injury versus multiple injuries (Yates's correction  $\chi^2 = 11.000$ ;  $p < 0.001$ ).

Perimortem injuries were mainly produced by blunt and sharp-blunt forces and were the most common in all the observed groups. A few individuals offer the possibility of reconstructing the type of weapon used. Among them, the lesions are consistent with lethal weapons such as clubs (*porras* and *macanas*; Chamussy 2012), axes, projectiles such as pebbles thrown with slings, and spears. A stone flake, possibly associated with a *macana* (a hand-held weapon), was detected in the nose of one individual (see Supplemental Table 5 and additional documentation); it suggests that this kind of weapon could produce serious damage, including soft tissue loss, in the face of the victim. No other weapon was detected in the contexts or was linked to the individuals.

In QCC, intentional traumas are more conspicuous among the affected individuals, followed by accidental and other causes, such as stress / pathological fractures and traumas of ambiguous origin. Those traumas of ambiguous origin did not appear in adult males but only in females and subadults. Accidental and ambiguous traumas are possibly related to falls from a height or other unknown events. Only three cases of fractures related to stress and pathologies (i.e., osteoporosis, tuberculosis) were detected in adult women. Most individuals show multiple injuries (antemortem and perimortem), but no clear side pattern (right or left side) was observed. Nor were traumatic surgical interventions (i.e., amputation, trepanation) observed.

The traumas observed in subadults, all consistent with blunt force trauma, include four examples of intentional-lethal cranial vault fractures (Figure 2). In addition, fractures of ambiguous origin were observed in ribs in two children: ZAC0485, a  $\leq 1$ -year-old with a healed fracture in the eleventh right rib, and ZAC0630, a 4.5-year-old with a fracture in the eighth right rib in an early stage of healing and possibly related to the cause of death.



**Table 3.** Location of Antemortem and Perimortem Traumatic Injuries in Individuals from Quebrada Chupacigarro Cemetery.\*

Trauma by anatomic region	Males (n = 9)				Females (n = 7)				Subadults** (n = 6)			
	AM	%	PM	%	AM	%	PM	%	AM	%	PM	%
cranial vault	2	22.2	3	33.3	1	14.3	3	42.9			4	66.7
facial bones	2	22.2	2	22.2	2	28.6	2	28.6				
thorax	3	33.3	6	66.7	4	57.1	6	85.7	1	16.6	3	50.0
pelvis			2	22.2			1	14.3				
humerus			1	11.1								
ulna	1	11.1	1	11.1	2	28.6	1	14.3			1	16.6
radius	1	11.1	1	11.1	2	28.6						
hand bones	3	33.3			1	14.3						
femur			1	11.1								
tibia					1	14.3						
fibula			2	22.2			1	14.3				
feet bones	2	22.2			1	14.3						

\* See Supplemental Table 5 for traumatic injuries description. *n* = total number of individuals affected by trauma.

\*\* All subadults <12 years were classified as Undetermined sex. AM = antemortem; PM = perimortem.

## Discussion

### *Nature of the Violence in the Middle Valley of Supe around 500–400 BC*

In QCC, evidence of trauma is generalized. Reconstruction of the timing, manner, and mechanism of trauma indicates that most were intentional/malintent/inflicted. Perimortem trauma is the most frequent type and appears widely distributed among adult individuals of both sexes, and even in children. However, intentional antemortem trauma is also common, and several individuals show both antemortem and perimortem trauma corresponding to at least two violent events. Thus, the markers suggest an exposure to repetitive and lethal violence over the life course.

Among the more commonly observed lesions are depressed fractures in the cranial vault, other maxillofacial fractures, thoracic fractures mainly in ribs and scapulae, and “defensive” fractures of the middle or distal third of the ulna (parry fractures). All are possibly linked to interpersonal violence (Campillo 2001; Martin and Harrod 2015).

At least four types of cranial fractures were observed: pond fractures or depressed/comminuted/penetrating fractures, spider’s web or *stellate* fractures, hinge fractures, and ring fractures (Crudele et al. 2020; Lovell 1997). Although they can be produced by accidents, depressed and penetrating fractures usually are the result of interpersonal violence (Galloway et al. 2014). Maxillofacial fractures, which include nasal, zygomatic, maxillary, mandible, and dental fractures, are also common and clearly suggest interpersonal violence. For instance, maxillofacial fractures are the first type of trauma in combat sports practitioners (45%), and nasal fractures represent 85% of the total (Shirani et al. 2010).

The association between ring fractures and cervical fractures strongly suggests fatal falls from a height; cranial base fractures from a height of 3–6 m reach about 25% (Kohli and Banerjee 2006). In QCC, however, fractures on the cranial base could also be linked to lethal traumas in the cranial vault (three cases), even without vault bone fractures (two cases; Crudele et al. 2020). Ring fractures have been associated with a specific type of blunt trauma, such as execution of the individual kneeling with the head down and receiving a strong impact on the back of the neck (Ta’ala et al. 2006). Gómez (2016) attributes ring fractures observed in individuals from Paracas (about 400–200 BC) on the south coast of Peru to this cause. This interpretation is plausible for most of this kind of fractures observed in QCC.

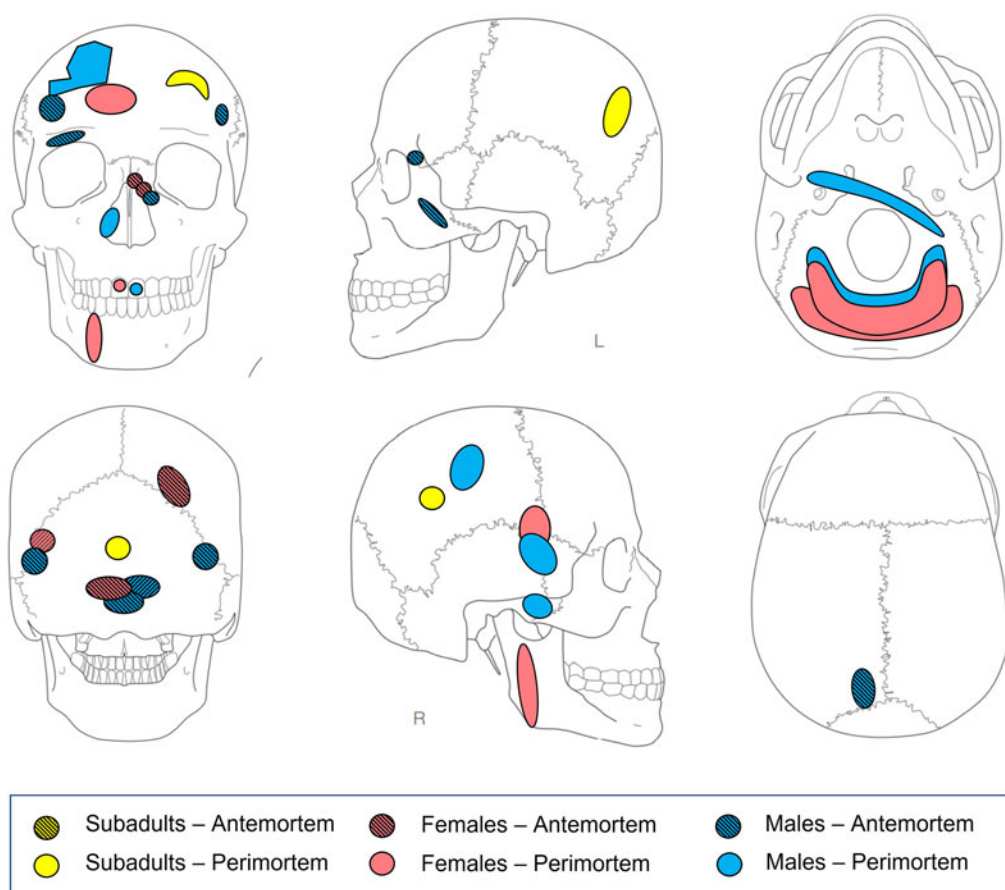


Figure 2. Cranial trauma in QCC sorted by age and sex. (Color online)

Although no clear side pattern of trauma was detected in QCC, the more common lethal lesions in the cranium were produced by both blunt and sharp-blunt forces. In QCC, at least 12 individuals (eight adults and four subadults) show intentional trauma produced by clubs or sharp-edged objects. These injuries, inflicted with the clear intention to kill the opponent, can be interpreted as markers of intercommunity violence (Martin and Harrod 2015).

Among the individuals affected by trauma, a high proportion (77%) show multiple intentional injuries, antemortem and perimortem, in the cranium, thorax, and pelvis produced by lethal weapons (i.e., *porras*, *macanas*, axes, and spears) compatible with repetitive intercommunity violent events.

Non-intentional lesions are rarely fatal (Campillo 2001; Tung 2007). Among the most common accidental fractures observed in QCC are those of the distal radius, observed in at least three individuals, and hand and feet bone fractures, observed in four individuals. The radius lesions normally occur in individuals who suffer face-down falls with lesions in the facial bones, wrists, and hands. From a bioarchaeological perspective, these falls have been related to carrying heavy loads on the back or moving along steep terrain (Buikstra and Ubelaker 1994; Campillo 2001). However, considering the recurrence and particularities of the context, these lesions could be interpreted as an indirect result of violence, possibly from accidents linked to pursuits. Scapular fractures have been attributed to the strong impact caused by accidental falls from a height or interpersonal violence (Galloway et al. 2014), but in QCC they are linked to blunt-sharp forces.

The trauma patterns observed in QCC individuals do not indicate a gender profile. Whereas males were more prone to suffer both perimortem and antemortem trauma, females suffered violence of the

same nature and scale, and even subadults were affected by perimortem injuries. The picture is not compatible with “gender violence” (Martin and Harrod 2015).

An androcentric emphasis, however, prevails in the bioarchaeological literature about human violence. The study of violence assumes women as victims and overlooks women’s violent behaviors or the participation of women and children as actors in violent events (Martin et al. 2010; Owens 2007). In QCC, the nature of the injuries indicates that women faced recurrent violence and, in most of the documented cases, were victims of lethal violence. In the last case, however, their bodies were treated with the same rituals after death, suggesting that they were members of the local society. The fact that those women, mainly females in reproductive age, suffered lethal injuries relativizes perpetrators’ intention of capture and forced abduction and rather suggests ethnocide (Martin and Harrod 2015; Martin et al. 2010).

The trauma record shows that QCC children were the targets of interpersonal violence, but it is difficult to identify the true nature of their lesions. Despite the intrinsic difficulty of identifying bone fractures in subadults (Lewis 2013), all our ambiguous cases suggest only two, not necessarily mutually exclusive, causes: accidents related to inadequate childcare or interpersonal violence. Some traumas, such as rib fractures, can be interpreted as child abuse, and their co-occurrence with trauma in women can be interpreted as gender violence (Gaither 2012). Intra- and intercommunity violence could both be present at QCC.

Considering the whole context, another plausible interpretation is that some children perished in the same kind of event that killed the adults. The context is not entirely compatible with ritual violence (Gaither et al. 2008; Nagaoka et al. 2017; Verano 2001). In addition, the subadults show injury patterns like those of the adults, as was also observed in other violent contexts in the Andes (e.g., in the Punta Lobos context [Verano and Toyne 2011]). Finally, the presence of children, males, and females with lethal trauma in QCC could be interpreted as result of a massacre or a raid.

Although the integrated data suggest intercommunity violence, we cannot yet define with precision the scale and nature of the violence exerted on the Chupacigarro people. Despite their neighboring locations in the cemetery, spatial and stratigraphic relationships, and radiocarbon dates, it is not possible to confirm that all the individuals with trauma correspond to a unique event. However, it is reasonable to presume, at least for the corpses buried in the same stratigraphic horizon (see Supplemental Table 5), that they were killed in the same event—despite the lack of evidence of hands tied, ropes, or signs that could indicate they were prisoners. The funerary patterns suggest that they were buried by their own people.

To apply categorizations using only one cemetery and relatively small samples is challenging for any context. In the case of QCC, the observed injuries show a mix of features that complicate the recognition of intra- and intergroup violence. Thus, one question arises: Are those osteological markers useful in identifying violence categories and possible explanations for violent events, or on the contrary, do they throw shadows on our perceptions of the phenomena?

### ***The QCC Case in the Context of Violence in the North-Central Coast during the Middle-Late Formative Transition (500–400 BC)***

To answer this question, it is first necessary to acknowledge that one problem persists in the study of violence in the north and north-central coast of Peru. Depending on the valley there is a considerable overlap of periods and absolute chronologies, an issue mainly related to the inaccuracy of some radiocarbon dates (for a comprehensive approach to this subject, see Chamussy and Goepfert 2019) and the fact that most of the Middle Formative dates plot into the Hallstatt Plateau (for an introductory discussion about this topic, see Kembel and Hass 2015). Thus, many sites cannot be dated with precision.

Second, the volume of bioarchaeological data available for the Formative period is relatively insignificant when compared to later precontact periods of the Central Andes (Arkush and Tung 2013; Toyne et al. 2020:Table 4; Vega Dulanto 2016). Bioarchaeological studies on temporal trends of violence focused on the Formative period are limited, but all coincide in suggesting a picture of rising violence from around 400 BC to AD 100 that is unprecedented in Andean history (Arkush and

Tung 2013; Gómez 2016; Pechenkina et al. 2007; Pezo-Lanfranco and Eggers 2013; Vega Dulanto 2016); this violence included extreme expressions of interpersonal violence such as massacres and massive decapitations in some contexts (Valdez 2009). Although in more arid environments, such as the Atacama region (northern Chile), the violence seemed to be endemic since earlier times (Standen et al. 2021), most of the bioarchaeological data from the Middle Formative or previous periods in the Central Andes suggest low levels of violence or, at most, “ritual violence” (Arkush and Tung 2013; Nakaoka et al. 2017). Throughout the last half of the first millennium BC, the violence markers show a noticeable increase, especially in the north coast of Peru during the Salinar phase (Arkush and Tung, 2013; Pezo-Lanfranco and Eggers 2013) but also in the central (Pechenkina et al. 2007; Vega Dulanto 2016) and south-central coast (Gómez 2016; Tomasto 2009). For instance, between the Middle Formative and the Late Formative, the prevalence of traumatic injuries increases from 15% to 85% on the north coast (Pezo-Lanfranco and Eggers 2013), and the frequency of cranial trauma increases from about 5% to 18% in the Central Andes as a whole (Arkush and Tung 2013).

In several studies, violence was invariably attributed to multicausal processes greatly influenced by climatic changes linked to El Niño-Southern Oscillation (ENSO), which led to population pressure and social collapse (Contreras 2010; Harrod and Martin 2014). During the first millennium BC, the Peruvian paleoclimatic data show the maximum intensity of El Niño with strong individual events, high sedimentary flux, and high marine temperature over the last 20 ka, especially after 800 BC (Rein et al. 2005; Sandweiss and Moseley 2001). Dillehay and Kolata (2004:Table 1) reported mega El Niño phenomena with events of major flooding in at least two periods—840–415 cal BC and 530–375 cal BC—for the north coast, and other correlated biomarkers have been found (Elera et al. 1992). However, although these dates could be extrapolated to the north-central coast because episodic flooding is roughly similar between both regions, the absolute chronology of flooding events shows large uncertainty (Wells and Noller 1999:782).

Climatic instability could be also attributed to desertification processes and not necessarily to ENSO. Geoarchaeological studies on loess from the south-central coast, currently the driest region of Central Andes, suggest higher humidity than the present until about 800 BC (precipitation <250 mm/a) when a strong process of desertification started—precipitation progressively falls to 100 mm/a at about 200 BC—as an effect of the migration to the south of the Bolivian High Anticyclone (Eitel et al. 2005; Mächtle et al. 2010). In addition, the Middle to Late Formative transition was a period of strong global and local climate fluctuations (Fleury et al. 2016). Finally, other catastrophic events recognized in the archaeological record could be involved. A tsunami affected several coastal sites in the north coast around 800 BC (Bird 1987; Elera 1998:274), and an earthquake, dated between 550 and 500 BC, possibly precipitated the fall of Chavin de Huantar (Kembel and Hass 2015:406, 421).

Yet, although the potential impact of high-magnitude ENSO phenomena and tectonic instability in the daily life and history of the Central Andes is undeniable, the intensity and recurrence of these events were variable over time and did not prevent successful adaptation (Contreras 2010). Paleodemographic data of the Andean region suggest a period of continuous exponential population growth from 5000 to 4000 years BP related to the expansion of farming systems and a noticeable increase in settlements density and habitation areas, especially between 4000 and 2000 years BP (Goldberg et al. 2016:Figures 2–4).

The extent of violence observed in QCC is consistent with the hypothesized scenario of population pressure and sociopolitical reorganization postulated for the Middle to Late Formative transition. The prevalence of nonspecific physiological stress markers in the QCC individuals strongly suggests population pressure and poor living conditions (Pezo-Lanfranco et al. 2021).

Our radiocarbon dates indicate that intercommunity violence could be related, in chronological terms, to the political changes around the fall of the Chavin religious tradition that led to the subsequent tensions characterizing the region during the Late Formative (Kembel and Hass 2015:405, 406, 418). The fall of Chavin as the hegemonic religious tradition may have been associated with an economic crisis linked to the disarticulation of supralocal trade networks and the rise of new local polities/factions more dependent on local production (Burger 2014; Ikehara 2021).

This clear trend of political fragmentation and intergroup conflict has been also observed in several valleys of the region (Ikehara and Chicoine 2011). In Supe Valley, the Chimú Capac fortress located on a hilltop of the lower valley shows a system of concentric walls dated to the Middle Formative period (Valkenier 1995). In the Fortaleza valley to the north, 39 fortified sites dating between 900 and 200 BC were recorded (Brown Vega et al. 2011; Perales Munguia 2006). Data on fortresses or defensive buildings from Pativilca for the Middle and Late Formative remain unpublished but suggest a similar pattern (Perales Munguia 2007). In the Huaura Valley, in the south, a system of 34 fortresses, including the Acaray fortress, operated between 900 and 200 cal BC (2σ), possibly to protect the valley from threats arriving from the highlands (Brown Vega 2009; Brown Vega et al. 2011).

In the northern valleys of Huarney and Culebras, fortresses located at strategic locations and evidence of population growth, political fragmentation, and a “permanent state of war” among local communities are noticeable from 350 BC to AD 100 (Giersz and Prządka 2009; Giersz et al. 2015). In Casma, there was an increase in the number of occupations from 45 during the Pallka phase (1000–350 BC) to 196 during the Patazca phase (350–1 BC; Pozorski and Pozorski 1987; Wells and Noller 1999), including the fortress of Chankillo and about 30 minor fortresses (Chamussy and Goepfert 2019:20; Ghezzi 2006).

In the low valley of Nepeña, possibly the best-documented example of this transition, the abandonment of recently built ceremonial centers was dated around 450 cal BC and was attributed to drastic changes in intra- and intercommunity interactions (Ikehara 2021). In the middle valley of Nepeña, during the Samanco phase (450–150 BC), Ikehara (2016) reports expressive demographic growth and 37 fortresses related to the eruption of the White-on-Red material as evidence of intra-valley conflict around or after the Chavin fall.

In the Santa Valley, Wilson (1987, 1988) also verified changes in settlement patterns and 40 fortresses strategically emplaced during the Middle–Late Formative transition between its Cayhuamaca (1000–350 BC) and Vinzos (350–1 BC) phases. Whereas Wilson hypothesizes external conflict (warfare), possibly against the Casma/Sechin polity, Chamussy and Goepfert (2019) suggest that these fortresses were built to protect against highlands groups like the Huaras from Callejon de Huaylas and Callejon de Conchucos.

Several authors interpret the presence of fortifications around the time of the Middle to Late Formative transition and later as a result of internal conflict between local factions from the same valley (Ghezzi 2006; Ikehara 2021; Ikehara and Chicoine 2011; Wilson 1988, 1995). However, others argue that the spread of “institutionalized war” on the north and north-central coast of Peru is linked to the intrusion or demic expansion from the north or the highlands (Chamussy and Goepfert 2019:9–10; Pozorski and Pozorski 2018). It remains unresolved whether this conflict was a “total war,” a “ritualized war” (Makowski 2010; Topic and Topic 1997), or indeed a war at all.

Although caution is necessary to make interregional comparisons and to extrapolate findings of specific sites to the entire region, the recurrence of deviant contexts of violence like that studied here leads to consideration of the possibility of large-scale conflict after the fall of the Chavin establishment, in a context of social crisis, population pressure, and competition for resources. The trauma patterns of QCC align with the conclusions of other researchers who characterize the Middle to Late Formative transition and the Late Formative as violent times (Billman 1996; Ikehara 2021; Ikehara and Chicoine 2011; Pozorski and Pozorski 2018; Willey 1953).

## Conclusion

The bioarchaeological markers of violence recorded in Quebrada Chupacigarro individuals suggest that living conditions in the middle Supe Valley during the Middle to Late Formative transition were relatively violent, possibly related to environmental constraints or newer demographic conditions in a context of regional sociopolitical restructuring. Although we cannot precisely define the nature of the violence suffered by QCC individuals, a high prevalence of trauma linked to interpersonal violence in adults and subadults, both males and females, suggests a generalized exposure to repetitive and lethal violence. Thus, the Supe Valley was part of this regional picture of rising population pressure and possible competition around scant resources. These results are widely consistent with



hypothesized scenarios of internal (between local peer communities) and external conflict of a larger scale (warfare?) on the coast of the Central Andes around 500–400 BC.

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Supplemental Table 1.  $^{14}\text{C}$  AMS Dates from Quebrada Chupacigarro Contexts.

Supplemental Table 2.  $^{14}\text{C}$  Date Combination of Quebrada Chupacigarro Dates.

Supplemental Table 3. Age-at-Death and Sex Classification of Individuals Recovered at Quebrada Chupacigarro Cemetery.

Supplemental Table 4. Prevalence of Trauma in Quebrada Chupacigarro Cemetery: Differences between Groups.

Supplemental Table 5. Description of Trauma in Quebrada Chupacigarro Individuals.

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