Introduction

The Formative Period (3000–50 BC) is a segment of Peru’s prehistory that is characterized by the rise and development of the Andean civilization. The first public architecture was constructed c. 3000 BC, which some archaeologists define as the beginning of the Formative Period (Seki, 2014). The construction and renovation of public architecture preceded the manufacture of pottery and was the basis of the development of the Andean civilization (Onuki, 1998). These activities required laborers and food supplies, which led to population growth, socioeconomic development, and a reliance on agriculture and animal domestication in the Andes (Onuki, 1998). The Pacopampa site is one of the largest Formative Period sites in Peru’s northern highlands. The site is composed of three large platforms and covers a total area of about 4 hectares. Three low platforms surrounding a sunken plaza were constructed and renovated in the Middle Formative Period (Pacopampa I phase; 1200–700 BC) and the earlier half of the Late Formative Period (Pacopampa II phase; 700–400 BC) (Figure 1b). The excavation of the uppermost platform—where the core ritual architecture was concentrated—revealed that three low platforms associated with small rooms surrounded a sunken square court belonging to the Pacopampa I and II phases (Figure 1b). The presence of large-scale public architecture and plaza, decorated stone sculptures, and archaeological remains related to rituals, support the idea that the Pacopampa site functioned as a ceremonial center (Seki et al., 2010). Excavation during the 2015 field season identified an elite tomb called the ‘Serpent-Jaguar Priests’ tomb (Figure 1c). This tomb was located just off the eastern side of a sunken square patio on the low northern platform of the Pacopampa II phase (Figure 1b). The tomb had a boot-shaped structure with a broad bottom in cross-section (Figure 1c). This tomb was located just off the eastern side of a sunken square patio on the low northern platform of the Pacopampa II phase (Figure 1b). The tomb had a boot-shaped structure with a broad bottom in cross-section (Figure 1c). At the bottom of the tomb, a middle-aged female was laid over the remains of a young male. The central position of the tomb and the rich repertoire of grave goods suggest that these individuals had symbolic importance and belonged to an elite social group. The possible presence of artificial cranial deformation in the female suggests that the buried individuals were socially different from the other burial individuals of this site. There is no dental caries in these two individuals. The comparison of caries frequencies between these two individuals and non-elites showed lower caries frequencies in the former than in the latter. Taking into consideration existing isotopic data of Formative Period sites, the social differences in the caries frequencies can be attributed to the elites’ dietary patterns—which contained fewer cariogenic foods. Thus, this study revealed the emergence of social stratification in Peru’s northern highlands and its possible pathological impacts.

Bioarchaeology of human skeletons from an elite tomb at Pacopampa in Peru’s northern highlands

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Abstract The Pacopampa site is one of the largest Formative Period sites in Peru’s northern highlands. This study describes newly excavated human remains from the site, compares them with previous findings, and provides bioarchaeological approaches to assess social stratification in Formative Period Andes, leading to an understanding of how social stratification emerged in the Andean civilization. The human remains studied were two individuals from an elite tomb (the ‘Serpent-Jaguar Priests’ tomb) at the ceremonial center of the site. At the bottom of the tomb, a middle-aged female was laid over the remains of a young male. The central position of the tomb and the rich repertoire of grave goods suggest that these individuals had symbolic importance and belonged to an elite social group. The possible presence of artificial cranial deformation in the female suggests that the buried individuals were socially different from the other burial individuals of this site. There is no dental caries in these two individuals. The comparison of caries frequencies between these two individuals and non-elites showed lower caries frequencies in the former than in the latter. Taking into consideration existing isotopic data of Formative Period sites, the social differences in the caries frequencies can be attributed to the elites’ dietary patterns—which contained fewer cariogenic foods. Thus, this study revealed the emergence of social stratification in Peru’s northern highlands and its possible pathological impacts.

Key words: artificial cranial deformation, bioarchaeology, dental caries, social stratification, stature

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Materials and Methods

The human remains targeted in this study were those from the Serpent-Jaguar Priests tomb. The materials used in this study were curated by the Pacopampa Archaeological Project and temporarily housed at the Center for Pacopampa Archaeological Project (Jr. Bolognesi, Centro Poblado de Pacopampa, Distrito de Querocoto, Provincia de Chota, Region Cajamarca, Peru) with the permission of the Peruvian Ministry of Culture.

The radiocarbon dating of two individuals was performed by Beta Analytic (Miami, FL, USA). The IntCal13 dataset was used to calibrate the radiocarbon ages (Bronk Ramsey, 2009). Sex determination was carried out through a macroscopic assessment of their pelvic (Bruzek, 2002) and cranial features (Walker, 2008). The age-at-death estimates were based on the degree of ossification and the epiphyseal union of the pelvis and long bones (Brothwell, 1981), the auricular surface of the ilium (Lovejoy et al., 1985; Buckberry and Chamberlain, 2002), the pubic symphysis (Brooks and Suchey, 1990), and dental wear (Lovejoy, 1985). Stature was estimated using the equations outlined by Genovés (1967), which utilize the maximum lengths of the femur and tibia. Comparative data for stature and dental disease were gath-
HIGH-STATUS HUMAN SKELETONS FROM PACOPAMPA

eled from the remains of Pacopampa non-elites (Supplementary Table 1) (T. Nagaoka et al., unpublished data). The lack of artificial cranial deformation, mineral pigments, gold and silver ornaments, and associated precious goods were determinant factors in the identification of the non-elite class. The statistical analyses were performed with the open-source software R 3.1.2 (R Core Team, 2014).

Results

The radiocarbon dates of H1 and H2 corresponded to the earlier half of the Late Formative Period (2360 ± 30 and 2350 ± 30 $^{14}$C yr BP, respectively).

In the Serpent-Jaguar Priests tomb, H1 was laid over H2 (Figure 2, Figure 3). The body of H1 was placed in a flexed position, lying on the left side down and faced to the east (Figure 2a, b). The right upper limbs (15–18 in Figure 2b) and the right calcaneus (19 in Figure 3b) of H1 were not located in their original position, but the remaining parts were left in the anatomical position (Figure 2a, b). The right calcaneus of H1 (19 in Figure 3b, e) was laid around the right lower limbs of H2 (7–9 in Figure 3b), which indicates that the calcaneus was intentionally displaced postmortem. A ceramic stirrup bottle (Figure 2c) was shaped to give it the head of a jaguar and the body of a serpent (Figure 2c), features that gave the tomb its name.

H1 was estimated to be a female from the broad and symmetric great sciatic notch, double composite arc, and the presence of a ventral arc (Phenice, 1969; Bruzek, 2002) and little projection in the nuchal region and mastoid processes (Walker, 2008). The individual was estimated to be middle-aged (35–54 years) from the sixth stage in Brooks-Suchey’s (1990) pubic symphysis system, the fifth stage in Lovejoy et al.’s (1985) auricular surface system, the sixth stage in Buckberry and Chamberlain’s (2002) auricular surface system, and the E–H stage in Lovejoy’s (1985) dental wear system. The posterior part of the cranium was vertically flattened, which implies that the cranium was artificially deformed (Figure 4). The upper and lower limb bones were gracile and the deltoid tuberosity of the humerus and the pilaster of the femur were weakly developed. The medial epicondyle of the humerus and the trochlear notch of the right and left ulna exhibited the proliferation of irregular bone growth. The estimated stature was 140.5 cm based on Genovés’ (1967) equations for the maximum length of the femur (right, 349 mm; left, 352 mm). The caries frequency was 0% (0/26) and the antemortem tooth loss frequency was 0% (0/27) when third molars were excluded.

H2 was detected below H1 (Figure 3a, b). Judging from the position of its vertebrae and lower limbs, the body was placed in a flexed position, facing upward. The individual was poorly preserved, but the bones were found to be articulated (Figure 3b). A gold necklace made of ovoid gold beads and an oval pendant, one of the oldest gold ornaments found...
The human remains (no. 15PC-B2-Ent 541-H2) from the tomb of the Serpent-Jaguar Priests. (a) Photograph of the human remains with a vessel: 1, mineral pigments (magnified in (c)); 2, a gold necklace (magnified in (d)); 3, commingled right calcaneus (magnified in (e)). (b) Schema of the human remains (no. 15PC-B2-Ent 541-H2): 1, cranium; 2, mandible; 3, vertebrae; 4, ribs; 5, sacrum; 6, right pubis; 7, right femur; 8, right patella; 9, right tibia and fibula; 10, right foot bones; 11, left femur; 12, left patella; 13, left tibia; 14, left fibula; 15, left foot bones; 16, right humerus; 17, right radius; 18, right ulna; 19, right calcaneus from the 15PC-B2-Ent 541-H1 individual. (c) Mineral pigments (red cinnabar, dark red hematite, blue azurite, green malachite, dark silver magnetite, and white barite) were spread near to the skull. (d) A gold necklace was worn around the mandible. (e) Right calcaneus of the 15PC-B2-Ent 541-H1 individual was placed on the 15PC-B2-Ent 541-H2 lower limb bones after death. All the foot bones of the 15PC-B2-Ent 541-H2 individual were articulated.

in South America, was worn around its mandible (Figure 3d) and mineral pigments (i.e. red cinnabar, dark red hematite, blue azurite, green malachite, dark silver magnetite, and white barite) were spread near to its skull (Figure 3c).

H2 was estimated to be a male from the absence of a ventral arc and the development of mental eminence (Phenice, 1969). The individual was estimated to be about 15 years old given the first stage in Brooks-Suchey’s (1990) pubic symphysysis system, the B stage in Lovejoy’s dental wear system, and the uncompleted epiphyseal unions of long bones (Brothwell, 1981). The caries frequency was 0% (0/24) and the antemortem tooth loss frequency was 0% (0/16) third molars were excluded.

The estimated stature of the H1 female was 140.5 cm, which is 7 cm (~2 standard deviations) shorter than the average stature of the Pacopampa non-elite females (number of individuals = 12; mean = 147.6 cm; standard deviation = 3.9 cm). The caries frequencies of H1 and H2 are significantly less than those of the non-elite females (18.0%, 51/283; P < 0.05 by Fisher’s exact test) and males (21.0%, 58/276; P < 0.01 by Fisher’s exact test) respectively (Supplementary Table 1).
Discussion

The central position of the tomb and its rich repertoire of grave goods suggest that the two individuals buried in the Serpent-Jaguar Priests tomb had symbolic importance and belonged to an elite social group. The tomb had a boot-shaped structure with a broad bottom chamber in cross-section, which is shared by some elite tombs seen at Kuntur Wasi (Seki, 2017). The association with a variety of minerals such as red cinnabar, dark red hematite, blue azurite, green malachite, dark silver magnetite, and white barite has not been detected in other Formative Period sites in Peru—the only exception being the Lady of Pacopampa tomb (radio-carbon date: $2330 \pm 30 \text{ ^14C yr BP}$), wherein red and blue pigments were spread over the cranium of the entombed remains (Nagaoka et al., 2012). A previous excavation at Pacopampa unearthed the tomb of the Lady of Pacopampa, which contained a female skeleton marked with red and blue pigments, showing fronto-occipital cranial deformation, and possessing a pair of gold earplugs, a pair of gold earrings, and shell ornaments (Nagaoka et al., 2012). The possible presence of artificial cranial deformation in the H1 female and the Lady of Pacopampa suggests that these individuals were socially different from the other burial individuals of this site. Both deformed and non-deformed individuals appeared within the Pacopampa site, and the practice of deformation there was associated with a rich repertoire of grave goods. The features of the Serpent-Jaguar Priests thus support the assumption that the emergence of social stratification in the northern highlands was dated to the earlier half of the Late Formative Period (Nagaoka et al., 2012).

It is interesting that the right calcaneus of H1 was moved postmortem around the right lower limbs of the H2, although almost all bones were articulated. The observed pattern of disarticulation of the foot bones at Pacopampa is similar to the case of Sipán elite burials. The human remains from elite tombs at Sipán (AD 50–700) exhibited a distinct funerary tradition in multiple burials, wherein the foot bones of some individuals were intentionally jumbled to be out of normal position (Verano, 1997). The jumbled foot bones, Verano (1997) suggested, were the result of an extended mortuary ritual for the individuals who accompanied the principal interment. Considering the fact that we could not identify any cut marks in the right calcaneus of H1, its separation was done after soft-tissue decomposition. However, because of the boot-shaped structure of the tomb, the lack of space to move bones within the tomb, and our stratigraphic interpretation at the tomb, an added burial was impossible—implying that the burial of H1 and H2 occurred at the same time. It is unknown whether these cases of mortuary practice at Pacopampa and Sipán were identically motivated, but in light of existing data, this practice seems likely to have been related to elite burials.

It is highly likely that social stratification could have led to an increase in the variation in pathological conditions across different social classes. We did not detect any caries and antemortem tooth loss in H1 and H2. Caries frequencies were higher in low-status individuals than in those who occupied high social positions from the Middle Sicán Period (AD 900–1100) in Peru (Klaus et al., 2010) and the Classic Period (AD 250–900) of Maya sites in Honduras (White, 1994). These results suggested that, within these societies, the elite individuals consumed less maize than the non-elites. The case of the Pacopampa site is consistent with these observations. Seki and Yoneda (2005) reconstructed Kuntur Wasi’s dietary patterns using carbon and nitrogen isotopes and demonstrated that the elites less consumed C$_4$ foods (such as maize). If the dietary patterns detected at Kuntur Wasi were true for the other Formative Period sites, the social difference in caries frequencies at Pacopampa could be attributed to the notion that elites were less exposed to cariogenic foods and that the social differences in diets played an important role in any increase in the variation in caries prevalence. It is known that the Inka elites used chicha (maize beer) in rituals as reciprocal exchanges between humans and divine entities (Hastorf and Johannessen, 1993). However, at least at Pacopampa and Kuntur Wasi, elites might not have drunk as much as their descendants did, because of the limited use of C$_4$ foods in the Formative Period compared with later years (Seki and Yoneda, 2005). This study assumes socioeconomic differences in caries frequencies between high- and low-status individuals in the Formative Period, when social stratification first appeared in ancient Peru. This study illustrates bioarchaeological approaches to social stratification in Formative Period Andes and has led to fascinating assumptions regarding the emergence of social stratification and its possible pathological impacts.

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Author contributions

T.N. designed the research, cleaned and reconstructed the human skeletons, collected and analyzed the data, and wrote the paper. Y.S. conducted the fieldwork and revised the paper. D.M.C. conducted the fieldwork and J.P.V.H. excavated the human skeletons.

Ethical standards

The materials and methods of this study did not require approval by the ethics committee of our institute. All necessary permits were obtained for the described study from the Peruvian Ministry of Culture (Permission No. 270-2015-DGPA-VMPCIC/MC).

Conflict of interest

The authors declare that they have no conflict of interest.

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| Sample                  | Social class, age at death, and sex | Dentition            | Teeth | Carious teeth | % | Fisher’s exact test | P value |
|-------------------------|-------------------------------------|----------------------|-------|---------------|---|---------------------|---------|
| **15PC-B2-Ent 541-H1**  | (Serpent-Jaguar Priests)            |                      |       |               |   |                     |         |
| Elite class             |                                     | Upper                | 6     | 0             | 0 |                     | —       |
| Middle-aged adult       |                                     | Upper                | 7     | 0             | 0 |                     | —       |
| Female                  |                                     | Upper                | 13    | 0             | 0 |                     | —       |
|                         |                                     | Lower                | 5     | 0             | 0 |                     | —       |
|                         |                                     | Lower                | 8     | 0             | 0 |                     | —       |
|                         |                                     | Lower + Upper        | 13    | 0             | 0 |                     | —       |
|                         |                                     | Upper + Lower        | 11    | 0             | 0 |                     | —       |
|                         |                                     | Upper + Lower        | 15    | 0             | 0 |                     | —       |
|                         |                                     | Upper + Lower        | 26    | 0             | 0 |                     | —       |
| Non-elite females       |                                     | Upper                | 65    | 4             | 6.2| 1.000               |         |
| Young and middle-aged adults |                               | Upper                | 74    | 19            | 25.7| 0.190              |         |
| Female                  |                                     | Upper + Lower        | 139   | 23            | 16.5| 0.219              |         |
|                         |                                     | Lower                | 66    | 5             | 7.6 | 1.000              |         |
|                         |                                     | Lower                | 78    | 23            | 29.5| 0.102              |         |
|                         |                                     | Lower + Upper        | 144   | 28            | 19.4| 0.127              |         |
|                         |                                     | Upper + Lower        | 131   | 9             | 6.9 | 1.000              |         |
|                         |                                     | Upper + Lower        | 152   | 42            | 27.6| 0.013*             |         |
|                         |                                     | Upper + Lower        | 283   | 51            | 18.0| 0.012*             |         |
| **15PC-B2-Ent 541-H2**  | (Serpent-Jaguar Priests)            |                      |       |               |   |                     |         |
| Elite class             |                                     | Upper                | 3     | 0             | 0 |                     | —       |
| Young-aged adult        |                                     | Upper                | 8     | 0             | 0 |                     | —       |
| Male                    |                                     | Upper                | 11    | 0             | 0 |                     | —       |
|                         |                                     | Lower                | 5     | 0             | 0 |                     | —       |
|                         |                                     | Lower                | 8     | 0             | 0 |                     | —       |
|                         |                                     | Lower + Upper        | 13    | 0             | 0 |                     | —       |
|                         |                                     | Upper + Lower        | 8     | 0             | 0 |                     | —       |
|                         |                                     | Upper + Lower        | 24    | 0             | 0 |                     | —       |
| Non-elite males         |                                     | Upper                | 60    | 10            | 16.7| 1.000              |         |
| Young and middle-aged adults |                               | Upper                | 63    | 13            | 20.6| 0.336              |         |
| Male                    |                                     | Upper + Lower        | 123   | 23            | 18.7| 0.210              |         |
|                         |                                     | Lower                | 70    | 11            | 15.7| 1.000              |         |
|                         |                                     | Lower + Upper        | 83    | 24            | 28.9| 0.105              |         |
|                         |                                     | Lower + Upper        | 153   | 35            | 22.9| 0.072              |         |
|                         |                                     | Upper + Lower        | 130   | 21            | 16.2| 0.607              |         |
|                         |                                     | Upper + Lower        | 146   | 37            | 25.3| 0.024*             |         |
|                         |                                     | Upper + Lower        | 241   | 38            | 15.8| 0.006**            |         |

*P < 0.05, **P < 0.01.