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Social Change and Health Status in Prehispanic Northwest Argentina (Quebrada de Humahuaca, Jujuy) ca. 500-1550 AD

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Abstract

The effects of social, political and economic changes on the health and lifestyle of past populations from Quebrada de Humahuaca (Jujuy, Argentina) ca. 500- 1550 AD are approached through the study of bioarchaeological indicators of nutritional and functional stress, trauma, infections and dental pathologies in a sample of human bone remains (N=134). Although crude frequencies of pathologies varied, only changes in functional stress markers proved to be statistically significant, indicating that populations engaged in heavier labor force over time. This result can be related to the trend toward labor intensification seen in the archaeological record. Metabolic stress indicators increased between the Early Regional Development Period (ca. 900-1250 AD) and Late Regional Development Period (ca. 1250- 1430 AD), possibly related to the concentration of population in dense nucleated settlements. No change in oral pathologies related to diet were seen, suggesting that diet change little over time. Variations in trauma frequencies were not significant either, contrary to the idea of an escalation of conflict during the Late Regional Development Period as indicated from other archaeological indicators. Our results serve both to confront models developed from the archaeological record and to complement them with biological data indicating that further analysis is required, especially in finer temporal units.

Keywords: large scale changes- bioarchaeology- stress indicators- Quebrada de Humahuaca- Northwest Argentina

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1. Introduction

The study of health and adaptation of human past populations in response to large scale changes has long been a topic of research for bioarchaeology (Armelagos, 2003; Goodman et al. 1992; Agarwal & Glencross 2011). Shifts in subsistence (Cohen & Armelagos 1984, Cohen et al. 1984), variations in power centralization or economical change (Goodman et al. 1992, Powell 1991; Nelson et al. 1994; Van Gerven et al. 1981, 1995) and contact periods (Larsen & Milner 1993, Larsen & Harn 1994) have been assessed from a biocultural approach. In this regard, the aim of this paper is to evaluate how the proposed social, economical and political changes posited for Northwest Argentina ca. 500 b.C.- 1550 A.D. impacted on health and lifestyle of people that inhabited it. To this end we consider a variety of bioarchaeological indicators of nutritional and functional stress, trauma, infections and dental pathologies, capable of accounting for the lifestyle of the people and their health from archaeological sites from Quebrada de Humahuca (Jujuy, Argentina).

Northwest Argentina (NWA) is a geographical region defined by the presence of the Andean mountain range, running in a NS direction, and several intermountain valleys, *quebradas*, and a high altitude area (more than 3,500masl) called *puna* that sustained the development of societies along its temporal occupation. The most important valleys and *quebradas* from North to South are Quebrada de Humahuaca, Quebrada del Toro, Calchaquí Valley, Santa María or Yokavil Valley, Cajón Valley, and Hualfín Valley. The human occupation in the *puna* areas was concentrated in certain oasis such as Antofagasta de la Sierra in Catamarca Province, Huachichocana, Inca Cueva, Rinconada in Jujuy Province, and Pastos Grandes in Salta Province (Figure 1).

1.1. The Quebrada de Humahuaca: Occupation and Social History

Located in the central sector of the province of Jujuy, the Quebrada de Humahuaca is a narrow arid valley crossed by the Rio Grande with a N - S direction and a longitude of nearly 100 km. Bounded on the east by the mountain ranges of Zenta - Aparzo - Hornocal - Tilcara and on the west by Aguilar - Mal Paso - Chañi, it receives water from several side streams causing the geographical distribution of rains to be markedly irregular (Albeck 1992; Cabrera 1976).

According to the productive capacity, the Quebrada de Humahuaca can be divided in three different areas: [3]

1- Below 3,100 masl: formed by the valley bottoms, including the Rio Grande and the tributaries, suitable for cultivation area of cool season grasses such as maize (Zea mays), beans (Phaseolus vulgaris), pepper (Capsicum anuum) and pumpkin (Cucurbita pepo).
2- Between 3,100 and 3,500 masl: suitable for the production of microtherm products like potato (Solanum tuberosum), oca (Oxalis tuberosa), quinoa (Chenopodium quinoa) and amaranth (Amaranthus caudatus).
3- Near the slopes of the mountains where resources suitable for grazing and hunting abound (Nielsen 2001 and 2003).

Previous archaeological research for the time period comprised in this study points that communities from ca. 500-900 AD where small with no indication of centralized political controls or structural inequalities. In this period, appropriation of resources was regulated by reciprocal relationships arising from kinship (Nielsen 2001).

The settlements were located according to the possibilities of exploiting the resources of their immediate environment in low and accessible land in direct association with permanent watercourses and favorable areas for agriculture and livestock, especially located in the ravines transverse to the main valley (Olivera and Palma 1986; Nielsen 2001, 2003). Residential sites were spatially integrated with farming activities and given the low density of occupation of the landscape; intra-group tensions could be resolved by fission (Nielsen 2001).

The economic basis of these societies was agriculture and pastoralism, complemented with hunting activities (Palma & Olivera 1992-1993, Mercolli 2005). Moreover, recent research suggests that strategies related to herd management were oriented to the use of young animals that supply meat and were less specialized for transport (Mercolli 2004 and 2005).

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[3] All sites considered in this presentation are located in the first area of the valley bottoms and are located in the middle sector of the Quebrada de Humahuaca, which runs from the modern localities of Volcán to Uquía.

These societies also obtained foreign subsistence resources (timber, salt, lithic raw materials) through "non-exclusive" mechanisms such as direct access or reciprocal exchanges with other communities (Nielsen 2003).

Around 900 AD not only the number of sites increased but also changed their location, as they were moved to the main Quebrada. The first signs of subsistence intensification are evident and productive activities seem to have developed in spatially separate areas, but close to domestic space; also, some sites appear to have been occupied temporarily for the development of complementary productive activities such as pastoralism (Nielsen 2001). Evidence for interregional exchange are important as ceramic from Humahuaca (Isla pottery style) was find in areas as far as San Pedro de Atacama in Northern Chile (Tarrago 1997). Bioarchaeological record from this time period records the first cases of trophy heads, for example in Keta-Kara (Pelissero 1995) and Puerta de Juella (Nielsen 2001).

Previous research posits that by 1250 AD the Quebrada de Humahuaca experienced the emergence of political formations of an unprecedented scale for the area, able to mobilize and coordinate a large amount of labor. There are marked differences in the size of the sites; also some public spaces were identified, which led to propose the existence of settlement hierarchies (Nielsen 1996, 2001).

The high and middle portions of the tributary ravines were abandoned as areas of permanent residence and the population concentrated on the main ravine, forming clusters usually located in places of great visibility and difficult access, which would provide them with defensive properties (Nielsen 2001, 2003).

Agricultural production, the core of the economy of this era, was located in areas away from the sites of permanent residence, with development of a major water infrastructure. It is in this period that specialized places in agricultural production are activated as the Alfarcito, Cosmate and Coctaca (Nielsen 1995 and 2003).

In turn, an intensification of herd exploitation is evidenced by the seasonal movement of herds of *llamas* (lama glama) towards ecological zones with better pastures, and an increase in the extraction of secondary products (fiber and transportation) while it a decline in hunting activities was recorded (Mercolli 2004 and 2005; Nielsen 2003).

There are evidences of increased interregional traffic; the arrival of both luxury and subsistence foreign resources could have circulated by the action of *puneños* caravan groups, although it is possible they were also obtained through the "organization of logistic parties" from Humahuaca (Nielsen 2003).

It has been traditionally proposed that this period was characterized by the presence of conflict between regions (Nielsen 2003), which would have led to situations of social violence. Nielsen (2004) has proposed that societies from Quebrada de Humahuaca would have a strong corporate orientation, where mechanisms regulated the exercise of political power and restricted economic accumulation by individuals or particular lineages. The corporate nature of the power forced the individuals who exercised political functions to constantly negotiate their position with the other members of the group. Beyond these mechanisms limiting the accumulation of power within lineages, there were others which balanced relations between the chiefs and the community at large, subordinating the legitimacy of political power to the fulfillment of certain obligations (Nielsen 2004).

While political hierarchies were possibly translated into economic advantages, as they served to justify forms of appropriation of resources forbidden to other lineages or community members, economic accumulation was limited by redistributive and generosity responsibilities associated to their positions of authority and the decentralized nature of the productive structure. The main forms of accumulation were based on social and symbolic capital; in that sense, the true wealth of the *curaca* did not reside in the property he owned but in the magnitude of redistributive network he articulated (Nielsen 2004).

For the Inca moment in the Quebrada de Humahuaca, the exploitation of mineral and agricultural resources and craft production to sustain hospitality are among the main objectives sought by the Empire. One of the imperatives of imperial control was to reinforce the border of the territory, especially with communities located in the eastern jungles, so that for this period the first forts were set towards the north of the Quebrada de Humahuaca, as Juire, Pukará Morado, El Durazno, Puerta de Zenta or to the south as the small fort Cucho de Ocloyas (Garay de Fumagalli 2003; Oliveto & Ventura 2009).

Inca intervention brought about a series of political changes as moving the regional centres of power, economic changes as the relocation of populations or the creation of new economic centers and ritual changes as the introduction of new practices or stylistic change (Nielsen & Walker 1999; Nielsen 2003).

As this revision shows, social, economic and political changes occurred along the historical trajectory of societies from the Quebrada de Humahuaca, involving labor intensification, nucleation in dense permanent settlements away from productive areas and variations in power centralization (from the presence of egalitarian to corporate societies and the annexation to the Inca empire). The question is if the bioarchaeological record can help us to understand how these changes acted upon the people's lifestyle. We present in the following section the materials analyzed and methodology applied to approach this goal.

2. Materials

Human osseous remains come from several sites encompassing the time period from 500-1550 AD. The composition of the entire sample and discrimination per sub-sample are presented in Table 1.

Two samples are from the Late Formative Period (500-900 AD), in both cases, human remains were recovered from salvage excavations. At Til 20, individuals were buried in single, double and multiple burials; some directly on earth and others in burial chambers while children were buried in urns (Table 1) (Bordach et al 1999, Mendonça et al. 1991 and 2002). Material recovered allows assigning chronologically the site to the Late Formative Period (500-900 AD.) and additionally, there are radiocarbon datings for the nearby Til 22 site that given its proximity and cultural similarity could be related to Til 20 (Rivolta 1996; Tarragó y Albeck 1997). [4]

[4] Radiocarbon datings for Til 22 are the following: (LP–336) 940 ± 60 BP (cal 1 sig. 1022–1177, 2 sigmas 995–1230); (LP–349) 1025 ± 140 BP (cal 1 sig. 886–1169, 2 sigmas 688–1283) and (LP–346) 1190 ± 90 BP (cal 1 sig. 718–973, 2 sigmas 661–1020) .

The second context is Flores 1 where an urn containing the skeletal remains from two subadults was recovered and other human skeletal remains were recovered in at least three different layers: in the upper layer a skeleton in regular condition was found, in the middle strata there were two skeletons with accompanying goods and, finally, in the bottom layer the skeletal remains of one individual were recovered in bad condition (Zaburlin et al. 2004, Seldes 2007) (Table 1). The burial of adult individuals was conducted directly and in genuflex position being the only preparation the presence of a flat rock which supported the individual's 2 back and a stone slab covering the bodies of individuals 1 and 2. According to the excavated surface is not possible to determine whether this is a housing area such as Til 22 (Rivolta 1996; Rivolta & Albeck 1992) or a funerary context as it seems Til 20 (Bordach et al 1999; Mendonça et al 1991 and 2002); however, the presence of two large pots of storage could be referring to burial in a domestic environment (Zaburlin et al. 2004).

For the following time period (Early Regional Development Period or RDP I) (900-1250 AD), remains are from a residential settlement called Muyuna, located on a high river terrace on the left bank of the Rio Grande (approximately 400 m from the current course of the river and a level of 2.850 m). At the foot of the terrace where the site is located, the floodplain of the river is quite spacious and offers good possibilities for crop irrigation. Ceramic material recovered during the excavations correspond to Alfarcito Polychrome and Island Polychrome styles, placing the site in the Early Regional Development Period (900 - 1250 AD.). Radiocarbon dates obtained so far on site support this chronological assignment (Nielsen 1997). [5] Human skeletal remains were found in various features of enclosure 3 which is a structure located to the east of the site. All burials were filled with clean sand probably brought from the river as part of the funerary treatment (Seldes 2007).

The following time period is the Late Period of Regional Development (PRD II, ca. 1250- 1430 AD) and human remains come from two sites. Hornillos is located in the middle sector of the Quebrada de Humahuaca in Tilcara department. This is a pre-Hispanic settlement of permanent residence of 5.6 ha in size. Two areas with human remains were excavated. The first consisted of a multiple burial with at least four individuals associated with ceramic remains. Along with this burial, an urn that contained the remains of two subadult individuals was found (Mamani 2001).

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[5] Radiocarbon dating: (AA-13668) 1022 ± 50 BP, 983-1028 AD cal 1 sigma, 898-1157 AD cal 2 sigmas (Nielsen 1997b).

The second area corresponds to a direct burial of one individual and the interment in an urn of a subadult individual. In the same area and along a stone wall human bones corresponding to a subadult were also found (Mamani 2001).

Los Amarillos is located on a high plateau on the left bank of the River Yakoraite, tributary to the Río Grande, covering an area of approximately 10 has., this complex settlements has separate public and residential areas, internal circulation networks, supply and disposal spaces (Berardi 2004; Nielsen 1995). It is possible to infer that the site had an initial occupation in the Early Period of Regional Development and continued to grow, mainly during the Late Period of Regional Development. Successive excavations at the site have recovered human remains from different contexts (Seldes 2007): skeletal remains from six subadults, two adults and two adult individuals without their skulls were found in Complex A; twenty individuals were recovered from two multiple secondary burials and a direct burial in Complex E (Avalos 2002), human remains of at least sixteen individuals with no anatomical connection were found at enclosure 320, and in Unit 400 two occupational events were identified, during the first the unit was used as a residence and burial place and during the second event a burial, containing at least twenty-four individuals (Angiorama 2003).

Human remains dating to the Inca period (ca. 1430-1550) were found in Esquina de Huajra, a settlement located 45 km from the modern city of San Salvador de Jujuy in Tumbaya Department (Figure 1). The site was built on the slopes of a landform elevated 90m above the valley level. In 2001, a salvage project was conducted at the site and six tombs were found, along with other archaeological materials. The tombs were located in what was called Terrace III, and five of them were excavated (tombs 1, 2, 3, 4, and 6). The minimal number of individuals recorded is eighteen, comprising adults of both sexes and unsexed subadults of different ages at death (Gheggi 2005-2006) (Table 1). Radiocarbon analyses postulate an occupation span ranging from 1400A.D. onwards. This would imply that the site was occupied (also possibly built) in a late stage of the Inca Period, continuing this occupation in the initial stage of the Early Colonial Period (Cremonte and Gheggi 2012).

Figure 1: Map Showing Archaeological Sites Mentioned in the text

3. Methodology

Adult age and sex estimation were based upon standard osteological protocols (Buikstra & Ubelaker, 1994). Both authors conducted detailed osteological and dental inventories, in addition to identifying pathological conditions. Sex was scored as female, male or indeterminate in the case of adults, and age was grouped into general gross cathegories: perinate (0-3 months), child (4- 10 years), juvenile (11-17 years), middle adult (18-30 years), older adult (+30 years).

The skeletal and dental tissues of 134 individuals were examined for evidence of pathological conditions associated with metabolic stress (i.e. porotic hyperostosis and cribra orbitalia), general physiological stress (i.e. dental enamel hylopasia and periosteal reaccions), trauma (i.e. fractures), functional stress (i.e. degenerative joint disease and muscle skeletal markers) and diet (i.e. dental wear and dental infections including caries, abscesses and antemortem tooth loss). Comparisons were made between time periods using descriptive statistics (Fisher's exact test).

Cribra orbitalia (CO) and porotic hyperostosis (PH) were described and scored according to standard protocols which include state of healing, location and severity (Buikstra & Ubelaker, 1994) but for the purpose of this study, only presence/absence will be consider. Although both conditions were traditionally associated with anemia, several other diseases can produce lesions which macrocospically appear very similar to porotic hyperostosis and cribra orbitalia (Ortner, 2003; Walker et al., 2009). So, both conditions were taken as reflecting metabolic disease and not exclusively evidence for anemia.

Enamel hypoplasias can be defined as a defect in enamel occurred during the first phase of its deposition, resulting from an important metabolic stress so as to interrupt ameloblastic activity. The study of these lesions provides information about nutritional status, infectious disease or cultural activities. While it is not a marker of specific disease, it is useful in estimating the overall health of past populations (Langsjoen 1998: 405). Presence or absence of enamel defects were recorded for adults and subadults.

Periosteal reactions are expected when the inner layer of the periostium is affected. Primary periosteal reactions are mainly produced by two pathological conditions, trauma and infectious diseases, and secondary to any specific disease (Ortner & Putschar 1981: 132). In most cases, this condition cannot be assigned to any specific disease (unless the distribution of the lesion/s indicates so) and thus provides a general indicator of health status of a population (Larsen & Harn 1994: 227), especially if the stress was so severe or prolonged as to have exhausted the potential response of an organism's other systems (Huss-Ashmore et al. 1982: 399).

Bone trauma was assessed by the presence of fractures. Fractures are breaks in skeletal tissue product of the action of an external force applied directly or indirectly to the bone (Aufderheide & Rodriguez Martin 1998).

Macroscopic observations were conducted in each bone of the series and fractures classified according to whether were consolidated or active at the time of death; and the body part it affected which allows inferring patterns of behavior as well as probable accidental or conflict situations.

Degenerative joint disease (DJD) is a non-inflammatory chronic progressive pathological condition, characterized by loss of articular cartilage. This loss causes injuries that result from direct contact between bones in areas of joints. While several joints may be involved in the DJD, those affected most early are those weight bearing, especially those of the lower extremities (Aufderheide & Rodriguez-Martin 1998: 93). Other pathological changes associated with manifestations of bone degenerative arthritis are Schmorl's nodes. These are developed on the surfaces of the vertebral bodies following intervertebral disc degeneration, herniation and subsequent erosion of the vertebral surface (Ortner & Putschar 1981: 430). When pathological modifications were observed, the presence and extension of the following traits were recorded for each bone element: lipping, porosity and eburnation (Buikstra & Ubelaker 1994).

Additionally, in order to assess daily activities of the individuals considered for this study, musculoskeletal stress markers (MSM) were recorded. Daily activities throughout the life of an individual, involves different degrees of physical exertion; if this is minimal, will not leave marks on the bones; however, if the activity requires great efforts, the body is strengthened to develop greater muscle attachments (Larsen 1997: 188). In order to analyze this indicator muscle attachments of each postcranial bone were recorded determining whether they were strongly marked.

Dental wear is considered a natural enamel erosion process (Molnar 1971), as a result of the masticatory process. During chewing, abrasion, attrition and erosion are confused by acting simultaneously making them difficult to distinguish; therefore all three components are encompassed as "wear" of dental enamel (Larsen 1997). The degree and type of wear is strongly correlated with a number of factors such as the type and texture of foods that make up the diet, methods of preparation and the use of teeth as tools (Larsen 1997; Molnar 1971).

That is, wear depends on various circumstances that can accelerate the process and remove the areas to make them prone to caries activity (Hillson 1996; Larsen 1987 and 1997; Molnar 1971; Powell 1985).

In the case of hunter - gatherers it is expected that the degree of wear of tooth enamel to be high given the type of nutrition based on plants and fibrous roots. In agropastoral societies a decrease in tooth wear would be expected because the diet consists of softer foods; however, consumption of abrasive materials may cause more wear in this societies as a result of grinding activity (Larsen 1987). Presence and degree of tooth wear were quantified following Smith (1984) for the incisors, premolars and canines, resulting in values for each piece ranging from 1 to 8. In order to facilitate comparison and discussion, ranges of involvement of this condition were established: 1-3 (mild); 4-5 (moderate); 6-8 (severe). For molars the method proposed by Scott (1979) was used, where a value is given to each molar quadrant and then added, resulting in a number of 4 to 40 for each dental piece. In this case, the obtained values were divided into the following cathegories: 4-16 (mild); 17-28 (moderate); 29-40 (severe).

Dental infections included caries, abscesses and antemortem tooth loss. Caries are multifactorial and multibacterial infections affecting calcified tissues of the teeth through the demineralization of the inorganic portion and destruction of the organic component. Ii is a progressive type of disease, since if the environmental conditions of formation injury continue; it will progress to complete destruction (Langsjoen 1998: 402). For the recognition of caries, we recorded the number and location (occlusal, interproximal, neck or root caries). Abscesses in turn are the result of a localized infection; produced by exposure, bacterial contamination of the endodontic cavity and death of the pulp tissue and are strongly associated with the presence of caries (Hillson 1996). Presence and location of the canal was recorded when a dental abscess was identified.

Antemortem tooth loss results from the process of tooth loss and generates the progressive reabsorption of alveolar bone. It is closely related to cariogenic activity and that is why it is considered as an indicator of diet.

It has been suggested that injuries and antemortem tooth loss positively covariate with a diet rich in carbohydrates and negatively with a high degree of wear of tooth enamel since wear tends remove potential sources of caries (Hillson 1996; Powell 1985) and to increase the antemortem tooth loss (Hillson 1996). The premortem loss of teeth was recorded for each mandible or maxilar present.

4. Results

Demographic composition of the sample is presented in Table 1 and Table 2 shows the results of crude prevalence for each condition in each time period. Further statistical comparisons were made between periods for each condition. [6]

		Late Formative Period	Early Regional Developments Period	Late Regional Developments Period	Inca	Total
AGE	SEX	N	N	N	N	N
PERINATO	INDET.	1	6	14	3	24
CHILD	INDET.	4	2	25	5	37
JUVENILE	FEM.			1	1	2
	MALE.	1		0		1
	INDET.	1		2		3
MIDDLE ADULT	FEM.	6	5	7	4	22
	MALE	5	1	14	4	24
	INDET.	4	3	10		17
OLDER ADULT	FEM.			2	1	3
	MALE			0		0
	INDET.			2		2
TOTAL		22	17	77	18	**134**

Table 1: Age and Sex Composition of the Sample

[6] Fisher Exact test was performed when comparing frequencies in 2x2 contingency tables. As this test requires that no row or column where all values are 0, several comparisons were not computable.

		LATE FORMATIVE (500-900 AD)		EARLY REGIONAL DEVELOPMENTS PERIOD (900-1250 AD)		LATE REGIONAL DEVELOPMENTS PERIOD (900-1250 AD)	INCA		
		N	%	N	%	N	%	N	%
METABOLIC STRESS	PH and CO	3/12	25	0/8	0	29/69	42.02	1/5	20
DIET	Dental infections	8/16	50	4/7	57.1	51/84	60.71	6/10	60
	Dental wear	15/16	93.8	6/7	85.7	59/62	85.5	8/10	80
FUNCTIONAL STRESS	DJD	1/13	7.69	6/9	66.7	42/63	66.66	9/10	90
	MSM	3/5	60	2/9	22.2	5/34	14,7	8/10	80
TRAUMA	Accidental	2/5	40	0/9	0	11/68	16.17	0/18	0
	Violent	1/5	20	0/9	0	0/68	0	0/18	0
GENERAL STRESS	Enamel hypoplasia	0/13	0	0/5	0	21/70	30	3/10	30
	Periosteal reactions	1/14	7.14	0/11	0	29/73	39.72	1/18	5.5

Table 2: Prevalence of Pathological Conditions per Time Period

While we can observe changes in the frequencies of diseases over time, the statistical test applied do not allow positing health trends along the sequence for most indicators.

For metabolic disorders, comparison of frequencies between the PRD I and PRD II were the only one that proved to be statistically significant (P= 0.021, Fisher Exact Test) indicating that the increase in PH and CO frequencies during the PRD II was not random.

For those tests that were computable, no statistically significant results were met for comparisons of dental infections and dental wear along time periods. This may imply that no important differences in the resources consumed existed through the sequence.

Degenerative joint disease showed statistically significant results when comparing samples from the Late Formative period against all other temporal periods (i.e. PRD I, P=0.006; PRD II, P=0.0001; Inca, P= 0.0001, Fisher Exact Test) indicating a clear trend toward the increasing of this condition over time.

For MSM, statistically significant results were met between the frequencies of samples of the Late Formative period and PRD II (P=0,049, Fisher Exact Test), PRD I and Inca (P= 0,023, Fisher Exact Test) and PRD II and Inca (P= 0.0002, Fisher Exact Test). Interestingly, there is not significant result between Late Formative period and PDR I, where most important changes regarding agricultural intensification and labor took place. Apart from that, the other results fit well with those met for DJD, as both conditions are related to work load during daily activities.

Regarding trauma, frequency of accidental trauma was higher when comparing the Late Formative Period with the Inca Period (P=0.039, Fisher Exact Test) but not for all other time periods. Violent trauma showed no statistically significant results for those test that could be computed (i.e. Late Formative with all other time periods).

General indicators of stress showed statistically significant results when comparing frequencies from Late Formative Period with PRD II for enamel hypoplasias (P= 0.032, Fisher Exact Test) and periosteal reactions (P= 0.028, Fisher Exact Test).

5. Discussion and Conclusions

These results raise a number of questions regarding the articulation between the bioarchaeological and the archaeological record, or rather, between the analysis of human skeletal remains and models postulated by archaeologists to explain the processes of evolution and social change in prehispanic societies. The results presented here partly accommodates with what would be expected from those models but also raise new questions.

For example, and assuming that diet did not change much along the sequence, as dental infections and wear seem to show in this study, the increase in metabolic stress experienced during the PRD II in contrast to the PRD I could be related to the concentration of population in dense settlements, one of the main changes of this period as archaeological evidence signals (Nielsen et al. 1997; Nielsen 1996, 2001). Population aggregation in settlements with poor sanitation could lead to the spread of pathogens (Cohen 1989; Larsen 1997; Mensforth et al 1978; Reinhhard 1992; Steckel et al 2002; Ubelaker 1992). As we have already mention, numerous other diseases can produce lesions similar to porotic hyperostosis and cribra orbitalia, including scurvy, rickets, hemangiomas, hematomas, localized infections and trauma (Ortner, 2003; Walker et al., 2009). Recent research has posited that hemolytic anemia could cause the lesions seen in the cranial vault. Interestingly hemolytic anemias can be caused by poor nutrition (such as lack of vitamin B12 and folic acid) (Antony, 1995; Martini & Ober. 2001: 633; Walker et al 2009), chronic diarrhea due to bacterial infections that lead to inadequate absorption of nutrients in the intestine (Walker 1986) and by infestation with the fish parasite *Diphyllobothrium* (Bathurst 2005). Thus, Walker and colleagues (2009) have argued that porotic hyperostosis and many of the orbital injuries are a result of megaloblastic anemia acquired by infants who are breastfed by mothers with scarce reserves of vitamin B12 and children being weaned who live in unsanitary conditions leading to further loss of nutrients through numerous episodes of diarrhea or consuming contaminated food under poor hygienic conditions.

Moreover, gross comparisons of dental pathologies proved not to be statistically significant, reflecting, as we already mention, that the same set of resources may have composed the basic diet along the temporal sequence. This raises two questions, the first regarding power centralization and food consumption and the other in reference to the changes seen in the archaeological record towards agricultural intensification.

On the one hand, if former independent populations were aggregated into larger political units, traditionally recognized as "chiefdoms”, it could have implied that the management of the means of production or resources were not in the hands of members of the household but in the "boss", "lord" or "chief". We may think that, given the homogeneity in diet arising for results, resources may have been equally distributed in spite of existing mechanisms of social differentiation.

While numerous studies have shown a direct relationship between social status and access to better food resources (Ambrose et al. 2003; Nelson et al 1994; Welch & Scarry 1995), there are also data that indicate either the opposite or the existence of intermediate situations (Powell 1991, 1992).

On the other hand, taken into account that agricultural intensification is a tendency in the trajectory of the area it could be expected a decrease in oral pathologies, especially caries and dental wear) associated with the increasing consumption of softer foods. However, it is not the case, as no changes were recorded in frequencies for oral conditions. Instead, indicators of functional stress (degenerative joint disease in particular) point to labour intensification, perhaps, as a response to agricultural intensification. It could be possible that the produce of what was being grown was not consumed by the population but serve as surplus to exchange for other items (luxury or not).

Considering that the PRD in general has traditionally be seen as a era of social unrest, political disintegration and conflict (Tarragó 2000, Nielsen 2007) it is remarkable the absence of statistical significance for the comparisons of trauma frequencies, both accidental and violent. Nevertheless, studies conducted with additional samples from Quebrada de Humahuaca have shown the occurrence of interpersonal violence during the PDR (Gheggi & Seldes 2012; Botta 2014). It makes us think that using such ample time frames may be darkening processes occurring at shorter time scales or that some lines of evidence, as burial evidence, work out at different scales than, for example, settlement patterns or ceramic types from which the archaeological models were built. Also, it is possible to think that other set of evidence could be suitable for studying conflict in different time periods (i.e. rock art, pottery depictions, weapons).

This means recognizing that the relationship between patterns of social change and bioarcheology are not linear; for example, the relationship between social status and health status is not resolved single or directly; the individual is immersed in a series of cultural logics (attitudes, values, perceptions, projects) that prevent doing linear and universal relationships (Saitta 1998: 127). Also, sample size, especially the difference in quantity of individuals composing each subgroup should be taken into account, and in this regard we consider this study to be exploratory in nature.

However, this should not prevent us from working with osteological samples, but help us to wonder to what extent bioarchaeological record conforms to models postulated by archaeology and to what extent it can make contributions of its own to the study of social change, especially considering the relationship between change at larger scales as well as intrapopulational health differences.

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