

## Cranial Trauma in Ancient Egyptians from the Bahriyah Oasis, Greco-Roman Period

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**Abstract:** Evidence of skeletal trauma is common in the remains of past populations. The causes of trauma can have accidental or violent origins. Periods of imperialism may be associated with a climate of tension resulting in the creation of violent conflicts. The aim of this study is to determine the cranial trauma rate and pattern among ancient Egyptians from the Bahriyah Oasis during the Greco-Roman period (332 BC-AD 395). The study also aims to trace the possible evidence of violent interactions that may have happened during this period. The material consisted of 160 skulls of adult ancient Egyptians, 92 males and 68 females. They were recovered from Bahriyah Oasis. The results showed that, 31 (19.4 %) of 160 crania examined presented with cranial trauma. The rate of trauma was 18.6 % in males and 20.6 % in females. The parietal bone exhibited the highest prevalence of trauma (65.9%) followed by the frontal bone (27.3%) and the occipital bone (6.8%). Depression fractures accounted for 88.6% of the trauma events, and blade injuries made up 11.7%. The prevalence of cranial trauma observed in this population is significantly higher than what has been reported in other ancient Egyptian populations. The results suggest that interpersonal violence was the most likely cause for the high prevalence of cranial trauma among ancient Egyptians living under the Roman rule. The increase in violent behavior may be the result of the social and political disruption during this period.

**Key words:** Cranial Trauma, Ancient Egyptians, Greco-Roman Period, Interpersonal violence

### INTRODUCTION

Human remains excavated from archaeological sites offer unique information regarding the environmental, economic, and social conditions of past populations<sup>[42]</sup>. The prevalence and distribution patterns of trauma in the human skeletal remains can reflect the risks to which such societies were exposed to in their daily activities or during periods of social unrest. Certain types of trauma (e.g. rib fractures) can provide researchers with socio-cultural information on the population being assessed<sup>[8,12]</sup>. The most common cranial trauma types among ancient populations are: compressed fractures that result from blunt force blows, fractures caused by blade or edged weapons and circular injuries with radiating fractures<sup>[29,43]</sup>.

Very little is known about life in the Bahriyah Oasis before the Middle Kingdom (2133 BC). It was not until the later dynasties that the Bahriyah emerged as a major center in ancient Egypt. In the 26<sup>th</sup> Dynasty (664-525 BC), the Bahriyah Oasis developed into an important agricultural and trade center with its own governors. At the beginning of the Roman period, the Oasis witnessed a revival with new system of aqueducts and wells being implemented and it seems that the Oasis, accordingly, flourished during the rest of the

Roman period<sup>[15,23]</sup>. The Roman period was time of prosperity, as exemplified by the wealth of Ptolemaic and massive exports of grain to Rome.

In contrast, the lot of the humble and poor was not enviable anywhere in the Roman Empire and the population of Egypt appears to have been singled out for exceptionally harsh treatment<sup>[28]</sup>. Archaeological literature indicated that ancient Egyptians living in Bahriyah Oasis during the Greco-Roman period were engaged in many activities including agriculture, wine and linen textile production; which was known during the Roman times<sup>[16]</sup>. Linen was regarded as a valuable commodity and was exported throughout the Mediterranean region<sup>[33]</sup>.

Roman policy towards Egyptians conveys to us a quality of repression suggestive of vindictiveness. The Roman rule in Egypt has been described as unjust where anarchy prevailed, and religious persecutions added to the misery of the people<sup>[15]</sup>. The Roman government sought to maintain a rigidly fixed social structure, in which Roman, citizens of Greek cities, metropolitans, and Egyptians were kept clearly distinct and barred by a complex set of rules from many forms of interaction<sup>[6]</sup>. Evidence for frequent episodes of large scale violence during the Roman period has been documented both in written records and in the form of

weapons, fortifications and large scale destruction, but there is a little direct evidence of this in skeletal remains<sup>[11]</sup>. Periods of imperial domination in peripheral regions may be associated with social and political unrest and a climate of tension with the potential to make or increase violent conflicts<sup>[24,27,14]</sup>. Militarism and the use of force have often played a key role in the persistence and expansion of ancient empires<sup>[20,21,14,31,43]</sup>.

The purpose of this study was to examine the frequency and pattern of cranial trauma among ancient Egyptians from the Bahriyah Oasis during the Greco-Roman period and to assess the available evidence for violence that may accompanied social, political and environmental disruption during the occupation of Egypt by the Roman Empire.

### MATERIALS AND METHODS

Bahriyah Oasis (Fig. 1) is located in the Libyan Desert, 360 Km. Southwest of Cairo. The Bahriyah Oasis is a natural depression in a plateau surrounded by isolated black hills, due to the high Ferrous content of the soil. Water is available year round via artisan wells through the floors of the Oasis depression<sup>[18]</sup>. The material of the present study consisted of 160 skulls of adult ancient Egyptian individuals. The preservation of crania is excellent. The site was excavated and dated to the Greco-Roman period (332 BC-AD 395)<sup>[15]</sup> and the human remains were recovered by the human remains study group, National Research Centre during the excavation seasons by the Supreme Council of Antiquities between 1991 and 1994. The tombs are large and rocky while the bones were commingled. Sex determination was carried out using cranial morphological markers (mastoid process, glabella, supra-orbital ridge, nuchal crest, parietal eminence, orbit, palate, occipital condyles, external occipital protuberance, fronto-nasal junction, styloid process, mandible, chin of mandible, and teeth), size, shape and mass of the skull,<sup>[10]</sup>. Age at death was estimated using the degree of ectocranial suture closure<sup>[30]</sup>.

Crania were carefully examined for signs of injuries, as well as, signs of antemortem, postmortem and perimortem fractures. Signs of healing is the best indicator that a traumatic lesion occurred antemortem<sup>[5]</sup>. Antemortem trauma was distinguished from perimortem trauma by the appearance of new bone deposits, resulting in callus formation or beveled edges. Cases with clear postmortem breakage were excluded.

The type of skull vault trauma, trauma feature and location were recorded. Skull elements were counted by side and information was recorded for each lesion: bone type, side, and position on the bone, and shape. Chi-square test was carried out for injury variations between the cranial vault bones, sexes and locations.

### RESULTS AND DISCUSSION

**Results:** The sample consisted of 160 individuals, 92 males and 68 females. The distribution of cranial trauma frequencies by sex and age is provided in Table 1.

The mean age at death for males with cranial trauma was 43.5 years and was 48.5 years for females, with a range 35-60 years. Out of the 160 Egyptian crania examined, 31 individuals (19.4 %) had antemortem injuries, males exhibited a cranial trauma rate of 18.5 % (17/92) of and females showed a rate of 20.6% (14/68). The difference in antemortem injuries between the sexes is not statistically significant. Old adults exhibited a higher frequency of cranial trauma than the middle-aged adults, with significant difference in females ( $\chi^2 = 7.84$ ;  $P < .005$ ).

The distribution of cranial trauma frequencies by bone location in males and females is presented in Table 2. Total number of bones with trauma features equals 44 (29 parietal bones, 12 frontal bones and 3 occipital bones). All lesions showed clear signs of healing. The majority of lesions were observed on the parietal bone with 13 of 21 of trauma event in males = (61.9 %) and 16 of the 23 observed lesions in females (69.56%) being located on this bone. The frontal trauma rate was 23.8 % (5/21) in males and 30.43 % (7/23) in females. Occipital trauma showed the lowest rate of trauma, males exhibited lesions in of 14.3% (3/21). Of the partial trauma in males, 61.5% (8/13) was found on the right parietal bone and 38.5 % (5/13) on the left parietal bone. While in females, left parietal trauma accounted 62.5% (10/16) and right parietal trauma was observed in 37.5% (6/16) of cases. The frontal trauma accounted higher frequencies on the left side in males 60% (3/5) and in females 57.1% (4/7).

Table 3 shows the rate of trauma in three anatomical areas of the cranium (parietal, frontal and occipital). The parietal bone exhibited the highest prevalence of trauma 65.9% (29/44) followed by the frontal bone 27.3% (12/44) and the occipital bone 6.8% (3/44). The cranial trauma rate is significantly higher in the parietal bones compared to the frontal bones ( $\chi^2 = 13.2$ ;  $P < .001$  and occipital bones ( $\chi^2 = 32.2$ ;  $P < .001$ ).

The rate of trauma type by cranial location and the mean traumatic lesion areas are reported in Table 4. Data shows that 89.6% of the parietal injuries are depressed fractures and 10.3% are made with blade weapons.

Depressed fractures accounted for 88.63% (39/44) of all trauma events and blade injuries made up 11.4 % (5/44). The mean area of depressed fracture lesions was 295.5 mm<sup>2</sup> and the mean area of blade injury was



**Fig. 1:** A map of Egypt showing the location of Bahriyah Oasis (360 Km southwest of Cairo, in the western desert).

**Table 1.** The distribution of trauma frequencies (%) by sex and age.

Age (years)	Number of injuries								
	Males			Females			Total		
	N	n	%	N	n	%	N	n	%
Young adult(20–29)	0	0	0	3	0	0	3	0	0
Mid-Adult(30–49)	62	11	17.7	55	8	14.5	117	19	16.5
Old Adult(50+ )	30	6	20	10	6	60*	40	12	30
Total	92	17	18.5	68	14	20.6	160	31	19.4
Mean age		43.50			48.50			46.40	

N: total number of examined individuals in each age group; N<sup>a</sup>: number of individuals with trauma lesions.

\* P < .05, significantly different from mid adult.

**Table 2.** The distribution of trauma frequencies (%) by bone for males and females.

Sex	Trauma Total	Parietal		Frontal		Occipital	
		n	%	n	%	n	%
Males	21	13	61.9	5	23.8	3	14.3
Females	23	16	69.6	7	30.4	0	0

n, number of fractured bone

110 mm<sup>2</sup>. The depressed fracture injuries range in size from 20 mm to 56 mm in length and the blade injuries range from 19 mm to 86 mm in length. Figures 1 to 4

show different types of trauma lesions at different cranial locations.

**Table 3:** The distribution of frequencies (%) of wound location by area.

Trauma location	n	%
Parietal	29/44	65.9*
Frontal	12/44	27.3
Occipital	3/44	6.8
Total	44/44	100

n, number of fractured bone

\* P < .05, significantly different from frontal and occipital bones.

**Table 4:** Trauma type, rate, location and mean area of lesion

	Blade Injury		Depressed Sfracture	
	n	%	n	%
Parietal	3	10.3	26	89.7
Frontal	2	16.6	10	83.3
Occipital	0	0	3	100
% type by total trauma lesions	5/44	11.4	39/44	88.6
Mean area of	110 mm <sup>2</sup>		295.5 mm <sup>2</sup>	

trauma lesions

n, number of fractured bone



**Fig. 2:** Healed depressed fracture on the frontal bone (17X 14 mm). Female, old adult (50<sup>+</sup> years). Scale is in Cm.

**Discussion:** Special attention was given to traumatic lesions which may be associated with violence. These lesions were compared to literature such as Ortner & Putschar<sup>[32]</sup> and Walker<sup>[40]</sup>. The exact lesion as well as ectocranial dimensions and shape of all fractures were recorded. Pathological fractures were excluded from the study.

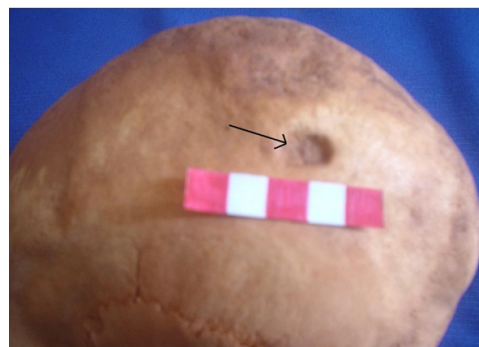
Depressed fracture could have resulted from blunt force and blade injury could have resulted from edged weapons<sup>[22]</sup>.



**Fig. 3:** Healed depressed fracture on the occipital bone (24 X 20 mm). Male, mid adult (30-49 years). Scale is in Cm.



**Fig. 4:** Healed depressed fracture on the left parietal bone (28 x 18 mm). Male, old adult (50<sup>+</sup> years). Scale is in Cm.



**Fig. 5:** Healed depressed fracture on the left parietal bone (15 x 12 mm). Female, mid adult (30-49 years). Scale is in Cm.

Bioarchaeology may be utilized to infer social parameters since the lifestyle of an individual leaves clues on the skeleton. Social and economic changes affect the lifestyle of population groups and therefore they should be considered. Trauma represents extrinsic influence on the skeleton, which results from any factor. The types and locations of injuries will vary between populations and between individuals within a population<sup>[32]</sup>. Head injuries have been a feature of all human societies and one of the few experiences that cannot be hidden from archaeology, since the skull is easily damaged, and fractures, punctures, dents and gashes are found on skulls from all periods of the human past<sup>[17]</sup>.

The present study showed that the cranial trauma rate among ancient Egyptians from the Bahariya Oasis was 19.4 %, which is considered high when compared to other ancient Egyptian population groups. In a sample excavated from Giza and belonging to the Old Kingdom, the total percentage of skull fractures was 5.5 % (11/199), including 2.4 % (2/82) in male high officials, 5.7 % (3/53) in female workers and 9.4 % (6/64) in male workers<sup>[35]</sup>. Rates of total fractures are significantly different between the two Egyptian population samples ( $\chi^2 = 16.46$ ;  $P < .001$ ). Moreover, Bahriyah males showed significantly higher frequencies of fractures when compared to the Giza Old Kingdom high official males ( $\chi^2 = 9.88$ ;  $P < .001$ ), as well as Bahriyah females had significantly higher rates of skull fractures than Giza Old Kingdom worker females ( $\chi^2 = 4.33$ ;  $P < .03$ ). This may suggest that the Greco-Roman period was concomitant with high level of violence.

The association between Roman imperial expansion and high levels of interpersonal violence has been documented<sup>[20,34]</sup>. It is possible that the Roman Empire altered social, political, and economic relationships that created a climate of violence and causing conflict between subject groups. Militarism and the use of force have often played a key role in the persistence and expansion of ancient empires<sup>[20,21,14,43,31]</sup>. The rise in militarism for the Roman Empire may have resulted from a defensive strategy<sup>[13]</sup> or as an aggressive strategy to guarantee economic gain<sup>[20]</sup>.

The antemortem trauma was endemic among rural groups of Sudanese Nubian from the earlier Kerma period (2500-1750 B.C.) and the rate of cranial trauma was 22.9% (8 out of 35 skulls)<sup>[22]</sup>. She concluded that the period of social unrest may have associated with the high levels of trauma among Sudanese Nubians. She found that the accident related injuries was more frequent among rural peoples due to the nature of their lifestyle

Tung<sup>[39]</sup> reported that Wari Empire, dating to AD 650-800 was also affected by high levels of

interpersonal violence and suggested that Wari rule may have contributed to violence.

No significant difference was observed in the rate of cranial trauma between the sexes in the Bahriyah Oasis or in the Giza Old Kingdom populations. This implies that ancient Egyptian males and females were equally vulnerable to interpersonal violence. The cranial trauma rates in males and females in the present study are comparable with those reported among ancient rural and urban Nubian adults studied by Judd<sup>[22]</sup>.

High rate of cranial trauma were also reported in female crania from Australia<sup>[43]</sup>. Tung,<sup>[39]</sup> reported that individuals of Wari Empire experienced similar levels of violence. This confirms that imperialism can adversely affect populations living within empire's domain.

Many studies revealed that certain age-groups are more likely to be associated with trauma. In the present study, the age based cranial trauma pattern showed higher frequency in the old adults than the middle adults, with significant difference in females (Table 1). This may be explained as older adults are exposed to more years of risk for violence. Samples with older individuals can bias the sample leading to a higher rate of trauma relative to samples with younger individuals<sup>[19]</sup>. A number of the fractures in this Egyptian population may be due to the environment in which this group lived, as well as the economic practices they followed. Carrying water from river to household was typically a female occupation in recent Egyptian populations, and it may have been so in ancient Egyptian populations as well and this may explain the high frequency of trauma observed in the old adult females.

Egyptians from Bahriyah Oasis exhibited depressed fractures and blade injuries. The observed depressed fractures might be the result of blunt force blows. Blunt force trauma to the cranium is unlikely to occur accidentally, and is usually associated with interpersonal violence<sup>[3,9,36,37]</sup>.

There is a statistically significant difference in the rate of trauma between the three anatomical areas of the cranium. The parietal bones show the highest rate of trauma followed by the frontal and then the occipital bones (Table, 3). Injuries located on the frontal bones of the skull may suggest face-to-face fighting<sup>[41,24]</sup>. Traumas concentrated on the left side of the skull indicate hand-to-hand combat by right-handed individuals, but when located on the back of the skulls they indicate that the individuals were struck from behind while running away<sup>[25]</sup>.

The parietal lesions tended to be left-sided, which may indicate that the injuries resulted from face to face assault by right-handed attackers<sup>[4]</sup>. Tung<sup>[39]</sup> reported that wound patterning differs between the sexes, where

females display more wounds on the occipital bone, while males show more on the frontal ones. The pattern of violence varies with sex, i.e. certain patterns of violence may be directed specifically at females<sup>[25]</sup>.

In the present study the mean area of skull vault lesion was 295.5 mm<sup>2</sup> for depressed fracture and 110 mm<sup>2</sup> for blade injury resulted from edged weapons. The depressed fracture injuries range in length from 20 mm to 56 mm and blade injuries range from 19 mm to 86 mm in length. Clinical and forensic case studies found that stone missiles may produce injuries ranging between 286–3,317 mm<sup>2</sup> in area<sup>[7]</sup>, which may explain the injury pattern observed. Moreover, the cranial trauma pattern among ancient Egyptians living under the Roman rule may suggest that they were not engaged in warfare. The pattern of trauma suggests that blows were randomly given during violence, although the parietal bones had the highest rate of occurrence. Injury pattern for a population of individuals in which blows come from all directions may reflect conflict related to defense<sup>[43]</sup>. Lovell,<sup>[29]</sup> reported that fractures of the cranium are more related to interpersonal violence than fractures of long bones which are associated with falls and other accidents.

Periods of imperial domination in peripheral regions may be associated with social and political unrest and a climate of tension with the potential to make or increase violent conflict<sup>[24,14,27]</sup>. Torres-Rouff & Costa-Junqueira<sup>[38]</sup> indicated that violence became common place only during period of great social change and stress. Alvrus<sup>[2]</sup> reported that very high rate of cranial fractures indicates levels of considerable social stress that could lead to interpersonal violence.

In conclusion this study suggests that Roman rule in Egypt may have contributed to violence. The high rate of cranial trauma among ancient Egyptians from Bahriyah Oasis during the Greco-Roman period may indicate that this population experienced social stress that could elevate interpersonal violence.

## REFERENCES

1. Adams, B., 1988. Egyptian Mummies. Shire Egyptology. Shire Publications limited.
2. Alvrus, A., 1999. Fracture patterns among the Nubians of Semna South, Sudanese Nubia. International Journal of Osteoarchaeology, 9: 417-429.
3. Anderson, T., 1996. Cranial weapon injuries from Anglo-Saxon Dover. International Journal of Osteoarchaeology, 6: 10–14.
4. Atta, H.M., 1999. Edwin Smith Surgical Papyrus: The Oldest Known Surgical Treatise. American Surgeon, 65: 1190-2.
5. Aufderheide, A.C., C. Rodriguez-Martin, 1998. The Cambridge Encyclopaedia of Human Paleopathology. Cambridge: Cambridge University Press.
6. Bagnall, R. and B. Frier, 1994. The Demography of Roman Egypt. Cambridge Studies Population, Economy and Society in Past. Cambridge University press England.
7. Bhootra, B. and B. Bhana, 2004. An unusual missile-type head injury caused by a stone. American J. Forensic Medicine, 25: 355-57.
8. Brickley, M., 2006. Rib Fractures in the Archaeological Record: A Useful Source of Sociocultural Information. International Journal of Osteoarchaeology, 16: 61–75.
9. Bridges, P.S., 1996. Warfare and mortality at Koger's Island, Alabama. International Journal of Osteoarchaeology, 6: 66–75.
10. Buikstra, J. and D. Ubelaker, 1994. Standards for data collection from human skeletal remains. Arkansas Archaeological Survey research series no. 44. Fayetteville: Arkansas Archaeological Survey.
11. Dawson, L., T.E. Levy, P. Smith, 2003. Evidence of Interpersonal Violence at the Chalcolithic Village of Shiqmim (Israel). International Journal of Osteoarchaeology, 13: 115–119.
12. Domett, K.M. and N. Tayles, 2006. Adult Fracture Patterns in Prehistoric Thailand: A Biocultural Interpretation. International Journal of Osteoarchaeology, 16: 185–199.
13. Dyson, S.L., 1985. The creation of the Roman frontier. Princeton: Princeton University Press.
14. Earle, T.C., 1997. How chiefs come to power: the political economy in prehistory. Stanford: Stanford University Press.
15. Fakhry, A., 1974. The Oases of Egypt. Bahriyah and Farafra oases. American University In Cairo, Press, 66-67.
16. Fakhry, A., 1999. Egyptian Deserts part 2 Bahriyah, Farafra Oasis. Edited by Gaballah GA. Development of Contemporary Cultural Awareness series of scientific and historical Culture 100 Book Project. Supreme Council of Antiquities Press.
17. Filer, J., 1997. Fractures, punctures, dents and gashes. British Archaeology, 25.
18. Giddy, L., 1986. Egyptian Oases; Baharia, Dakhla, Farafra, and Khaka during Pharonic Time. Aris and Philips Ltd. England.
19. Glencross, B. and L. Sawchuk, 2003. The person-years construct: aging and the prevalence of health related phenomena from skeletal samples. International Journal of Osteoarchaeology, 13: 369–374.
20. Harris, W.V., 1979. War and imperialism in Republican Rome, 327–70 B.C. Oxford: Oxford University Press.

21. Hassig, R., 1988. Aztec warfare: imperial expansion and political control. Norman: University of Oklahoma Press.
22. Judd, M.A., 2006. Continuity of interpersonal violence between Nubian communities. *American Journal of Physical Anthropology*, 131: 324-333.
23. Kanawati, N., 1988. The tomb and It's significance in Ancient Egypt, prism archaeological series 3, Al ahram commercial presses- Cairo- Egypt.
24. Lambert, P.M., 1994. War and peace on the western front: a studyof violent conflict and its correlates in prehistoric hunter-gatherer societies of coastal southern California. Doctoral dissertation, University of California at Santa Barbara.
25. Lambert, P.M., 1997. Pattern of violence in prehistoric hunter gatherer societies of coastal southern California. In: Frayer D.W., Martin D.L., editors. *Troubled times: Violence and warfare in the past*. Amsterdam: Gordon and Breach, 77-109.
26. Larsen, C.S., 1997. Bioarcheology. Interpreting Behavior from the Human Skeleton, Cambridge University Press, Cambridge, 461.
27. Larsen, C.S., H.P. Huynh, B.G. McEwan, 1996. Death by gunshot: biocultural implications of trauma at Mission San Luis. *International Journal of Osteoarchaeology*, 6: 42–50.
28. Lewis, N., 1983. *Life in Egypt under Roman Rule*. Oxford: Clarendon Press.
29. Lovell, N.C., 1997. Trauma analysis in paleopathology. *Yearbook of Physical Anthropology*, 40: 139–170.
30. Meindle, R.S., C.O. Lovejoy, R.P. Men forth, R.A. Walker, 1985. A revised method of age determination using the os pubis with a review and tests of accuracy of other current methods of pubic symphyseal aging. *American Journal of Physical Anthropology*, 68: 29-45.
31. Morrison, K.D., 2001. Coercion, resistance, and hierarchy: local processes and imperial strategies in the Vijayanagara Empire. In: Alcock SE, D'Altroy TN, Morrison KD, Sinopoli CM, editors. *Empires*. Cambridge: Cambridge University Press, 252–278.
32. Ortner, D.J. and W.G.J. Putschar, 1985. Identification of pathological conditions in human skeletal remains. Washington, DC: Smithsonian Institution Press.
33. Redford, D.B., 2001. *The Oxford Encyclopedia of ancient Egypt*.Vol. 2 The American University in Cairo Press, 148-55.
34. Rich, J. and G. Shipley, 1993. *War and society in the Roman world*. London: Routledge.
35. Sarry EL-Din, A.M., 2003. Bone Fractures in ancient Egyptians from Giza Old Kingdom. *Egypt. Med. Journal*, NRC, 2(2): 1687- 1278.
36. Smith, M.O., 1997. Osteological indications of warfare in the archaic period of the Western Tennessee Valley. In *Troubled Times: Violence and Warfare in the Past*, Martin DL , Frayer DW (eds.). Gordon and Breach: Amsterdam, 241-266.
37. Standen, V.G. and B.T. Arriaza, 2000. Trauma in the pre-ceramic coastal populations of northern Chile: violence or occupational hazards? *American Journal of Physical Anthropology*, 112: 239-249.
38. Torres-Rouf, C. and M.A. Costa-Junqueira, 2006. Interpersonal violence in prehistoric San Pedro de Atacama, Chile: behavioral implications of environmental stress. *American Journal of Physical Anthropology*, 130:60-70.
39. Tung, T.A., 2007. Trauma and violence in the Wari Empire of the Peruvian Andes: warfare, raids and ritual fights. *American Journal of Physical Anthropology*, 133: 941-956.
40. Walker, P.L., 1989. Cranial injuries as evidence of violence in prehistoric southern California. *American Journal of Physical Anthropology*, 80: 313-323.
41. Walker, P.L., 1997. Wife beating, boxing, and broken noses: skeletal evidence for the cultural patterning of violence. In DL Martin, DW Frayer (eds.), *Troubled Times: Violence and Warfare in the Past*, Gordon and Breach Publishers, Amsterdam, 145-180.
42. Walker, P.L., 2001. A Bioarchaeological Perspective on toe History Of Violence. *Annual Review Anthropology*, 30: 573-596.
43. Webb, S., 1995. *Palaeopathology of Aboriginal Australians*. Cambridge: CambridgeUniversity Press.
44. Webster, D., 1998. Warfare and status rivalry: lowland Maya and Polynesian comparisons. In: Feinman GM, Marcus J, editors. *Archaic states*. Santa Fe: School of American Research Press, 311–352.