AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 132:48–58 (2007)

Cranial Trauma in Iron Age Samnite Agriculturists, Alfedena, Italy: Implications for Biocultural and Economic Stress

R. R. Paine,[1]* D. Mancinelli,[2] M. Ruggieri,[3] and A. Coppa[4]

[1]*Department of Sociology, Anthropology and Social Work, Texas Tech University, Lubbock, TX 79409*
[2]*Dipartmento di Scienza Ambientale, Università de L'Aquila, Italy*
[3]*Soprintendenza Archeologica dell'Abruzzo, Chieti, Italy*
[4]*Dipartmento di Biologia Animale e dell'Uomo, Università "La Sapienza" di Roma, Italy*

KEY WORDS early Italy; conflict; injuries

ABSTRACT The Samnites are an Iron Age protohistoric people from the central region of Italy. The skeletal remains are from the Alfedena necropolis, 6th through 5th centuries B.C. Macchiarelli et al. (Antropologia Contemporanea 4 (1981) 239–243) were the first to report on cranial trauma for this population, presenting four cases with extreme injuries. We re-examined this well documented skeletal population for additional examples of trauma. Previously unexamined remains from Alfedena, excavated at the turn of the 20th century, are also included in our analysis (Mariani. 1901. "Aufidena", ricerche archeologiche e storiche del Sannio settentrionale. Roma: Acc Naz Dei Lincei). Of the 209 adult crania examined, 12.9% of them exhibited trauma. Analysis of location and frequency of cranial trauma revealed that cranial injuries to the head appear to originate from all directions. The high rate of cranial trauma underscores the violent circumstances experienced during the Iron Age protohistoric period of central Italy. Males are much more likely to exhibit cranial injury than females ($P = 0.009$). We conclude that the injuries received by Samnite male farmer-warriors occurred while defending pastoral-agricultural resources. Trauma rates are similar for some Iron Age populations and not for others. Behavior associated with violence during the Iron Age period can not be generalized for all populations found in Italy. Am J Phys Anthropol 132:48–58, 2007.

Evidence for skeletal trauma is common in the remains of past peoples. The causes of trauma can have accidental or violent origins (Larsen, 1997). Although paleopathologists have made great strides in the interpretation of injuries found in prehistoric skeletal remains (Walker, 1989; White, 1992; Larsen, 1997; Lovell, 1997; Martin and Frayer, 1997; Jurmain, 1999), violent behavior related to the creation of these skeletal features is not always easily interpreted or understood from the bioarchaeological record. Still, human skeletal remains offer direct biological evidence specific to skeletal injuries, and these biological markers are useful in the reconstruction of the violent behavior of past peoples (Walker, 2001). The intent of this study is to document the presence of cranial injuries for an Iron Age burial population from central Italy and to assess the cause of this interpersonal violence.

The cranial samples examined in this project are from the Samnite necropolis of Alfedena, Italy. This necropolis is located in the mountainous Apennine range of Abruzzo southeast of Rome. The site dates back to the 6–5th centuries B.C. (Parise and Ruggeri, 1981). The economic livelihood of this protohistoric population is agro-pastoral. The Samnites' success as pastoral-agriculturists lead to an increase in population growth and it provided them with an excellent quality of life, as indicated by their long life expectancy (Coppa et al., 1981, 1990) and the lack of biological indicators for dietary stress (Cucina et al., 1996, 1998a,b, 2000). Increase in population density may have lead to small scale conflict, which appears to have erupted from time to time among Samnite communities as they attempted to protect or acquire resources.

The Samnites also appeared to have organized themselves into patrilineal communities. Clans and close-kin networks were created among related males, and family units were used for the purpose of protecting resources which included land, animals, and crops. Both the archaeological record and analyses of both skeletal and dental features support this claim. Epigenetic markers of the cranium show that males within grave circles located in the Alfedena necropolis shared specific discrete traits and were likely related to each other (Mogliazza and Rubini, 2003; and see Coppa and Macchiarelli, 1982). Burial location and grave goods are also useful in making this point clear.

The protohistoric Samnite burials of Alfedena are well studied (Mariani, 1901; Parise and Ruggeri, 1981; Parise, 1988). Of the numerous bioanthropological articles published on this skeletal population (e.g., Coppa et al., 1981, 1990; Cucina et al., 1996, 1998a,b, 2000; Mogliazza and Rubini, 2003) only Macchiarelli et al. (1981) has reported

Grant sponsor: MURST COFIN & CNR "PF Beni Culturali"; Grant number: 01.00524.PF36.

*Correspondence to: Robert R. Paine, Department of Sociology, Anthropology and Social Work, MS 1012, Texas Tech University, Lubbock, TX 79409, USA. E-mail: Robert.paine@ttu.edu

Received 4 June 2005; accepted 14 March 2006

DOI 10.1002/ajpa.20461
Published online 1 August 2006 in Wiley InterScience (www.interscience.wiley.com).

Fig. 1. An extreme blade wound. A 28-year-old Samnite male from the site of Alfedena, Italy (specimen no. 119).

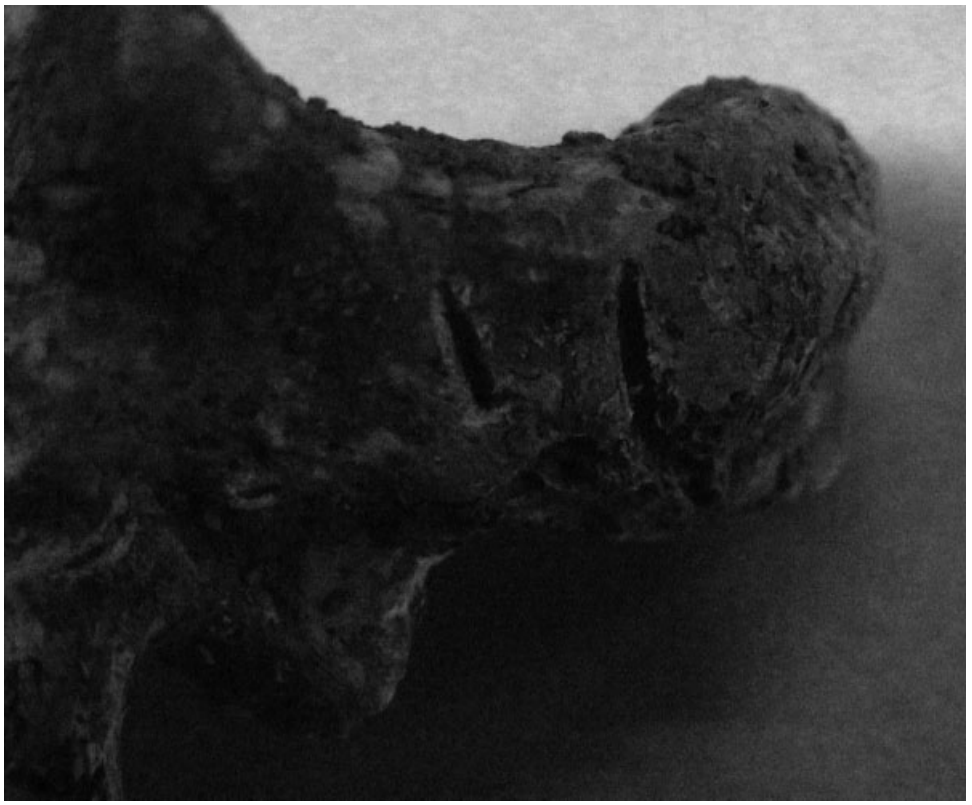

Fig. 2. Two incisive wounds to the transverse process of a vertebral bone. A 28-year-old Samnite male from the site of Alfedena, Italy (specimen no. 119).

on the occurrence of trauma for these Samnite burials. They discussed the presence of trauma observed on four skeletons, including a 28-year-old male (Fig. 1). He showed a large bladed injury, 240 mm in length, running from the frontal bone to the mid-portion of the occipital. As we examined the postcranial remains of this male we also observed several other injuries (Fig. 2). These wounds may have rendered this individual helpless and this may account for the extreme nature of the injury to the head.

It is clear that some individuals buried in the Alfedena necropolis experienced extreme interpersonal violent en-

TABLE 1. Sex profile for the Alfedena burials

	Male	Female	Unknown	Subadults	Total
Total burial numbers	156	69	4	17	246
Total number of crania	149	59	1	–	209

Additional demographic data for the skeletal material excavated during the 1973–79 period are offered by Coppa et al. (1981, 1982, 1990).

TABLE 2. Age profile and cranial injury numbers for the Alfedena adult burials

	Number of cranial injuries	
Age (years)	Male	Female
20–29	8 (2)[a]	8
30–39	48 (10)	10 (1)
40–49	38 (6)	8
50+	33 (7)	16 (1)
Unknown age	22	17

[a] Numbers in parentheses indicate the number of individuals with an injury for each age group.

counters. As we reevaluated this population for injuries, we found that the four cases of trauma reported in 1981 were simply the most obvious examples of trauma and that there were many other cases not reported or not recognized. The primary purpose of this study is to determine the nature of the injury pattern for the Alfedena burials by recording the rate and location of trauma. Specifically, we tested the hypothesis that there are sex-specific differences in cranial injuries for this population. We also tested the hypothesis that there are differences in cranial injury frequencies between Alfedena and several other skeletal populations, including three other Iron Age burial groups from Italy.

MATERIALS AND METHODS

The crania examined in this study come from the Italian necropolis of Alfedena. The earliest excavation and recovery of human burials at the necropolis occurred prior to 1901 (Mariani, 1901). This archaeological work yielded about 1,500 individuals and a descriptive report (Sergi, 1900–1901). Unfortunately, most of this skeletal material has been lost or has been misplaced. Still, 114 crania from this portion of the collection were recently made available for analysis; the postcranial is not available for observation.

One-hundred and thirty-two individuals recovered from three distinct circular grave features excavated during the 1973–1979 field work (Bedini et al., 1975) were examined. In summary, we have examined 100% of the crania available for the Alfedena burial population.

The archaeological work at the Alfedena site during the 1970s has helped to make the connection of burial placement to family/clan relationship for the last 132 burials recovered from the site (Bedini et al., 1975). The burials were placed in well-defined areas outlined by stones placed in circles; these circular grave features and the presence of funeral outfits have indicated clan/family specific loci in the necropolis. Coppa and Macchiarelli (1982) and others have shown a high rate of specific dental traits that suggest family/clan relationship among the some of the individuals found in the circular features (Capasso, 1985; Bondioli et al., 1986; and see Rubini, 1996; Mogliazza and Rubini, 2003 and their study on the epigenetic markers of the cranium).

Grave goods found with male burials suggest that men were also engaged in the defense of the community and its resources. The Samnite males are considered to be farmer-warriors organized by male kinship ties (Tagliamone, 1999). The weapons used to make cranial injuries (clubs/maces, swords, axes, and small-round stone or metal projectiles tossed by slings) have been found as part of the male grave offerings at Alfedena, and these weapons were most likely used in combat (Tagliamone, 1999).

Cranial samples

Of the 246 individuals examined, 229 of them are adults and of the adults, 209 crania were available for analysis. The preservation of the bone from Alfedena is good–excellent (Figs. 1–7), although some crania are fragmented. Our sample consists of 149 males, 59 females, and 1 individual of unknown sex (Table 1). An age profile for this population is provided in Table 2. Of the 149 males, there are age estimates for 127. We have age data for 42 of the 59 females.

The number of individuals with trauma was recorded as well as the type of trauma (compressed fractures that result from blunt force blows, fractures caused by bladed or edged weapons, circular injuries complete with beveled edges and radiating fractures, and the dislocation of the temporomandibular joint). These categories of trauma are common among prehistoric populations and have been well defined by numerous bioarchaeologists and forensic anthropologists (see Webb, 1995; Lovell, 1997; Berryman and Symes, 1998; Jurmain, 1999; and Weber and Czarnetzki, 2001). We also recorded trauma feature by the cranial location (anterior, lateral, and posterior) and by the specific bones involved. Anterior injuries include the frontal, malar, and mandibular bones, lateral wounds involved the right and left parietal and temporal bones, and the posterior trauma includes only the occipital bone. We use the term "trauma feature" to indicate a single injury to the cranium. The data set pertains specifically to the number of individuals with an injury, the number of actual trauma features, and the number of bones with an injury. Thus, the rate of trauma is recorded by individual, by feature, and by bone.

Statistical evaluation of the data is done using the Fisher's exact test, 2-tailed (Guo and Thompson, 1992). A 2×2 data matrix was created for testing the null hypothesis that there is no statistically significant difference in cranial trauma rate between males and females. Similar tests were performed to determine the difference of the location for healed and unhealed trauma on the crania at the anterior, posterior, and lateral areas. Finally, the Fisher's exact test was used to test the null hypothesis that there were no statistically significant differences in cranial trauma frequency between Alfedena to the Iron Age burial population from Pontecagnano, Italy (Robb, 1997); the Samnite burials of the Bazzano and Fossa sites (Miranda, personal communication.); and to a 13th century Medieval German burial population (Weber and Czarnetzki, 2001). These populations were picked for comparisons because they represent a population living in Italy at the same general time period or region as the Samnites of Alfedena, or they represent a

TABLE 3. Fisher's exact test results

	n	*P*	SE	Hypothesis
Alfedena young and old males	127	0.65928	0.00147	Not rejected
Alfedena males and females	208	0.00900	0.00037	Rejected*
Alfedena and Pontecagnano males	137	0.31221	0.00184	Not rejected
Alfedena and Pontecagnano total	265	0.82143	0.00080	Not rejected
Alfedena and Pontecagnano females	84	0.57805	0.00083	Not rejected
Pontecagnano males and females	56	0.68094	0.00080	Not rejected
Alfedena and Bazzano males	245	0.00258	0.00020	Rejected*
Alfedena and Bazzano total	346	0.01691	0.00062	Rejected**
Alfedena and Bazzano females	100	1.00000	0.00000	Not rejected
Alfedena and Med. German males	453	0.09336	0.000178	Not rejected
Samnites and Pontecagnano males	350	0.55162	0.00135	Not rejected
Samnites and Med. German males	623	0.59880	0.00266	Not rejected

Samnite numbers include burials from the sites of Alfedena, Bazzano, and Fossa.
The numbers for the Medieval German samples came from Weber and Czarnetzki (2001).
The numbers for the Pontecagnano samples came from Robb (1997).
The Bazzano and Fossa data are provided by Miranda (2005, personal communication).
*$P > 0.01$; **$P > 0.02$.

population with a considerably high rate of cranial trauma as a result of weapon use.

RESULTS

Of the 209 Alfedena crania examined, 27 individuals, or 12.9% of the total adult burial population, exhibited trauma, either well healed antemortem or unhealed perimortem injuries. An age profile of individuals with injuries is provided in Table 2. Nearly 17% (25/149) of the men show cranial injuries, while less than 4% (2/59) of the women do. Males with cranial trauma have a mean age at death of 43.8 years, with a range of 27–60 years. The age-at-death for males with or without trauma is nearly the same, 44 and 43 years, respectively. Young males (20–39 years of age, $n = 56$ with 12 cases of trauma) have the same trauma rate as older males (40–60 years of age, $n = 71$ with 13 cases of trauma), $P = 0.659$ (Table 3).

The females with cranial trauma have an estimated mean age at death of 50 years with an age range of 35–60 years. The two Alfedena females with trauma displayed round perimortem projectile wounds to the left side of the frontal bone just over the eye orbit. The female mean age-at-death for individuals without trauma is 44 years; this is a younger age of death than the females with trauma, and this comparison most likely reflects the small sample size of females with trauma.

Following the frequency models offered by Walker (1989), Webb (1995), and Jurmain, 1999, 2001) we have organized our results by cranial location, regionally, and by bone following a modified version of Webb (1995). Specifically, his model was expanded to include several additional bones, the temporal, malar, and mandible (Table 3). It is clear that for some individuals who exhibit cranial trauma, more than one bone is involved and several individuals show multiple trauma features. Of the 27 individuals observed with cranial trauma, 37 trauma features were recorded involving 42 cranial bones.

Seven of the Samnite males exhibit multiple trauma features to the skull. For example, Alfedena burial n. 2 exhibits two perimortem injuries. One injury is located on the right parietal. This injury is characterized by a circular hole with beveled edges on the internal surface (Fig. 3). The ectocranial wound measurements are 15 × 13 mm; the endocranial side of this trauma feature is nearly double the size of the ectocranial dimensions. The second injury to burial n. 2 is a large bladed perimortem stab wound to the right temporal bone, measuring 51.00 × 19.10 mm. A second example of multiple injuries to the skull is seen in Alfedena burial n. 58, a 29-year-old male (Fig. 4). This male shows three perimortem bladed wounds to the cranium, the first is on the coronal suture of the right parietal-frontal bones (53.50 × 6.72 mm), the second is on the posterior region of the right parietal bone (49.80 × 13.99 mm), and the third is on the occipital bone (56.60 × 24.27 mm). It is quite apparent that these individuals suffered extreme injuries that were meant to kill, not to stun.

Four individuals with cranial trauma also exhibited postcranial trauma. This includes an individual with healed rib fractures, an individual with a well healed fracture to the femur, and Alfedena burial n.119 who shows small incised perimortem wounds to a vertebral bone (Fig. 2), and a fibula.

A rate of trauma for each sex by bone location is reported in Table 4. The parietal bones show the highest rate of trauma at 42.8% and the mandible exhibits the lowest rate of trauma at 2.4%. The right parietal shows a higher rate of trauma than the left side, while the occipital, temporal, and frontal bones each shows higher rates of injury to the left side (Table 4).

Cranial trauma exhibited by the Samnite burials of Alfedena fall into four types: 1) compressed fractures that resulted from blunt force blows, 2) fractures caused by bladed or edged weapons, 3) circular injuries complete with beveled edges and radiating fractures, and 4) the dislocation of the temporomandibular joint. The rate of trauma type by bone is reported in Table 5. As an example of some of the higher frequencies observed; 64% of the parietal injuries are made with blade weapons, 36% of the frontal injuries are depressed fractures, and 25% of the temporal injuries are from projectiles.

Blunt force resulting in depressed fractures accounted for 46% of the trauma events and 12 of the 149 males (8%) show this form of injury. Figure 5 displays a male cranium with a well healed depressed fracture to the temporal bone measuring 55.43 × 36.29 mm. The depressed fracture injuries range in size from 55.43 mm in length to 21.5 mm.

Fractures from edged weapons made up 31% of the trauma events recorded and 5.3% of the males exhibit this form of trauma (Fig. 6). These injuries range in length from 240 mm (Fig. 1) to small stabs wounds of 18 mm.

The single case of dislocation of the temporomandibular joint accounts for 4% of the trauma observed (1/27), and 0.67% of the adult males with trauma. This injury

Fig. 3. A circular projectile wound with endo-cranial beveling. A Samnite male from the site of Alfedena, Italy.

Fig. 4. A 29-year-old Samnite male, with three unhealed blade injuries.

was most likely caused by blunt force to the face (Lovell, 1997). It is a unique injury that consists of condyles articulating in unlikely locations. This older male has a bifurcated left mandibular condyle (Fig. 7) that articulates with the posterior edge of the temporomandibular fossa. The right condyle articulates with the medial surface of the right zygomatic arch. The arch has a facet growing from the medial surface towards the midline of the body, and this facet helps to articulate the condyle into a functional joint.

Small circular projectile wounds, complete with radiating fracture lines and beveled endocranial edges were seen

TABLE 4. The distribution of cranial trauma frequencies (%) by bone for males and females

Sex	*N*	Trauma	P	PL	PR	F	FL	FR	O	OL	OR	T	TL	TR	M	MD
M	25	11.90	42.8	27.4	72.2	16.6	57.1	42.8	14.3	83.3	0	14.3	66.7	33.3	4.7	2.4
F	2	0.95	0	0	0	100	100	0	0	0	0	0	0	0	0	0

Total cranial population is 209, of which 27 individuals exhibit trauma lesions.
Number of trauma features equals 37, which involve 42 bones.
The percentage by bone is calculated by dividing the number of bones by 42.
PL and PR represent left and right parietal bones ($n = 18$); FL and FR represent left and right frontal bones ($n = 7$ for males and 2 for females); OL and OR represent left and right occipital bone ($n = 6$); TL and TR represent left and right temporal bones ($n = 6$); M, malar ($n = 2$); MD, mandible ($n = 1$).

TABLE 5. Trauma type, rate, and location

	Projectile trauma	Blade injury	Depressed fracture	Facial fracture	Dislocation
Parietal	50	64.2	45.4	0	0
Frontal	25	14.2	36.3	0	0
Occipital	0	28.7	9	0	0
Temporal	25	14.2	18.1	0	0
Malar	0	0	0	100	0
Mandible	0	0	0	0	100
Total % by type	*100*	*100*	*100*	*100*	*100*

Fig. 5. A 47-year-old Samnite male from the site of Alfedena, Italy; exhibiting a healed depressed fracture to the temporal bone.

in 22% of the individuals with cranial trauma (Fig. 3), and 2.7% of the males and 2.9% of the females show this form of trauma. These injuries range in size from 17 × 9 mm to 10.9 × 6 mm. The projectile injuries look very much like the impact site of a single gunshot wound to the cranium (see Berryman and Symes, 1998, for cranial gunshot wound characteristics). Slings were employed and they appear to have been able to generate enough impact force to cause cranial trauma much like that of a gunshot wound. None of these injuries resulted in exit wounds and none of them exhibit bone growth as a sign of healing.

Despite the high rate of cranial trauma for the Samnite farmer-warriors, not all of the 37 injuries (trauma events) ended in immediate death. That is, 35.1% of the injury features show signs of healing (Table 6). Just over half of the Samnite farmer-warriors survived their wounds showing antemortem healing. The occipital bone only exhibits unhealed trauma, while the malar and mandible bones show only healed injuries.

We also examined three anatomical areas of the cranium for trauma, including anterior, posterior, and lateral aspects. Anterior injuries involved the frontal, ma-

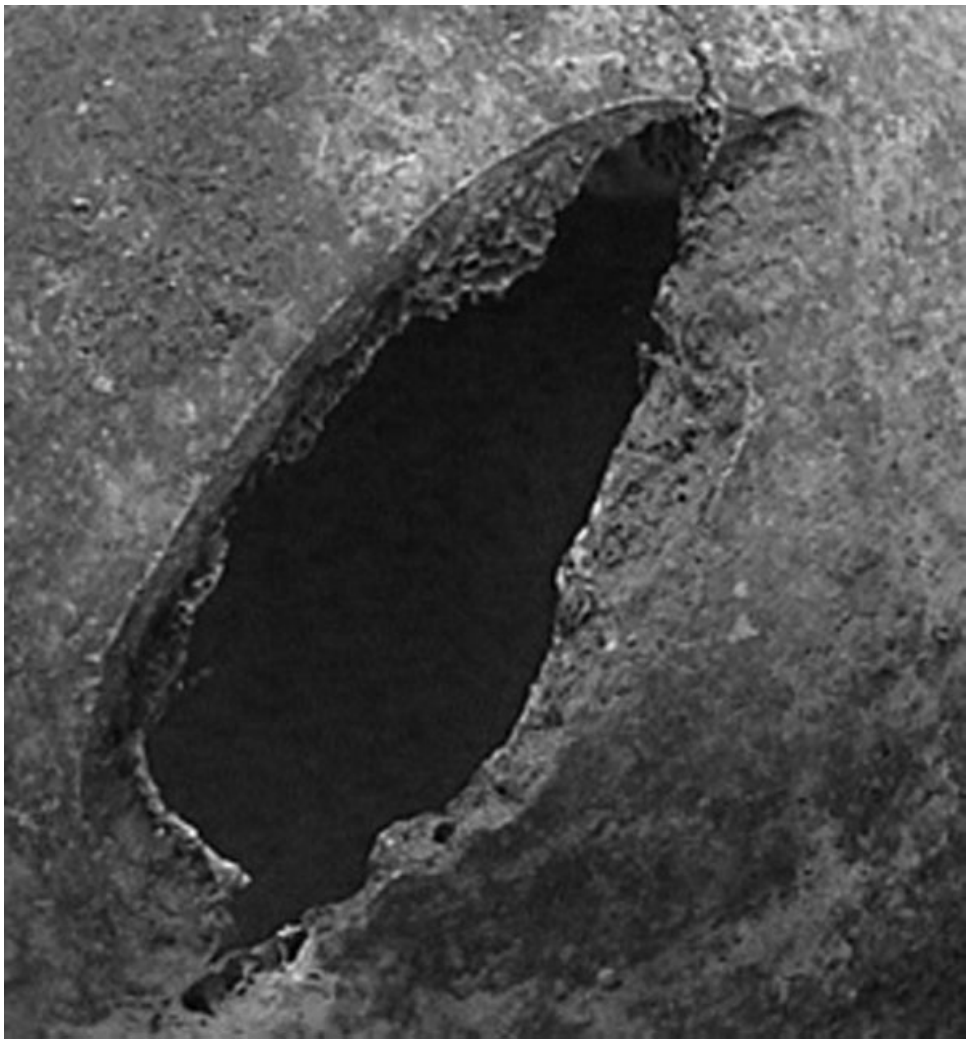

Fig. 6. A Samnite male, from the site of Alfedena, Italy showing a blade wound to the parietal.

lar, and mandible bones, and they account for 29.7% of the injuries (Table 7). Of the anterior injuries 40% are unhealed. Right and left lateral wounds involved the parietal and temporal bones and they account for 62.1% of the injuries. Lateral injuries were unhealed 69.5% of the time. Trauma features located in the posterior area, specifically on the occipital bone account for only 8.1% of the wounds and none of these injuries show signs of healing (Table 7). There are no statistically significant differences in injury rate or type for any of these areas (Table 8). Healed and unhealed injuries are evenly distributed.

A comparison of cranial trauma with the Pontecagnano burials

The Iron Age skeletal collection from the area of Pontecagnano, Italy has been well documented. These burials date back to the 7th–3rd centuries B.C. Grave goods and other archaeological evidence suggest that the Pontecagnano community was a highly stratified society (Robb et al., 2001). All indicators for the Samnites of Alfedena suggest they did not organize themselves into a ranked society (Tagliamone, 1999). Despite this behavioral difference between the two communities, the comparison between them is still useful. The Pontecagnano burials are represented by 25 females and 31 males (Robb, 1997). Two females and four males exhibit cranial wounds. The males exhibit a cranial trauma rate of 12.9% and females show a rate of 8%. The overall rate is nearly 11%. Eleven Pontecagnano males show postcranial injuries. According to Robb (1997), the trauma rate among the Pontecagnano males reflects specific gender based ideology and, does not reflect warfare over resources. The violence among the Pontecagnano males represents spontaneous, internal community actions resulting in mostly postcranial survivable injuries (Robb, 1997).

There is no statistically significant difference in the frequency of cranial trauma among males of the Alfedena and Pontecagnano populations, $P = 0.312$ (see Table 3). The same results holds true for a comparison between the females of Alfedena and Pontecagnano (Table 3).

Despite the fact that the cranial injury rates are the same for the males of both Iron Age populations, the Samnite farmer-warriors were specifically engaged in the defense of their community and property. Clearly, this activity also defines gender roles. This is certainly more apparent than in the data reported by Robb (1997) in which there is no statistically significant difference in the frequency of cranial trauma for males and females of the Pontecagnano population, $P = 0.68094$ (Table 3). The high rate of the cranial injuries, their extreme nature, and the relative lack of postcranial wounds for the Samnites (we observed only four males with postcranial wounds) suggests that the injuries experienced by these

Fig. 7. A dislocated temporomandibular joint with a bifurcated mandibular condyle.

TABLE 6. Frequency (%) of trauma features grouped by perimortem and antemortem

	n	Overall rate	Parietal ($n = 17$)	Frontal ($n = 8$)	Occipital ($n = 3$)	Temporal ($n = 6$)	Malar ($n = 2$)	Dislocation mandible ($n = 1$)
Perimortem	24	64.8	64.7	57.1	100	83.3	0	0
Antemortem	13	35.1	35.3	42.8	0	16.7	100	100
Total	*37*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

n, the number of injuries, total of 37.

TABLE 7. Frequency (%) of wound location by cranial area

Wound location	*n*	Total rate	Unhealed cases
Lateral	23/37	62.1	69.5
Anterior cranial	11/37	29.7	41.6
Posterior cranial	3/37	08.3	100

Lateral – parietal and temporal bones, left and right sides combined; anterior – frontal, facial bones, and mandible; posterior – occipital bone.

TABLE 8. Fisher's exact test results of healed and unhealed injuries by cranial area

	n	*P*	SE	Hypothesis ($P = 0.01$)
Anterior to lateral	34	0.13591	0.00104	Not rejected
Anterior to posterior	14	0.19181	0.00082	Not rejected
Lateral to posterior	26	0.53958	0.00069	Not rejected

males were meant to kill and not simply to disable (see Figs. 3 and 4 with multiple injuries). These are individuals that received extreme injuries that not simply injuries that would result from an attempt to stun the opponent as might happen during a contest over honor. Twenty-eight percent of the Alfedena males (7/25) wounded were struck repeatedly and show multiple cranial trauma features and 64.8% of the trauma is perimortem, the behavior associated with creating these injuries differs from what was reported by Robb (1997). Separate cultural values were utilized by the Iron Age people of Italy and this is reflected by these traumas.

Robb (1997) also reports on a male with a perimortem injury to the right parietal, a depressed fracture with an internal beveled edge and radiating fracture lines stemming from the impact site. He interprets this injury to be the result of a strong blunt impact to the head. The photo of this injury looks nearly identical to the six pro-

TABLE 9. Demographics of the populations used for comparative purposes

Site	Time period	Male *n*	Female *n*	Unknown adults *n*	Total *n*
Fossa Samnites[a]	900 B.C. – A.D. 100	74 (1)[b]	44 (1)	23	141 (2)
Bazzano Samnites[a]	900 B.C. – A.D. 100	96 (4)	41 (2)	15 (1)	152 (7)
SW Germany[c]	A.D. 600–800	?? (29)	?? (4)	0	304 (33)

[a] Data come from Miranda (2005, personal communication).
[b] Numbers in parentheses indicate the number of individuals with cranial trauma.
[c] Data come from Weber and Czarnetzki (2001).

jectile injuries seen in the Alfedena burials (Fig. 3). These injuries were created by small metal or stone missiles thrown by slings. According to Lovell (1997), sharp blunt force damage can result in an internal beveled edge but typically it is sloped on one side of the endocranial opening. Missile injuries, the result of high velocity projectiles, will produce beveled edges internally at the entry site of the cranium (Lovell, 1997; Berryman and Symes, 1998) often in an angled circular pattern as the missile hits the target perpendicularly. This is the morphological characteristic seen in the injuries exhibited by the Alfedena individuals and from our point of view also shown by the Pongtecagano male example presented by Robb (1997). The archaeological evidence for the Samnites indicated the potential use of slings (Tagliamone, 1999) and we assume that they are most likely the item employed to produce these injuries, at least for the Alfedena examples.

Other comparisons

We compared our findings to several other Italian Iron Age burial populations from the sites of Fossa and Bazzano. The Fossa site yielded only two examples of cranial trauma, one adult male with a blade wound and one adult female with a depressed fracture (Miranda, personal communication). These data are included in a combined Samnite population sample (Table 3) and the demographics for this population are offered in Table 9.

The Samnite burials from Bazzano, Italy exhibit seven individuals with blunt force injuries to the cranium (Miranda, personal communication). A comparison between the Alfedena burials to the Bazzano burials show the rate of injuries is significant and the null hypothesis is rejected at the $P > 0.01$ and $P > 0.02$; male sample size and total population, respectively. The Alfedena population rate of cranial trauma is higher than the Samnite population buried at Bazzano, while the mean age at death for those with trauma at Bazzano is 8 years less.

We combined the three Samnite male populations and compared the rate of trauma for all the Samnite males to that of the Pontecagnano males. There is no statistically significant difference in the rate of trauma between these two populations (Table 3).

We also compared our finding to a medieval German skeletal population from 4 burial locations dated to 6–8th centuries A.D. (Weber and Czarnetzki, 2001). Eleven percent of these burials showed signs of cranial injury. Of the 33 individuals to show injuries to the skull, 29 of them are male. Since Weber and Czarnetzki (2001) did not report their male numbers, a comparison of the trauma rate between males is not possible. The difference in the rate of cranial injuries between these populations is not significant (male and female data are combined for both populations), $P = 0.0933$ (Table 3). The Alfedena adult population exhibits a similar rate of trauma compared to the medieval German population, whose trauma has clearly been demonstrated to be associated with warfare (Weber and Czarnetzki, 2001). The combined Samnite samples yielded the same result; the null hypothesis is not rejected (Table 3). The insight gained from these results is that a 12% frequency for cranial trauma is not an unreasonable observation for a population involved in warfare using bladed and blunted weapons.

DISCUSSION

The Alfedena remains have yielded a considerable amount of data concerning cranial trauma experienced by males. The nature of most of the injuries (specifically large blade and small projectile wounds) and their severity suggest that they were the result of interpersonal violence. The observed compressed fractures might be the result of accidents, although this seems unlikely. The argument that the high rate of extreme cranial trauma for the Samnites was caused by males of the same community does not make sense either, in light of the overwhelming biological and archaeological evidence for kin-networks among males. It seems most likely that males from rival Samnite communities inflicted these extremely violent injuries.

The cranial trauma rates between Alfedena males and females are clearly different. This considerable difference highlights the critical point that primarily males were involved in violent encounters. Young adult males and older males were just as likely to be wounded, suggesting that adult Alfedena males at anytime during their life had the potential to be involved in violent encounters (Table 3).

The trauma pattern for these individuals tells us that the blows to the head came from all directions. No one portion of the cranium is favored over another; healed and unhealed injuries are evenly placed over the entire cranium. This is interpreted to mean that fighting took place in a fashion that resulted in a randomly dispersed injury pattern.

CONCLUSION

Observations of the Samnite farmer-warriors from the site of Alfedena, Italy, have shown that the number of cranial injuries due to conflict and violent encounters were considerable, reaching a rate of 12.9%. Adult males at any period of their lives were the predominate victims of cranial trauma, and therefore, we can conclude that they were subjected to different and often violent activities compared to females.

The pattern of trauma placement on the crania suggests that blows (healed and unhealed) were randomly given during these violent encounters. The least likely location of cranial trauma was to the back of the head

which had only 8.6% occurrence. An injury pattern for a population of individuals in which blows come from all directions may reflect conflict related to the defense of communal property and not a result of ritualized warfare (Webb, 1995).

In light of the pastoral-agricultural practices, social organization, and population growth potential for the Iron Age Samnites of Italy, the violence indicated by the extreme nature of the wounds, their frequency, and lack of specific pattern occurred while males defended or attempted to acquire resources. Archaeological evidence has been critical in our assessment. The connection of burial placement to family/clan relations by Bedini et al. (1975) from well defined portions of the necropolis, the presence of similar funeral outfits associated with clan/family affiliations, and the dental data presented by Coppa and Macchiarelli (1982) for these burials has helped us to consider the social organization of this community as patrilineal, organized for the production and protection of agriculture resources. The biological homogeneity of the males has provided evidence for strong community bonds that would have been reinforced during the defense of community resources (Rubini et al., 1999).

Violence and warfare present a considerable health risk to *Homo sapiens,* of the past and to present populations; this point was made very clear by Walker (2001). He calls for paleopathologists to use their findings on past populations to create a template for understanding how the rates of trauma can provide information to evaluate the health status of modern populations subjected to violence and warfare. This is critical if our discipline is to provide insight for the health risk specific to violence seen in modern communities. One way to begin to respond to this request is to advocate global and local comparisons of skeletal injury rates among prehistoric, historic, and modern communities looking for the specific biocultural-based behaviors that produce interpersonal violence. To this regard we agree with Walker (2001). The assessment of the Alfedena population has provided insight into the sociocultural factors that shaped violence during the Iron Age period of Italy. This assessment may provide a general understanding of the health risk for present day communities engaged in small scale conflict over resources. This is clearly the activity of adult males and this activity does have a significant impact on the health of men.

With respect to the data and work provided by Robb (1997) and Robb et al. (2001), we show that human behavior and social organization is more complex and diversified during the Iron Age period of Italy than might have been expected. Bioarchaeologists should no longer generalize behavior and cultural norms for the "Iron Age peoples" of Italy. Each Iron Age community must be examined in their specific cultural-economic context; we should not expect the same behavior and health pattern to emerge for all Iron Age communities. Continued work on the paleopathological assessment of the Iron Age peoples of Italy should help to clarify this point.

ACKNOWLEDGMENTS

R.R. Paine was supported by a visiting professorship offered by Alfredo Coppa and the Università "La Sapienza" di Roma, Italy. We thank Corrado Sterpetti and the staff from the Alfedena town council for their generous help in recovering and providing the crania from Mariani's excavation of 1901. We also thank the two anonymous reviewers and the editor who offered exceptional guidance and patience during the revision process. Megan Murphy was of considerable help during the final editing of the manuscript.

LITERATURE CITED

Bedini A, Bergonzi G, Delpino Fugazzola MA, Parise Bedoni F, Piana AP, von Eles P. 1975. Alfedena (L'Aquila): Scavi del 1974 della necropoli. Atti Acc Licei, serie 8, 24:409–481.

Berryman HE, Symes SA. 1998. Recognizing gunshot & blunt cranial trauma through fracture interpretation. In: Reichs KJ, editor. Forensic osteology: Advances in the identification of human remains. Springfield, IL: CC Thomas. pp 333–352.

Bondioli L, Corruccini RS, Macchiarelli R. 1986. Familial segregation in the Iron Age community of Alfedena, Abruzzo, Italy, based on osteodental trait analysis. Am J Phys Anthropol 71:393–400.

Capasso L. 1985. Familiar relationship reconstruction in the burial "circles" of the Alfedena necropolis (Iron Age: L'Aquila, Italy) using the mobility and topographic distribution of non-malignant osseous neoplasm. OSSA 12:3–7.

Coppa A, Colarossi P, Danubio ME, Mancinelli D, Petrone PP. 1990. Aspetti paleodemografici in campioni di popolazione adulta dell'Italia Centrale durante l'Età del Ferro. Antropologia Contemporanea 13:179–191.

Coppa A, Macchiarelli R. 1982. The maxillary dentition of the iron-age population of Alfedena (Middle-Adriatic area, Italy). J Hum Evol 11:219–235.

Coppa A, Macchiarelli R, Salvadei L. 1981. Craniologia della popolazione dell'età del Ferro di Alfedena (Abruzzo, Area Medio-Adriatica). Riv Antropol 61:275–290.

Cucina A, Coppa A, Mancinelli D. 1996. Stress impact in central Italy during the Iron Age: The evidence of linear enamel hypoplasis. Dent Anthropol Newsl 10:6–9.

Cucina A, Coppa A, Mancinelli D. 1998a. Stress and mortality in protohistoric samples from Central Italy. Sci Technol Cult Heritage 7:95–100.

Cucina A, Coppa A, Mancinelli D. 2000. Life span and physiological perturbations: Assessment of demographic parameters and linear enamel hypoplasia in past populations. Homo 51:56–67.

Cucina A, Mancinelli D, Coppa A. 1998b. Demography, nutrition and stress in the Italian peninsula from the Copper Age to the Roman Imperial Age. Riv Antropol (Roma) Suppl 76:135–138.

Guo SW, Thompson EA. 1992. Performing the exact test of Hardy-Weinberg proportions for multiple alleles. Biometrics 4:361–372.

Jurmain R. 1999. Stories from the skeleton: Behavior reconstruction in human osteology. Amsterdam: Gordon and Breach.

Jurmain R. 2001. Paleoepidemiological patterns of trauma in prehistoric population from central California. Am J Phys Anthropol 115:13–23.

Larsen CS. 1997. Bioarchaeology: Interpreting behavior from the human skeleton. New York: Cambridge University Press.

Lovell NC. 1997. Trauma analysis in paleopathology. Yrbk Phys Anthropol 40:139–170.

Macchiarelli R, Salvadei L, Dazzi M. 1981. Paleotraumatologia cranio-cerbrale nella comunità protosorica di Alfedena (VI-V sec. a.C., area medio-Adriatica) Antropologia Contemporanea 4:239–243.

Mariani L. 1901. "Aufidena", ricerche archeologiche e storiche del Sannio settentrionale. Roma: Acc Naz Dei Lincei.

Martin DL, Frayer DW, editors. 1997. Troubled times: Violence and warfare in the past. Amsterdam: Gorden and Breach.

Mogliazza S, Rubini M. 2003. Biological relations in ancient population use of genetic markers of skeletons. Archivio per l'Antropologia e la Etnologia CXXXII:1–19.

Parise BF, Ruggeri GM. 1981. Alfedena. La Necropoli di Campo Consilino. Chieti.
Parise BF. 1988. Pratiche funerarie e strutture sociali nel Sannio tra il VI ed il V secolo a.C. Riv Antropol LXVI:411–420.
Robb J. 1997. Violence and gender in early Italy. In: Martin DL and Frayer DW, editors. Troubled times: Violence and warfare in the past. Amsterdam: Gorden and Breach. pp 111–144.
Robb J, Bigazzi R, Lazzarini L, Scarsini C, Sonego F. 2001. Social "Status" and biological "Status": A comparison of grave goods and skeletal indicators from Pontecagnano. Am J Phys Anthropol 115:213–222.
Rubini M. 1996. Biological homogeneity and familial segregation in the iron age population of Alfedena (Abruzzo, Italy), based on cranial discrete trait analysis. Int J Osteoarch 6: 454–462.
Rubini M, Bonafeda E, Mogliazza S. 1999. The population of east Sicily during the second and first millennium BC: The problem of Greek colonies. Int J Osteoarch 9:8–17.
Sergi G. 1900–1901. Crani umani delle antiche tombe di Alfedena. Att Soc Roma Antropol 7:41–43.
Tagliamone G. 1999. Le Armi: Lo sviluppa di una societa aristocratica; il ruolo delle armi. In: AA. VV., editors. Piceni Popolo d'Europa. Roma: Editrice De Luca. pp 112–114.
Walker PL. 1989. Cranial injuries as evidence of violence in prehistoric Southern California. Am J Phys Anthropol 80:313–323.
Walker PL. 2001. A bioarchaeological perspective on the history of violence. Annu Rev Anthropol 30:573–596.
Webb S. 1995. Palaeopathology of aboriginal Australians: Health and disease across a Hunter-Gatherer continent. Cambridge, UK: Cambridge University Press.
Weber J, Czarnetzki A. 2001. Brief communication: Neurotramatological aspects of head injuries resulting from sharp & blunt force in early medieval period of Southwestern Germany. Am J Phys Anthropol 114:352–356.
White TD. 1992. Prehistoric cannibalism at Mancos 5MTUMR-2346. Princeton: Princeton University Press.