Skeletal evidence for violent trauma from the bronze age Qijia culture (2, 300-1,500 BCE), Gansu Province, China

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ABSTRACT
This research explores how social and environmental factors may have contributed to conflict during the early Bronze Age in Northwest China by analyzing violent trauma on human skeletal remains from a cemetery of the Qijia culture (2300-1500 BCE). The Qijia culture existed during a period of dramatic social, technological, and environmental change, though minimal research has been conducted on how these factors may have contributed to violence within the area of the Qijia and other contemporaneous material cultures. An osteological assessment was conducted on 361 individuals (n=241 adults, n=120 non-adults) that were excavated from the Mogou site, Lintan County, Gansu, China. Injuries indicative of violence, including sharp- and blunt-force trauma that was sustained ante- or peri-mortem, were identified, and the patterns of trauma were analysed. Violent injuries were found on 8.58% (n=31/361) of individuals, primarily adult males. No evidence of trauma was found on infants or children. Cranial trauma was found on 11.8% (n=23/195) of the adult individuals examined. Of these, 43.5% (n=10/23) presented with severe peri-mortem craniofacial trauma. The high rate of perimortem injuries and their locations indicate lethal intent. This lethality, in addition to the fact that individuals with trauma were predominantly male, suggest intergroup violence such as raiding, warfare, or feuding. Both social and environmental factors may have contributed to this conflict in the Tao River Valley, though future systematic archaeological and paleoenvironmental data will be needed to disentangle the many potential causal factors.

1. Introduction
Violence is one of the most enduring features of human societies (Campbell, 2014a, 2014b; Martin and Harrod, 2014). It may take the form of a state monopoly on the use of force, or of acts of physical violence between individuals, or it may manifest as structural, symbolic, or other non-physical forms of violence. As many forms of violence are complex and culturally encoded, they are difficult to see in the archaeological record, though archaeologists and bioarchaeologists have begun building frameworks to examine them (Martin and Harrod, 2014; Martin et al., 2012; Redfern, 2016; Tung, 2012). The types of violence most visible to bioarchaeologists are those that result in violence-related trauma, or trauma intentionally inflicted to cause harm (Knüsel and Smith, 2013). The factors that contribute to violence are complex and are often both social and political, arising from territorial expansion, competition over resources, or ideological differences (Martin and Harrod, 2014).

This study aims to interpret the skeletal evidence of violent trauma from a site located in Gansu Province (甘肃省) belonging to the Bronze Age Qijia culture (齐家文化, (2300-1500 BCE)) and to explore impetuses for violence within Northwest China. The Qijia culture existed during a period of dramatic social, technological, and environmental change, and minimal research has been conducted on how these factors may have contributed to violence within the area of the Qijia and other contemporaneous material cultures. We first examine the traumatic lesions to see in the archaeological record, though archaeologists and bioarchaeologists have begun building frameworks to examine them (Martin and Harrod, 2014; Martin et al., 2012; Redfern, 2016; Tung, 2012). The types of violence most visible to bioarchaeologists are those that result in violence-related trauma, or trauma intentionally inflicted to cause harm (Knüsel and Smith, 2013). The factors that contribute to violence are complex and are often both social and political, arising from territorial expansion, competition over resources, or ideological differences (Martin and Harrod, 2014).

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from the terminal Neolithic to the Early and Middle Bronze Age in Northwest China (Li et al., 2009; Mao et al., 2009; Xie et al., 2009). The Qijia culture complex was widespread throughout the upper Yellow River Valley and its tributaries. Archaeological sites with evidence of Qijia occupation have been found across a wide region of the northwest Loess Plateau (黄土高原), the eastern Hexi Corridor (河西走廊), and the eastern Qinghai-Tibet Plateau (青藏高原) (Chen, 2011; Mao et al., 2009; Xie et al., 2009). The Qijia area was part of a regional system of cultural contact and the movement of people, material culture, and technology (Cheung et al., 2017; Dong et al., 2014; Eng and Zhang, 2013; Jaffe and Flad, 2018; Linduff, 1998; Liu and Chen, 2012; Shelach, 2009; Wang, 2006; Womack et al., 2017). This interaction is evidenced by the exchange of types of bronze objects (Li, 2005; Liu and Chen, 2012) and ceramics between northeastern Qinghai Province and eastern Gansu Province from 2200 BCE onward (Cui et al., 2015), and by the transmission of technology in the form of wheeled transport and advancements in metallurgy within the cultures of the upper Yellow River Valley (黄河上游) (An, 1993; Linduff and Mei, 2009). Bronze objects found at Qijia culture sites are limited to small objects and weapons rather than vessels and include knives, awls, chisels, drill bits, daggers, axes, rings, ornaments, and mirrors, as well as slag; both forged and cast objects are found (Campbell, 2014c; Xie, 1981).

All Qijia culture sites appear to reflect a sedentary lifeway, with a varying mix of agricultural and pastoral food production strategies across Qijia territory (Xie, 1981, 2002). The dominant subsistence activity of the people at Qijia culture sites was agriculture, primarily of millet, though they were also among the earliest adopters in East Asia of West Asian crops such as wheat and barley. There is also evidence of a diverse assemblage of domesticated animal species at Qijia culture sites including, but not limited to, pig, dog, sheep, donkey, and cattle (Dong et al., 2014; Xie, 1981). There is some evidence that agricultural productivity declined over the course of the Qijia period, possibly due to climate change and drought around 4000 BP, and that pastoral production increased in importance. Crop seed densities in archaeological strata decrease over time, at least in certain sites (An et al., 2010), and spatial analysis of the distribution of Qijia sites shows a southward shift from the previous period (into latitudes with greater than 400 mm rainfall) and lower settlement density (An et al., 2005). Known Qijia settlement sites are not very large, ranging from 5.3 to 7.5 ha in area.

2.1.2. The Mogou site (磨沟遗址)

The Mogou site is located in Lintan County (临潭县), Gansu Province (Fig. 1), and was excavated between 2008 and 2012 by the Gansu Provincial Institute of Cultural Relics and Archaeology (GPICRA) and the School of Cultural Heritage of Northwest University. The cemetery is located on a terrace above the southwest bank of the Tao River (洮河) and the west bank of the Mogou stream on the border of Lintan and Minxian (岷县) Counties (Xie et al., 2009). If the cemetery was used by the inhabitants of a single large settlement, that settlement has not been found yet; the possibility also exists that the cemetery was used collectively by a group of smaller settlements.

Radiocarbon dates indicate that the burial ground was in use between 1750-1100 BCE, and the material culture shows it was used first by individuals of the Qijia culture (1750-1400 BCE) and later of the Siwa culture (寺洼文化) (1400-1100 BCE) (Mao et al., 2009; Xie et al., 2009), with the two cultural horizons possibly overlapping (Zhang et al., 2014). The site covers more than 30 ha, and excavations yielded a total of 1688 graves containing approximately 5000 individuals. The vast majority of the graves belonged to the Qijia culture, with fewer than 100 tombs containing Siwa material culture. A subset of the individuals from the Qijia graves were previously analyzed by Zhao (2013). The author identified several cases of violent trauma, though the main focus of this study was population affinity (Zhao et al., 2014, 2016).

2.1.3. Burial practices at Mogou

The majority of graves excavated at Mogou are pit graves, which can be further divided into two types: vertical shaft pits and vertical pits with side chambers. The latter type is most common, comprising 70% of the graves excavated in the 2008 season (Qian et al., 2009). Many of the side chamber graves contain multiple side chambers at different depths, as well as small niches in the grave walls. Burial practices at Mogou are particularly varied and include primary and secondary interments, with graves commonly containing between two and nine individuals of different sexes and all age categories. It is evident that many of the burials underwent degrees of re-organization over time (Qian et al., 2009). Human remains were often rearranged within the grave to create space for additional interments by gathering up partial or entire skeletons and shifting them to the side. In large multiple burials, individuals are often distributed at different depths or in multiple side chambers or niches, so only small groups of bodies were buried close together, and excavators were able to identify separate individuals in most cases. Frequent commingling did occur, though it was usually restricted to a few identifiable skeletal elements. If complete commingling occurred, it usually involved the remains of infants or young children. Individuals that were completely commingled, and commingled elements, were excluded from this analysis.

The significance of these different burial practices, and of the simple shaft vs. side chamber graves, is not known. They may reflect changes through time in the complexity of Qijia burial customs. Mogou is unique in its complexity, though there is a great deal of variation in Qijia burial practices across sites, reflecting a long and varied cultural history within one material culture horizon (Xie, 1981, 2002). Vertical shaft burials dominate most Qijia cemeteries and include mostly single and double burials, with a few multiple interments (Chen, 2016). At Qijia, the Qijia type site, among other Qijia sites, the skulls of some deceased seem to have been systematically removed (Womack et al., 2017), which was not the case at Mogou. Secondary disturbed burials are common at some Qijia sites and absent at others, but became common in subsequent periods in the region (Chen, 2006). Given the complexity of Qijia mortuary practices across sites, the complexity within Mogou itself, and the large size of the cemetery, a detailed interpretation of the mortuary traditions—both in terms of their meaning within Mogou, and of their relationship to regional traditions—will have to await a systematic analysis, which is currently being conducted for the full site report by the GPICRA archaeologists.

2.2. Methods

Over the course of four field seasons from 2015 to 2018, skeletal remains excavated at Mogou were macroscopically examined for evidence of violent trauma. Only individuals from the Qijia culture were examined for this study. Skeletons were only included if the skull was present, or if more than 50% of the postcranial elements were present and at least moderately well preserved. A total of 361 individuals (n = 241 adults, n = 120 non-adults) were examined as part of this study (Table 1, Fig. 2).

Age-at-death was estimated by pubic symphysial morphology (Brooks and Suchey, 1990), auricular surface morphology (Buckberry and Chamberlain, 2002; Lovejoy et al., 1985), and sternal rib ends (Içcan et al., 1984, 1985). Age-at-death estimates for juvenile skeletal remains were obtained by assessing dental development and epiphyseal fusion (Fazekas and Kösa, 1978; Moorrees et al., 1963; Scheuer and Black, 2000; Smith, 1991). Skeletons were divided into the following age categories: fetus (perina), infant (0–1 year), child (2–11), adolescent (12–17), young adult (18–34), middle adult (35–49), and mature/old adult (50+). If an individual could not be placed into one of these specific categories, they were placed into the broad classifications of juvenile or adult. The biological sex of each adult skeleton was estimated by examining the morphological characteristics of the pelvis (if
present) or cranial nonmetric traits (Buikstra and Ubelaker, 1994; Klales et al., 2012; Phenice, 1969). Biological sex for individuals aged between 10 and 15 years was estimated using the shape and depth of the greater sciatic notch (Schutkowski, 1993), auricular surface elevation and pre-auricular sulcus presence (Bass, 2005), and distal humerus morphology (Rogers, 1999, 2009).

Only trauma that was likely the result of a violent interaction was included in this analysis. The location of traumatic injuries on the skeleton and the type of trauma (i.e. sharp-or blunt-force) can be used to determine if an injury was sustained as a result of violence. The presence of trauma to the cranium or mandible is a relatively reliable indicator of violence (Brink, 2009; Brink et al., 1998; Guyomarc'h et al., 2010; Hussain et al., 1994; Kremer et al., 2008; Martin and Harrod, 2014), as are traumatic lesions located on the palmar side of the metacarpals and manual phalanges, ribs, and cervical vertebrae (Brickley and Smith, 2006; Brink et al., 1998; Judd, 2004, 2008; Kremer et al., 2008; Kremer and Sauvageau, 2009). The types of trauma relevant to this research include sharp- and blunt-force. In this context, sharp-force trauma is an injury produced by a tool or weapon with a sharp edge, which can be either beveled or pointed. Blunt-force trauma is produced by low velocity impact with a blunt object, or the impact of a body against a blunt object or surface (Scientific Working Group for Forensic Anthropology, 2011).

Sharp-force or projectile trauma located anywhere on the body is highly suggestive of interpersonal violence (Torres-Rouff and Costa Junqueira, 2006; Walker, 2001). As such, all sharp-force injuries in this sample were considered to be the result of violence. This included ante- and peri-mortem sharp-force trauma. Assessing blunt-force trauma is more difficult. We chose to include ante-mortem blunt-force trauma to the skull as an indicator of violence as, again, it has been well established as a reliable indicator (Brink, 2009; Brink et al., 1998; Guyomarc’h et al., 2010; Hussain et al., 1994; Kremer et al., 2008; Martin and Harrod, 2014). All examples of peri-mortem blunt-force trauma to the skull were included in this analysis, as were ante-mortem depression fractures on the cranium. Individuals with evidence of multiple peri-mortem injuries to the post-cranium were also included if three or more peri-mortem fractures were present on the ribs, metacarpals, manual phalanges, or cervical vertebrae. In order to minimize the likelihood of including accidental blunt-force trauma, ante-mortem fractures to the postcranium were not included in this assessment, nor were ante-mortem fractures to the nasal bones. As a result, this study will underestimate the true prevalence of violence but will identify the individuals that very likely experienced violence.

Injuries that are violence-related are generally classified into two categories: sharp-force or projectile trauma, and blunt-force trauma. Sharp-force trauma is produced by a tool or weapon with a sharp edge, which can be either beveled or pointed. Blunt-force trauma is produced by low velocity impact with a blunt object, or the impact of a body against a blunt object or surface. The location of traumatic injuries on the skeleton and the type of trauma (i.e. sharp-or blunt-force) can be used to determine if an injury was sustained as a result of violence. The presence of trauma to the cranium or mandible is a relatively reliable indicator of violence (Brink, 2009; Brink et al., 1998; Guyomarc’h et al., 2010; Hussain et al., 1994; Kremer et al., 2008; Martin and Harrod, 2014). All examples of peri-mortem blunt-force trauma to the skull were included in this analysis, as were ante-mortem depression fractures on the cranium. Individuals with evidence of multiple peri-mortem injuries to the post-cranium were also included if three or more peri-mortem fractures were present on the ribs, metacarpals, manual phalanges, or cervical vertebrae. In order to minimize the likelihood of including accidental blunt-force trauma, ante-mortem fractures to the postcranium were not included in this assessment, nor were ante-mortem fractures to the nasal bones. As a result, this study will underestimate the true prevalence of violence but will identify the individuals that very likely experienced violence.

Table 1
The demographics of individuals examined for this study.

| Age               | Male | Probable Male | Female | Probable Female | Indeterminate | Unobsolvable | N/A | Total |
|-------------------|------|---------------|--------|-----------------|---------------|--------------|-----|-------|
| Infant            | 13   |               | 13     |                 | 14            | 28           | 65  | 361   |
| Child             | 52   |               | 52     |                 |               |              |     |       |
| Adolescent        | 11   | 7             | 23     | 4               | 1             | 14           | 55  | 73    |
| Young Adult       | 34   | 3             | 31     | 4               | 1             |              | 73  |       |
| Middle Adult      | 43   | 2             | 31     | 4               |              |              | 80  |       |
| Mature/Old Adult  | 25   | 1             | 28     | 4               | 1             |              | 59  |       |
| Adult (not otherwise differentiated) | 8 | 4 | 3 | 1 | 13 | 29 |
| Total             | 110  | 17            | 101    | 38              | 2             | 28           | 65  | 361   |

Fig. 1. Map of the location of the Mogou site, Lintan County, Gansu.
categories: intragroup (also called collective violence) and intergroup violence. Intragroup includes trauma sustained through fighting or being beaten by a spouse or a rival, as well being struck for disciplinary reasons by a family member (i.e. parents, siblings) or by another member of the community. Intergroup violence is directed outside a community, typically occurring between two or more groups of people. This includes warfare-related activities as well as raiding, feuding, and ambushes (Durrant, 2011; Martin and Harrod, 2014). Although difficult to assess through the analysis of skeletal remains, certain types and patterns of trauma are more likely to result from one kind of violence than the other. For example, sharp-force trauma is much more likely to occur as a result of intergroup violence, and nonlethal violence is more likely intragroup. Although differentiation between these two types of violence is not always achievable, we relied on the location and the type of injury present to interpret the trauma observed (Martin and Harrod, 2014; Li et al., 2012; Malik et al., 2013; Rupani et al., 2013).

If a traumatic lesion was identified, a hand lens (10x) was used to magnify the affected area so the characteristics of the lesion could be described. Traumatic injuries were examined and determined to be ante-, peri-, or post-mortem in nature (Moraitis and Spiliopoulou, 2006; Sauer, 1998; Ubelaker and Adams, 1995; Walker, 2001). The type of trauma (blunt- or sharp-force), as well as the specific location and the orientation of the injury, were also recorded. If a traumatic lesion was consistent with sharp-force trauma, the characteristics of the cut mark were then used to classify the type of blade used to inflict the trauma, according to descriptions by Lewis (2008) for knife cut marks and sword wounds, and by Alunni-Perret et al. (2005) for hacking trauma and hatchet chop marks.

When appropriate, Chi-square or Fisher’s Exact Tests were used to determine statistical significance, and significance was set at p < 0.01.

3. Results

Evidence of violent trauma was found on 8.58% (n = 31/361) of individuals examined. Adult individuals were most commonly affected, with 12.0% (n = 29/241) of the adult sample presenting with traumatic lesions (Fig. 2). No evidence of trauma was identified on the skeletal remains of the infants or children, but trauma was identified on the cranium of one probable female adolescent individual. Within this sample, a variety of traumatic injuries were observed, and many individuals suffered multiple trauma. Sharp-force trauma was identified on 54.8% (n = 17/31) of individuals with traumatic lesions. Of these, 82.4% (n = 14/17) of injuries were inflicted peri-mortem. Eight individuals that had sharp-force trauma also presented with evidence of blunt-force trauma. Traumatic injuries were found on the cranium or the postcranium of 21 male and probable male individuals (n = 6 young adults, n = 7 middle adults, n = 4 mature/old adults, n = 4 adults), and on five female and probable female individuals (n = 2 adolescent, n = 2 young adults, n = 1 middle adult). (2, N = 177) = 11.15, p < .01).

3.1. Cranial injuries

Within this sample, 292 individuals had crania that could be examined for evidence of trauma (Table 2). A total of 8.2% (n = 24/292) of individuals with crania had evidence of trauma to one or more elements of the cranium. Of the adult individuals with preserved crania, 11.8% (n = 23/195) had cranial trauma, as did one probable adolescent female individual. No evidence of trauma was found on any of the crania from infants or children. Biological sex could be estimated for 177 of the adult individuals with crania. Of the adult individuals with evidence of violent trauma on the cranium, 86.9% (n = 20/23) were adult men. The most affected individuals within this subgroup were young adults (aged 20–34 years at time of death), closely followed by middle adults (aged 35–49 years at time of death). Significantly more adult males (n = 20) than adult females (n = 3) presented with cranial trauma (χ² = 11.77, p = .000599).

Evidence of both sharp-force and blunt-force trauma to the cranium was found within this sample (Table 3). Among those with trauma, individuals with evidence of only blunt-force trauma were most common (n = 13/24). Of the individuals with blunt-force trauma, 61.5% (n = 8/13) had injuries that occurred peri-mortem, while 38.46% (n = 5/13) had injuries that occurred ante-mortem. The majority of males with any cranial trauma (n = 14/20) had peri-mortem injuries. Multiple individuals (n = 8/24) had evidence of both sharp-force and blunt-force trauma to the cranium, the vast majority of which occurred peri-mortem (n = 6/8) (Fig. 3). However, two adult males (M405:R3, M678) had evidence of ante-mortem sharp- and blunt-force trauma. One of these individuals, a young adult male (M405:R3) had evidence of two well-healed sharp-force injuries on the occipital bone in addition to an ante-mortem blunt-force injury to the posterior of the left parietal bone.

Although only four female individuals had cranial trauma, evidence of peri-mortem trauma and ante-mortem trauma were identified with equal frequency. Two of the three crania of adult females had evidence of ante-mortem blunt-force trauma, and the other had peri-mortem sharp-force trauma. No females presented with evidence of both sharp- and blunt-force trauma, or both ante- and peri-mortem trauma.

Two individuals, both adult males, presented with both ante- and peri-mortem trauma to the cranium. For instance, one young adult male (M201) presented with multiple peri-mortem penetrating injuries to the left parietal and frontal bones, accompanied by a healed depression fracture to the left aspect of the frontal bone (Fig. 4).

3.2. Maxillofacial trauma

Maxillofacial trauma was identified on 32.3% (n = 10/31) of individuals with trauma, all of whom were adults. Most of these...
Table 2
Demographic distribution of individuals with and without cranial trauma.

| Age/Sex          | Cranial trauma | No cranial trauma | Cranium unobservable | Total |
|------------------|----------------|-------------------|----------------------|-------|
| Infants          |                |                   |                      |       |
| Sex Unobservable | 12             | 1                 |                      | 13    |
| Children         |                |                   |                      |       |
| Sex Unobservable | 46             | 6                 |                      | 52    |
| Adolescents      |                |                   |                      |       |
| Male             |                |                   |                      |       |
| P. Male          | 10             | 1                 |                      | 11    |
| Female           | 7              |                   |                      | 7     |
| P. Female        | 14             | 8                 |                      | 23    |
| Indeterminate    |                |                   |                      |       |
| Sex Unobservable | 7              | 7                 |                      | 14    |
| Total            | 1              | 38                | 16                   | 55    |
| Young Adults     |                |                   |                      |       |
| Male             |                |                   |                      |       |
| P. Male          | 5              | 24                |                      | 34    |
| Female           | 3              |                   |                      | 3     |
| Female           | 22             | 7                 |                      | 31    |
| P. Female        | 2              | 2                 |                      | 4     |
| Indeterminate    |                |                   |                      |       |
| Sex unobservable | 7              | 51                | 15                   | 73    |
| Total            | 7              | 59                | 14                   | 80    |
| Mature/Old Adults|                |                   |                      |       |
| Male             |                |                   |                      |       |
| P. Male          | 6              | 29                |                      | 43    |
| Female           | 1              |                   |                      | 2     |
| Female           | 20             | 8                 |                      | 28    |
| P. Female        | 5              | 1                 |                      | 6     |
| Indeterminate    |                |                   |                      |       |
| Sex unobservable | 1              | 1                 |                      | 2     |
| Total            | 4              | 39                | 16                   | 59    |
| Adult            |                |                   |                      |       |
| Male             |                |                   |                      |       |
| P. Male          | 5              | 3                 |                      | 8     |
| Female           | 3              | 1                 |                      | 4     |
| Female           | 20             | 8                 |                      | 28    |
| P. Female        | 5              | 1                 |                      | 6     |
| Indeterminate    |                |                   |                      |       |
| Sex unobservable | 13             | 1                 |                      | 14    |
| Total            | 5              | 23                | 2                    | 29    |
| Grand Total      | 24             | 268               | 71                   | 361   |

individuals (n = 9/10) also had evidence of cranial trauma. The vast majority of the maxillofacial trauma identified in this sample occurred peri-mortem (n = 8/10). All eight individuals with peri-mortem maxillofacial trauma suffered extensive damage to the splanchnocranium, and four of these individuals suffered multiple peri-mortem fractures that included blunt-force trauma. Two adult males (M1133:R1, M133:R1) had peri-mortem sharp-force injuries to the superior orbital margin of the frontal bone, in addition to extensive peri-mortem fractures to multiple facial elements. These were likely the result of blunt-force trauma. Individual M133:R1 presented with a horizontal maxillary fracture that extended through the anterolateral margins of the nasal fossa and through the inferior wall of the maxillary sinus. This fracture had caused the maxillary teeth to fracture away from the upper face. This classic Le Fort type I fracture was also identified on two other adult male individuals (M248, M1417:R2). Typically, Le Fort type I fractures are created by forces directed at the midface from straight on, but can also be the result of high-speed deceleration crashes where the midface strikes an object (Le Fort and Tessier, 1972; Phillips and Turco, 2017). M133:R1 also exhibited a Le Fort type III fracture, which resulted in craniofacial disjunction. There was complete transverse separation of the nasofrontal suture and the lateral orbital walls, pterygoid processes, and zygomatic arches. The medial maxillary, lateral maxillary, upper transverse maxillary, and posterior maxillary buttresses were also fractured.

Both sharp- and blunt-force trauma were present on individual M448:R3. A sharp-force injury was present on the left maxilla that extended along the axial plane immediately inferior to the nasal fossa and onto the mandible (further discussed below). This individual also sustained several blunt-force injuries to the frontal bone, immediately superior to the orbits, and to the right and left maxillae. The anterior nasal spine completely fractured away, and the damage to the surrounding maxillary bones suggests that repeated blows were sustained.

Three individuals (M295:R5, M366:R4, M448:R3) had evidence of peri-mortem sharp-force trauma to the mandible. M295:R5 also presented with mandible fractures, likely the result of blunt-force trauma, which caused the mandible to separate into four fragments. Three additional adult male individuals (M132:R2, M248, M1229) presented with anti-mortem fractures to the mandible. In all these cases, the left aspect of the mandible was affected.

Traumatic dental injuries were identified on three young adult males (M248, M448:R3, M1417:R2). In these cases, multiple teeth were fractured peri-mortem below the alveolar margin. The presence of splintering on the lingual surface of the alveolar margin, the presence of sharp margins on the fractured tooth root, and the coloration of the remaining root indicate that these fractures occurred peri-mortem. For instance, on the mandible of one young adult male (M448:R3), several teeth on the left side of the mandible, as well as the surrounding alveolar bone, were fractured (Fig. 5). The resultant trauma appears to have been caused by a bladed weapon that progressed from the anteromedial to the posterolateral aspect of the left mandible. There are also two sharp-force injuries to the right ramus of M448:R3. Similarly, there

Table 3
Demographic distribution of individuals with the different kinds of cranial trauma and stage of healing.

| Age/Sex          | Sharp-force | Blunt-force | Both | Total |
|------------------|-------------|-------------|------|-------|
|                  | Ante-mortem | Peri-mortem | Ante-mortem | Peri-mortem | Ante-mortem | Peri-mortem |      |
| Adolescent       |             |             |      |       |
| P. Female        |             |             | 1    |       |
| Young Adult      |             |             |      |       |
| Male             |             |             | 1    |       |
| Female           |             |             | 1    |       |
| Middle Adult     |             |             | 1    |       |
| Male             |             |             | 1    |       |
| Female           |             |             | 1    |       |
| Mature/Old Adult |             |             | 1    |       |
| Male             |             |             | 1    |       |
| Adult            |             |             | 1    |       |
| Grand Total      | 1           | 2           | 5    | 8     | 2           | 6          | 24   |
is evidence of sharp-force trauma to the anterior portion of the maxilla and maxillary teeth of individual M248. The location of the trauma on both of these individuals indicates that the attacker was facing the victim when the weapon strike occurred.

3.3. Postcranial trauma

Postcranial trauma that was likely the result of violence was identified on 4.0% (n = 11/272) of the individuals with postcranial elements preserved (Table 4). Each of these cases was peri-mortem. The majority of these traumatic lesions on the postcranial skeleton were classified as sharp-force trauma (n = 8/9/11). It is worth noting here that individuals that presented only with ante-mortem postcranial fractures were not included in this study. More males (n = 9) than females or probable females (n = 2) had violent trauma present on the postcranium. Injuries were identified on the upper arms of two

Fig. 3. Cranium of an old adult male (M1133:R1) with sharp-force trauma to the right parietal bone and blunt-force trauma affecting the right aspect of the frontal bone and greater wing of the sphenoid. Points of impact indicated by arrows. Photographs by Jenna Dittmar.

Fig. 4. Multiple peri-mortem trauma present on the left parietal and frontal of an adult male cranium (M201). Photograph by Jennifer Austen.
individuals, on the vertebral column of four individuals, and on the lower limbs of two individuals. One individual presented with multiple peri-mortem fractured ribs and another individual suffered multiple injuries to axial and appendicular skeletal elements. Five individuals, all adult males, had evidence of trauma to both the cranial and postcranial skeleton.

Sharp-force trauma in locations that are consistent with defensive injuries were identified on two young adult males, who also had peri-mortem trauma to the cranium, as well as on one adult female individual. Multiple defensive injuries were present on one young adult male individual (M448:R3), who presented with a peri-mortem sharp-force injury to the posterior aspect of the proximal ulna and to the posterior aspect of the distal right humerus (Fig. 6). The other individual (M248) had peri-mortem injuries on the posterior aspect of the distal left ulna which affected the inferior articular surface. The middle adult female (M1550:R3) had a peri-mortem blade-inflicted injury to the anterior aspect of the proximal right humerus.

### 3.4. Weapons

Based on the characteristics of the sharp-force injuries, multiple types of weapons were used in the violent encounters that caused these injuries. Bladed weapons accounted for the majority of the trauma found on both the cranial and postcranial skeletons, and an examination of the entry wounds revealed evidence of at least three different bladed weapons. The linear incisions identified on the majority of the individuals with sharp-force trauma (n=17) were inflicted by a thin-bladed weapon, such as a sword or large dagger. In addition, the observed narrow, linear ‘V’-shaped incisions with even walls most closely resemble traumatic lesions created by a sharp knife or a hand axe: sword marks are wider, deeper, and associated with damage to the walls of the lesion (Lewis, 2008), while the cross-sections of knife marks generally have smooth walls in a characteristic ‘V’ shape (Greenfield, 1999). Finally, a number of triangular-shaped incisions inflicted by a bladed weapon were identified on the cranial vaults of two individuals (M248, M448:R3) (Fig. 7).

The injuries inflicted on the individuals buried at Mogou might have been created by axes, daggers, or knives made of stone or bone. Alternately, they may have been created by something like the bronze ge (戈) dagger-axes or qi (鍙) hatchets that have been found in central China from the Bronze Age (Hong, 1992), or the bronze fu (斧) hatchets that have been found at Qijia sites. The fu hatchets are similar to those found in Western Asia and may have influenced the bronze weapons of the Shang and Zhou Dynasties (Liu, 2009). Most bladed weapons from this time in North China were short and suitable for hand-to-hand combat, rather than combat mounted on horseback.\(^1\)

Fig. 6. Defensive sharp-force injury to the posterior aspect of the proximal ulna on a young adult male (M448:R3). Photograph by Jenna Dittmar.

One young adult male (M448:R3) presented with multiple circular puncture wounds and resultant radiating fractures that affected the right scapula and both femora. This individual also had cranial and defensive injuries (see above). The penetrating injuries were circular combat, rather than combat mounted on horseback.\(^1\)

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\(^1\)Horses are present in Qijia contexts, but were almost certainly not ridden: horses make up a very small portion of the animal remains from Qijia culture contexts and were likely hunted for meat, bone, or use in ritual sacrifice (Tie, 2015). Wild horses may have migrated into the region as the climate shifted, and the Qijia culture was, at most, in the very early stages of domesticating horses (Flad et al., 2007; Liu, 2009; Shelach, 2009; Tie, 2015).

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### Table 4

| Demographic Distribution | Postcranial trauma | No postcranial trauma | Postcranial skeleton unobservable | Total |
|--------------------------|--------------------|-----------------------|----------------------------------|-------|
| **Infants**              |                    |                       |                                  |       |
| Sex Unobservable         | 6                  | 7                     | 13                               |       |
| **Children**             |                    |                       |                                  |       |
| Sex Unobservable         | 35                 | 17                    | 52                               |       |
| **Adolescents**          |                    |                       |                                  |       |
| Male                     |                    |                       |                                  |       |
| P. Male                  | 11                 | 11                    |                                  |       |
| Female                   | 7                  | 7                     |                                  |       |
| P. Female                | 21                 | 1                     | 23                               |       |
| Sex Unobservable         | 14                 | 14                    |                                  |       |
| Indeterminate            | 1                  | 1                     |                                  |       |
| Total                    | 1                  | 46                    | 8                                | 55    |
| **Young Adults**         |                    |                       |                                  |       |
| Male                     | 3                  | 28                    | 34                               |       |
| P. Male                  | 3                  | 3                     | 3                                |       |
| Female                   | 27                 | 4                     | 31                               |       |
| P. Female                | 4                  | 4                     | 4                                |       |
| Indeterminate            | 1                  | 1                     |                                  |       |
| Sex unobservable         | 1                  | 1                     |                                  |       |
| Total                    | 4                  | 55                    | 21                               | 80    |
| **Middle Adults**        |                    |                       |                                  |       |
| Male                     |                    |                       |                                  |       |
| P. Male                  | 3                  | 34                    | 43                               |       |
| Female                   | 1                  | 17                    | 31                               |       |
| P. Female                | 1                  | 2                     | 4                                |       |
| Indeterminate            | 1                  | 1                     |                                  |       |
| Sex unobservable         | 1                  | 1                     |                                  |       |
| Total                    | 4                  | 50                    | 6                                | 59    |
| **Mature/Old Adults**    |                    |                       |                                  |       |
| Male                     |                    |                       |                                  |       |
| P. Male                  | 3                  | 29                    | 25                               |       |
| Female                   | 1                  | 1                     | 1                                |       |
| P. Female                | 25                 | 3                     | 28                               |       |
| Indeterminate            | 3                  | 1                     | 4                                |       |
| Sex unobservable         | 1                  | 1                     |                                  |       |
| Total                    | 4                  | 50                    | 6                                | 59    |
| **Adult**                |                    |                       |                                  |       |
| Male                     |                    |                       |                                  |       |
| P. Male                  | 4                  | 4                     | 8                                |       |
| Female                   | 1                  | 3                     | 4                                |       |
| P. Female                | 3                  | 3                     | 3                                |       |
| Indeterminate            | 1                  | 1                     |                                  |       |
| Sex unobservable         | 1                  | 12                    | 13                               |       |
| Total                    | 6                  | 23                    | 29                               |       |
| **Grand Total**          | 11                 | 261                   | 89                               | 361   |
and were approximately 1.3 cm to 1.5 cm in diameter. As their diameter varied slightly between the injuries, it is possible that they were created by a sharp, conical object such as a conical stone arrowhead with a circular profile. However, no evidence of circular stone arrowheads has yet been reported from the Bronze Age in this region, and the arrowhead would have been rather thick at the base to create this lesion. An alternative possibility is that these injuries were created by a bronze awl. Awls have been uncovered at Qijia sites and it is possibly that an awl or a similar tool could have been employed as a weapon (Hong, 1992). However, the awl would have to be quite long and large in diameter to create these injuries. Finally, these injuries could have potentially been made by the sharpened end of a weapon shaft made of biodegradable material, as Qijia did have shafted weapons (Liu, 2009; Zhang, 2003).

The crania of two adult individuals presented with circular lesions that were caused by a weapon with a blunt, circular striking surface (M344:R3, M248) (Fig. 8). The impact of this weapon resulted in internal beveling at the point of impact on the endocranial surface. The radiating fractures from the location of the impact suggest that this weapon was wielded with substantial force. Evidence of this type of weapon was found only on the cranium. No weapons with a circular blunt surface have been identified, but again, some Qijia weapons, such as hatchets, would have been fixed to a haft. The hafts might have had circular butts that could cause this contusion if applied with force (Zhang, 2003). The lesion could also have been caused by a tool, such as the circular bone handle of an awl, being used as a weapon (Fig. 9).

4. Discussion

4.1. Intergroup conflict versus intragroup violence

The presence of peri-mortem blunt- and sharp-force trauma, in addition to extensive peri-mortem maxillofacial trauma, on the individuals described above is consistent with injuries sustained during hand-to-hand combat. The damage patterns identified on the facial bones of several individuals are consistent with multiple strikes to the face with a blunt object or the forceful, and likely, repetitive movement of a skull against an immobile object, or possibly the ground. This interpretation is further supported by the presence of defensive wounds on the postcranial skeletons of five individuals who also had evidence of peri-mortem cranial trauma. The presence of ante- and peri-mortem injuries on the same individuals (n = 2), including trauma caused by bladed weapons, suggests that these encounters occurred repeatedly. The predominance of lethal outcomes as a direct result of violence (77.42%, n = 24/31) within the Mogou site suggest that members of this community were engaged in conflicts in which a lethal outcome was the goal.

Consistent with much of the archaeological and clinical literature, the majority of both ante-mortem and peri-mortem violent injuries documented in this sample were found on adult males. This suggests that males were more likely to participate in and be the victims of violence. The pattern of the observed injuries combined with the male-skewed demographics and the patterns of the traumatic injuries on these individuals provide compelling evidence to support an interpretation of intergroup violence, which encompasses warfare, raiding, feuding, and ambushes (Durrant, 2011). Each of these activities could potentially provide an explanation for the traumatic injuries observed.

The location and pattern of the trauma on the skulls could be explained by hand-to-hand combat that occurred as part of a skirmish with another group. Warfare during this period would have been small-scale. Alternatively, raiding and feuding could also lead to lethal outcomes. Black (1983) defines feuding as an extended period of back and forth killings, where one death generally occurs at a time (Black, 1983). Feuds tend to occur between groups that are relatively homogeneous in ethnicity, are similar in size and have similar resources, and are isolated from one another (Black, 2004). Similar to warfare, both raiding and feuding are typically organized and conducted by groups, or coalitions, of adult males. These coalitions bring males together to conduct raids, as well as to protect their own community from other groups (Kelly, 2005). As there are a number of known Qijia culture settlements within the Tao River Valley, each of these activities could potentially offer an explanation. It is also likely that the violence at Mogou took place over a long period of time and on repeated occasions, as evidenced by the
fact that some individuals had suffered both ante-mortem and peri-mortem injuries, and the fact that the burials in which violence was identified likely came from different periods of occupation of the site. Though not all of the burials have been individually sequenced at this time (this analysis is ongoing by GPicra), the individuals who suffered violent trauma come from throughout the number sequence of graves at Mogou, meaning that they do represent different phases of occupation.

The lack of violent trauma on the skeletons of the non-adults and females at the Mogou site could be indicative of a type of warfare and raiding in which the abduction of females and children was the goal. Raids of this kind often leave the males of the community dead, and the females and children taken as captives (Cameron, 2013; Patterson, 1982). Violence against females in the form of raiding and captivity has been documented in several early pre-state populations (Cameron, 2008). Further evidence to support this theory is the fact that so many individuals with peri-mortem injuries were interred in primary burials at Mogou. This indicates that the encounter, or encounters, happened near enough to the settlement for the remains of the dead to be recovered.

The patterns of the observed trauma and the demographic distribution of trauma victims at Mogou are inconsistent with nonlethal intragroup violence, such as domestic violence, punishment, or ritual violence used as a form of social control (Martin and Harrod, 2012, 2014). It must be acknowledged that interpreting the motivations behind past violence is not always possible, and thus it can be very difficult to differentiate between intragroup and intergroup conflict in past societies. This is further complicated by the fact that intragroup and intergroup violence can coexist within a given society. Further analysis of intergroup violence at Mogou will therefore have to await the discovery and excavation of an associated settlement, related findings of violence in other contemporaneous cemeteries in the Tao River Valley, or the future detailed sequencing of the Mogou graves, which may reveal temporal changes in violence in the population.

### 4.2. Violence across Bronze Age Northwest China

The presence of violent trauma at Mogou is consistent with some archaeological evidence for conflict throughout the Qijia culture complex area. For instance, the Lajia site (喇家遗址), an early Qijia culture site (2200-1900 BCE) in Qinghai province, was encircled by a defensive ditch (Wang, 2017). However, during the later occupation of the site, the ditch was no longer used and was built over (Yu et al., 2017; Zhang, 2014). By consulting the available published data on Northwestern Chinese populations, which are still somewhat scant, we have concluded that the frequency of violent trauma at Mogou is substantially higher than that of most other skeletal assemblages from this time and region, and was more lethal (Table 5).

The late Bronze Age Siwa culture (1400-700 BCE) site of Xujianian (徐家碾) in Zhouchang County is located in eastern Gansu on the Loess Plateau, the region where Mogou is also located. At Xujianian, only one out of 61 skeletons that were examined showed signs of trauma. This was a humeral fracture, and there were no cases of apparent violent trauma (Wang, 2006). This is clearly a much lower prevalence of violence than at Mogou. It will be interesting in future research to examine the Siwa burials from Mogou to determine whether the frequency of violent trauma declined from the Qijia into the Siwa period.

In nearby eastern Qinghai, at the middle Bronze Age, sedentary agricultural Xindian culture (辛店文化) site of Xiaohandi (小旱地) (1500-1000 BCE), only two out of 44 skeletons showed evidence for trauma (4.55%) (Berger, 2017). One was an ante-mortem depressed skull fracture overlying the left coronal suture, and one was an ante-mortem left ulnar fracture. Since the ulnar fracture could represent a defensive wound, these injuries could indicate interpersonal violence. However, they were both found on adult females, and were nonlethal, so they do not specifically suggest combat with lethal intentions.

Also in eastern Qinghai, the later Shangsunjiazhai site (上孙家寨遗址) belongs to the middle Bronze Age Kayue culture (卡约文化) (1600 BCE-600 BCE). The people at Kayue sites seem to have followed a mixed economy, with a greater emphasis on pastoralism than at contemporaneous Xindian and Siwa sites, and sites generally found at higher altitudes (Xie, 2002). At Shangsunjiazhai, 11 of 211 crania, or 5.2%, exhibited violent trauma (Han et al., 2005). All were young and middle adults. Nine of the 11 cranial belonged to male individuals, five were blunt trauma and seven were sharp trauma, four individuals suffered multiple traumatic lesions, and eight of the 11 experienced peri-mortem and three ante-mortem injuries. This is a very similar profile to the trauma observed at Mogou, and the overall prevalence of violent trauma is not significantly different ($\chi^2 = 1.3787$, p = 0.2403).

In the semi-arid Hexi Corridor of Gansu, the early Bronze Age Siba culture (沙井文化) site of Huoshaozou (火烧沟), contemporaneous with Mogou, only had one case of trauma, a possibly perimortem depressed skull fracture on an adolescent female. This amounts to a cranial trauma rate of about 2% (1/49), substantially lower than that of Mogou (Berger, 2017). While the postcranial remains from this site are somewhat fragmentary, the preservation of the crania is about equivalent to that of Mogou. Once again, the presence of possible nonlethal violence committed against a female individual would be more consistent with domestic violence or another form of intragroup violence for social control than with intergroup violence with lethal intent. Also in the Hexi Corridor, the late Bronze Age Shajing culture (沙井文化)
cemeteries of Hamadun (蛤蟆墩) and Xigang (西岗), though they were associated with a fortified settlement, showed no evidence for violent trauma in any of the 50 skeletons examined (Berger, 2017).

One significant limitation of this comparison is that different standards of observation and recording, as well as different levels of preservation, could impact the frequency of trauma observed at different sites. In addition, data on trauma from this region and period are still limited, though publications in paleopathology are increasingly produced in China. The Chinese bioarchaeology literature does include additional data on trauma in skeletal series from other time periods and regions, however, these are less relevant to the interpretation of violence at Mogou.

### 4.3. Violence and climate change

Within the literature the archaeological cultures of northwest China, one of the often-cited explanation for intergroup violence is resource scarcity, especially in the context of climate change. This “climate-conflict” model (Harrod and Martin, 2014) relies on multiple assumptions, including: 1) that climate change corresponded to a scarcity of resources, and 2) that humans respond to scarcity by competing for resources through violent conflict. Although many studies have identified a relationship between increased levels of violence and climate change (see Zhang et al., 2011), this relationship is far from straightforward. As a result, most of the arguments that attempt to explain the relationship between climate change and violence rely on an environmentally deterministic approach that leads to over-simplistic interpretations of cultural, economic and political changes (Shaffer, 2017). Many modern and ancient cases demonstrate that human societies have a wide range of responses to resource scarcity. For instance, see Di Cosmo et al. (2018) on the pastoralist Uyghur Empire’s non-violent response to a nearly unparalleled drought event. In the human past, as in hopes for the human future, it seems violence, while sometimes correlated with climate change events, is not the inevitable outcome (Harrod and Martin, 2014; Shaffer, 2017).

In the case of Northwest China, the climate-conflict model may have some merit, as North China was one of the regions impacted by climate change and drought around 2000 BCE (An et al., 2005; Han, 2008; Hou et al., 2012; Madsen and Elston, 2007). However, it still remains for us to demonstrate how climate change translated into violence in the particular time and place of Mogou. Just within the narrow geographic and temporal range of the bioarchaeological studies cited in the previous section, there are varying levels and types of violence. This clearly demonstrates that local social, political, and economic conditions, as well as connections to regional processes, contribute to levels of violence. Rather than pointing to the climate-conflict model, the evidence from Bronze Age Northwest China points to Harrod and Martin’s (2014) own proposed model of the relationship between violent conflict and climate change. They term this model the Biocultural Model for Multicausal Pathways to Increased Violence. The model essentially acknowledges that rather than a straight line from climate change to conflict, there is a complex interaction of factors such as environment degradation, social fragmentation, inequality, and migration, along with climate change, that lead to violent conflict.

Though much of the archaeological literature on the Qijia period comprise of typological analyses of material culture, Harrod and Martin’s multicausal process can be glimpsed in some of the data that are available. For instance, using a spatial analysis of known Majiaoyao (马家窑) (late Neolithic) and Qijia sites, Hou et al. (2012) found evidence of changes in site distribution that may have social significance. They found that, compared to the previous period, Qijia sites are distributed farther south, tend to be located slightly farther from rivers, are not as densely distributed, and have multiple dense regions of settlement rather than a single core area. The authors interpret these changes to mean that people in the Qijia period were less reliant on agriculture than their predecessors, engaged in some herding...
(supported by the presence of sheep at Qijia sites), were forced southward into areas with greater precipitation to maintain their agricultural productivity, and had a more dispersed and possibly competitive political structure. They speculate that the presence of multiple competing sites or site clusters, as well as declining agricultural productivity, may have led to intergroup violence or warfare. They also refer to the reported discovery of Qijia burials with missing crania or other elements (Xu and Ge, 1981), though it is unclear if this was the result of violence or of secondary burial and disturbance of remains.

Additionally, we must be precise when talking about the impact of climate on a specific site or locale. Regional data show that there was a climate shift from wet to dry conditions at c. 2000-1800 BCE in the Western Loess Plateau (An et al., 2003; Li et al., 1993). Density of domestic flora in archaeological strata, combined with the above-mentioned analysis of site distribution, suggest that this climate change event corresponded to a reduction in site density and a movement to lower latitudes during the Qijia period, along with a shift from sedentary agriculture towards mixed agropastoralism (An et al., 2005, 2010; Hou et al., 2012). Though these conclusions are necessarily preliminary until systematic survey data are available, and a larger quantity of plant and animal remains have been quantitatively analyzed, they are suggestive of resource scarcity or a need to shift subsistence activities.

However, Mogou was primarily in use during a period that, at least in other parts of North China, constituted a warm local maximum in the midst of a longer cold and dry spell. Groups in the region were developing an increasingly diverse and resilient subsistence economy (Han, 2008). Bioarchaeological evidence, though still limited, has not demonstrated acute resource shortages elsewhere in Northwest China (Berger and Wang, 2017). Resource scarcity has also not been definitively demonstrated at Mogou: though metabolic diseases are present, these are not adequate to diagnose agricultural shortfalls.

Future research on local environmental conditions and economic practices may reveal a more proximate cause for the violence at Mogou, which may or may not be linked to an ultimate cause of climatic or environmental change. In any case, violence is not simply or directly caused by sociopolitical complexity, sedentism, or economic mode (Harrod and Martin, 2014; Redfern, 2016). The factors that caused the people of Mogou to experience more intergroup violence than others are likely multiple, interconnected, and complex.

Finally, the regional-scale processes of social change taking place in China in the Bronze Age are a compelling explanatory model for the violence at Mogou, with or without reference to climate change. In addition to sharing recent ancestry with some other groups in North China (Gao et al., 2015; Zhao et al., 2014), the people associated with the Qijia material culture complex also shared some material culture and technology, as well as elements of cultural identity, with other groups in the region. It is clear that the people of the Qijia culture were part of a growing web of cultural contact and exchange across China and even the rest of Inner Asia (Liu, 2009), and long-range contact with the Eurasian steppe was evident by the very end of the Qijia period (Shelach, 2009).

Though traditional archaeological research in China has focused on the formation of complex state-level societies in the Central Plains, a new picture of early complex society in China has begun to emerge in the last few decades. It seems that during the late Neolithic and early Bronze Age, during the end of the third and the first half of the second millennia BCE, and contemporaneous with Qijia, areas both within and outside the Central Plains were home to a network of independent, powerful, interconnected polities. These were characterized by instability, long-distance trade, and large fortified settlements that may have controlled areas of up to 2000 sq km (Shelach and Jaffe, 2014), and had far-reaching economic and political power (Jaang et al., 2018; Jaffe and Flad, 2018). These include not only the Erlitou site (二里头遗址) of the middle Yellow River Valley, sometimes associated with the legendary Xia Dynasty, but also, at various times, the sites of Liangchengzhen (两城镇遗址) in Shan dong, Taosi (陶寺遗址) in Shanxi, and Shimao (石峁遗址) in the Ordos region (see also Jaang et al., 2018; Sun et al., 2018).

Although these subregions were in contact with one another, they remained politically independent for at least most of the period under consideration here. ... (R)elatively unstable regional states arose during Longshan [3000-1900 BCE], continuing throughout the Erlitou period [1900-1500 BCE]. These regional states underwent cycles of rise and decline, each peaking at a different time and representing different combinations of leadership and legitimation strategies (Shelach and Jaffe, 2014).

Unfortunately, the settlement associated with Mogou has not yet been identified or excavated, so nothing is known about the site structure. Regional spatial analyses also have not revealed a major fortified center within the Qijia culture area. However, it is clear that Qijia existed within a period of increasing social complexity, centralized control of resources, and ever longer-distance trade and competition. Furthermore, the asynchronous rise and fall of these Bronze Age polities is probably not directly attributable to the climate change event around 2000 BCE. Around the time of the event, population declined in some places but increased in others (Shelach and Jaffe, 2014).

A number of models have been proposed to theorize the link between climate change and social complexity or social change. Liu and Chen (2006) propose that control of elite goods allowed Central Plains polities to achieve state-level complexity. Wu and Liu (2001) suggest that climate change prevented the societies outside the Central Plains from achieving state-level complexity. They propose that climate change led to migration into the Central Plains, which in turn led to environmental circumscription (after Carneiro, 1970) and drove the development of a state (the legendary Xia Dynasty, or archaeological Erlitou culture) in the Central Plains. By contrast, Hou et al. (2012), similar to Brooks (2006) and Issar and Zohar (2007), propose that climate was the very driver of increasing complexity in the “ peripheral” parts of China, such as the Northwest.

Along with the rise of states and increasing regional complexity, it seems that as the Chinese state emerged and grew in power, both client relationships and violent conflicts arose with groups on the periphery (Shelach, 2009). In the late Bronze Age and Iron Age, the groups most at risk for violence were those living outside the direct administrative control of the Chinese empire, both through conflict with the Chinese and with each other. In the early centuries of Chinese imperial power, during the occupation of the late Shang capital at Anyang (1250-1050 BCE), an astounding 12,000 people were ritually sacrificed for burial in the royal tombs, a number of victims confirmed by both archaeological and textual records (Barfield, 1989; Campbell, 2014a; Cheung et al., 2017; Eng, 2007; Eng and Zhang, 2013). Intriguingly, recent isotope work has suggested that many of these sacrificial victims were millet farmers from Western China, not far from Mogou (Cheung et al., 2017). The burials at Mogou predate those at Anyang by only a few hundred years at most, and even if their enemies were not as far away as the Shang capital, they may already have been experiencing the effects of increasing political complexity and intergroup contact.

Further detailed bioarchaeological studies of violence in the Bronze Age of Northwest China will clarify the patterns of conflict as well as their causes. Finally, in addition to the lack of settlement context, a weakness of the current study is the fact that the large quantity of mortuary and material culture data from the Mogou excavation are still being analyzed. Until the burial goods have been thoroughly cataloged and studied, the precise temporal sequence of the graves cannot be known. At present, it is only known which areas of the cemetery approximately correspond to the early, middle, and late periods of occupation. Furthermore, while some of the Siwa period graves have been analyzed and published (Mao et al., 2014; Yin, 2014), we cannot be certain that some of the supposedly Qijia period graves will not be found to belong to the subsequent Siwa period when the full analysis is completed.
5. Conclusion

The lethal intent of these violent encounters, combined with the male-skewed demographics of the individuals that were presented with trauma, provides compelling evidence to support an interpretation of intergroup violence, which encompasses warfare, raiding, feuding, and ambushes (Durrant, 2011). The co-occurrence of ante- and peri-mortem trauma suggests that repeated instances of violence were experienced by some individuals within this society. Due to the limitations surrounding the phasing of the site, it is not yet possible to determine how many violent encounters may have caused these instances of trauma, or whether they were concentrated during a particular phase of the site.

Intergroup conflict between Chinese civilization and the groups on its periphery would eventually become an intrinsic part of the worldview of the Chinese state, and the cases at Mogou may be some of the earliest instances of this emerging regional conflict, or of conflict between the people of Mogou and other local groups. The role that climate change may have played in this intergroup conflict remains to be clarified as more archaeological data become available. The violence at Mogou should be interpreted within the context of the growing body of bioarchaeological data from the region, as well as the rich archaeological context of China. This and future research will help us begin to untangle the threads of power, economy, ecology, and ideology that contributed to shifting rates of violence throughout Chinese history and prehistory.

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