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# BONES OF COMPLEXITY

Bioarchaeological Case Studies of  
Social Organization and Skeletal Biology

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## 7

## Health Status and Burial Status in Early China

EKATERINA PECHENKINA, MA XIAOLIN, AND FAN WENQUAN

It might seem indisputable that the status of an individual in his or her community can have a significant impact on that person's general well-being, especially in complex societies. Social status is often a significant determinant of access to resources and may therefore be expected to influence such quotidian phenomena as nutrition and the quality of diet. Social status is also likely to influence the degree of involvement in strenuous labor, which in turn defines mechanical stress on the musculoskeletal system, which affects the progression of degenerative joint diseases and the likelihood of traumatic injuries (Bennike et al. 2005; Bielicki and Welon 1982; Brabin and Brabin 1992; Goodman et al. 1987; Reddy 1993). Levels of psychological stress—likewise strongly affected by an individual's standing in their community—can exert a nearly holistic control over human physiology and mediate the functioning of the immune system, thereby shaping an individual's susceptibility to various infectious diseases (Kaplan et al. 1991; Rhen and Cidlowski 2005, 1714; Sapolsky 2004; Sapolsky and Share 1994). Thus, skeletal evidence of deficiency, infectious disease, and traumatic injury may be generally expected to vary in accordance with social status.

Notwithstanding this logic, a plethora of bioarchaeological research on the correspondence between social status and health in the human past has discovered little clear evidence of such simple co-variation (Cucina and İşcan 1997; Knüsel et al. 1997; Palkovich 1984; Powell 1991; Robb et al. 2001; Tung and Del Castillo 2005). Two main reasons for the lack of congruence between status and human health in the past are apparent. First, the relationship between funerary and the social status of a buried individual may be more complex than we realize. While social status has certainly been shown to affect burial construction and influence the selection of associated grave goods, many other factors are also known to bear on those deci-

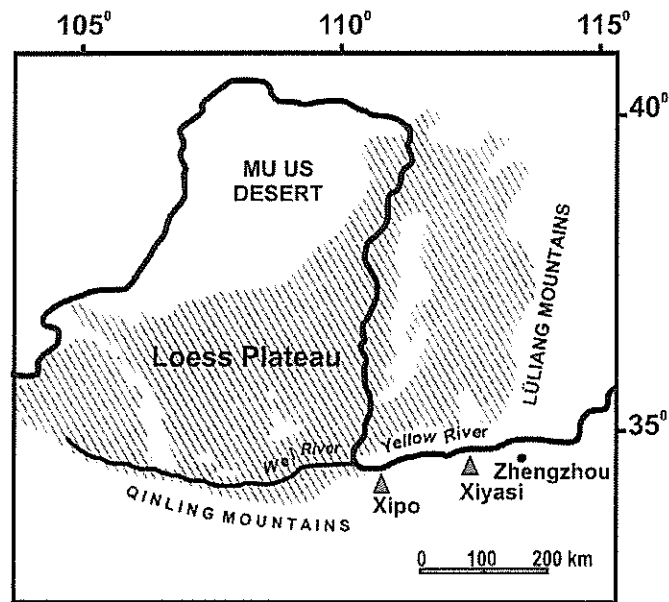


Figure 7.1. Location of Xipo and Xiyasi archaeological sites. Drawing by Kate Pechenkina.

sions, including changes in fashion, competition among the living for both status and control over territory, and the age, sex, number of children, and occupation of the deceased (Binford 1971; Buikstra 1995; Goldstein 1981; O'Shea 1984:36; Saxe 1971). Second, biological stress markers found on the skeleton may sometimes be indirect or circuitous reflections of health status (Robb et al. 2001). Certain life events may have a greater effect on skeletal health than others, while the overwhelming majority of diseases leave no trace on the skeleton at all. Thus, in bioarchaeological research in general—and for the purposes of this study specially—we focus specifically on correspondences between burial status and skeletal health.

In this chapter, we report on the relationship between funerary elaboration and health status based on the examination of skeletal collections recovered at cemeteries dating to two distinct periods in the Chinese past (Fig. 7.1). First, we characterize a skeletal series from Xipo (西坡), a large Middle Neolithic site in Henan Province that is attributed to the Middle/Late phase of Yangshao culture (4000–3000 BC). The material from Xipo is one of the earliest known assemblages from the region for which some form of status differentiation is suggested by an unequal distribution of funerary goods among the burials. Roughly contemporaneous smaller sites

from the same area (e.g., Guanxia) present evidence of minimalist ritual; small objects, such as personal jewelry as burial goods, are only rarely included. Second, we consider skeletal material from the Xiyasi (西亚斯) site, a state-level stratified society dating to the terminal phase of the Bronze Age during the Eastern Zhou dynasty (770–221 BC). We compare evidence of the relationship between burial complexity and health status in early societies with limited regional political hierarchy and little archaeological evidence of status heterogeneity to that pertaining to an early state-level polity in which hereditary social hierarchy was already well established and far more distinct. Through these comparisons, we test whether increasing social inequality and establishment of hereditary political hierarchies led to an increased heterogeneity in the health of local populations from early China.

### Methods and Data

Multiple attributes of funerary contexts were used to assess the social status of an individual, including the size of the burial, the complexity of its architecture, the number and type of burial goods, and body orientation. The intrinsic meaning of the funerary context likely changed from the time of early Neolithic communities to the state-level hierarchical society of the terminal Bronze Age. Moreover, the variation in size of the excavated cemeteries and the degree to which the burials were disturbed in some instances necessitated following differing approaches to the analysis of specific funerary assemblages. In order to establish a relationship between different aspects of the funerary context and the social ranking of the deceased, we examined funerary contexts at the two sites independently. Our rationale for specific treatment and status-related grouping of the funerary contexts is detailed in the sections that focus on each time period.

We pursued a multifactorial approach to estimating age at death (Lovejoy et al. 1985a) based on all available skeletal elements. We used age-related morphological changes in pubic symphysis (Meindl et al. 1985; Zhang 1986), auricular surface (Lovejoy et al. 1985b; Buckberry and Chamberlain 2002), medial end of clavicles (Wu et al. 1984), sternal end of ribs (İşcan 1991; İşcan et al. 1984), and maxillary suture obliteration (Mann et al. 1991) to generate an integrative age estimate. Sexual dimorphism is well expressed in adult skeletons from the Central Plain region of China (Wu et al. 1982), allowing us to determine sex of adult skeletons with great confidence. We used Wu and colleagues' (1982) description of sex-related differences in innominate

bones from Han populations as a principal population-specific criterion for identifying the sex of adult skeletons. We also used cranial morphology to evaluate sex (Buikstra and Ubelaker 1994, 20).

Health status was evaluated based on the most commonly reported skeletal parameters and lesions, including long-bone length as a proxy for achieved adult stature, parameters of oral health, and the prevalence of cribra orbitalia and porotic hyperostosis, enamel hypoplasia, degenerative joint disease, and traumatic injuries (Buikstra and Ubelaker 1994; Steckel et al. 2002). When considering the interplay between burial status and indicators of skeletal health, it is useful to maintain a distinction between skeletal parameters that are influenced by morbidity and nutrition status during childhood and skeletal changes that progress with age. Childhood health is reflected by adult long-bone length, enamel hypoplasia, cribra orbitalia, and porotic hyperostosis, as all these parameters are affected by biological stress during childhood. Porotic hyperostosis and cribra orbitalia fall into the category of skeletal markers related to early childhood stress, as these lesions develop in response to bone marrow hyperplasia only during the first few years of an individual's life when the cranial bones still have blood-cell-producing red marrow (Ortner and Putschar 1981; Stuart-Macadam 1987, 1992).

Adult stature was determined based on measured long-bone length, using formulae developed using data on contemporary Chinese populations (for females, Chen 1980; for males, Shao 1985). Because of the fragmentary nature of human remains in the available collections, adult stature could be computed only for a small number of individuals. Porotic hyperostosis and cribra orbitalia were scored following Stuart-Macadam (1985) as excessive porosity with pore coalescence on the bones of cranial vault and orbital roof. Slight microporosity corresponding to Stuart-Macadam's category 1 (Light) was noted but not included in the study, as such porosity may not be related to pathological changes and is often an outcome of normal bone growth. Enamel hypoplasia was recorded following Goodman et al. (1987) on the labial surfaces of anterior teeth.

We examined two groups of skeletal indicators that progress with age and might therefore be affected by an individual's status during adulthood. Oral health parameters, including the distribution of dental carious lesions, antemortem tooth loss, and accretion of calculus, are closely related to food composition, food texture, and the parafunctional use of the teeth. These indicators were scored according to standard procedures. Dental caries were examined with a dental probe and only lesions that admitted the

probe were scored as present. Thus, initial carious discolorations were not included into dental caries count (Lukacs 1989). Calculus accretion was classified as absent, mild, moderate, or severe, according to the protocol of Hillson (1979). To obtain ordinal measures of oral health that could be corrected for age, dental caries prevalence was calculated for each individual as the number of affected teeth divided by number of teeth present. Antemortem tooth loss was calculated as the number of teeth lost per number of dental sockets or tooth positions present. Calculus accretion was quantified as the number of teeth showing accretion times severity score, divided by the number of teeth present.

The progression of degenerative changes on the joint surfaces and the prevalence and distribution of traumatic injury are influenced by the severity and distribution of mechanical stress as related to habitually stressful physical labor, habitual postures, or traumatic injuries. In order to produce ordinal measures of degenerative joint disease, severity-based scores of osteophyte, erosion, and eburnation development (Roberts and Manchester 2005) were scored for both sides of the body and for all individual joint surfaces that form the shoulder, elbow, hip, knee, ankle, foot articulations and all vertebrae. Skeletal fractures were classified as antemortem or perimortem based on the degree of healing. The location and type of fracture was recorded following Lovell (1997). All healed fractures were radiographed in order to further evaluate fracture type and degree of healing.

To control for the varying demographic composition of the different burial subsets, the distribution of these indicators was examined in association with the estimated age at death. We used the midpoint of the estimated age range as a proxy for age at death. For the open age ranges pertaining to older individuals (i.e., 50+ and 60+), the 55-year and 65-year data points were used, respectively. To test the statistical significance of all observed differences, the effect of age was removed by linear regression and the residuals were compared using ANOVA tests.

## Results

### The Case of Middle Yangshao (Middle Neolithic)

Yangshao (仰韶) was a Middle Neolithic cultural tradition in northern China. From approximately 5000 until 3000 BC, it dominated cultural development across a broad swath of the Central Plain surrounding the middle reaches of the Yellow River. Yangshao material culture is best known

for its black-on-red painted pottery (An 1959; Liu 2004; Ren and Wu 1999; Yan 1989). Yangshao subsistence was based predominately on millet farming and the tending of domesticated pigs, dogs, and probably poultry, but exploitation of wild resources was continued to varying degrees (Ren 1996; Wang 1985; Yan 1992; Yuan and Flad 2002). The Yangshao tradition is typically divided into three phases: Early, or Banpo (4900–4000 BC); Middle, or Miaodigou (4000–3500 BC); and Late, or Xiwang (3500–3000 BC) (Dai 1998; Liu 2004; Zhang and Qiao 1992). Considerable changes in population density and settlement patterns marked the transition from Early to Middle Yangshao (Dai 1998; Ma 2003; Su 1999; Yan 1989). Although fairly little evidence of social inequality is found during the Middle Neolithic, considerable variation among residential sectors and households in terms of activity emphases and resource accumulation is present in Yangshao settlements (Peterson et al. 2010; Peterson and Shelach 2012).

Xipo (西坡), a 40-hectare Middle Yangshao site in western Henan (Fig. 7.1), provides early evidence of the development of social hierarchies in China (Ma et al. 2005, 2006). A three-tier settlement hierarchy among the structures is visible at Xipo, including several large buildings that would have required a substantial investment of labor. The largest of these (F105) measured 516 m<sup>2</sup> and has been interpreted as a gathering place for the whole region that was likely used for ritual activities or other public functions (Ma 2003, 100). An unequal distribution of grave goods among the individuals buried at Xipo probably reflects at least some degree of social stratification (Ma et al. 2005, 2006).

#### Xipo Mortuary Patterns

Thirty-four burials excavated at Xipo were generally similar in organization. Bodies were placed in a supine position, with the arms alongside of the body and the head facing due west or northwest. In only one case was the head facing south. Single interments were placed in rectangular graves. Burial M11 was unique in that it contained the remains of two individuals: an adult, likely a female, alongside a two- to four-year-old child. Size of the burial cuts varied from slightly larger than minimally sufficient to place the body (e.g., Burial M19's pit was 1.8 m long, and 0.6 m wide) to considerably larger interments with accessory pits for grave goods (such as Burial M27's grave cut, which was 5.03 m long and 3.36 m wide). Since none of analyzed parameters approached normality in their distribution, we used the Kolmogorov-Smirnov test (K-S test) of the equality of continuous, one-dimensional probability distributions of burial area and burial

length. This identified eight burials, each with an area of greater than 8 m<sup>2</sup> and a length in excess of 3 m, as being unusually large. Of these, four burials with an area more than 10 m<sup>2</sup> were clearly size outliers at a 95 percent level of significance.

The number and quality of grave goods varied considerably among the Xipo burials. Six had no grave goods, and the maximum number of items placed into a burial was fourteen (Burial M3). The median number of grave objects was two. A Kolmogorov-Smirnov test suggests that placing more than two objects into a grave could likely be considered as special treatment in some respect. Fifteen of the Xipo burials fit into this category.

The most common burial goods were ceramic vessels of several types, including ritual vessels, such as pear-shaped *hu* (壺) and bowl-shaped *gui* (簋), and utilitarian bowls and cups. Stone objects included axes, scrapers, and a spindle whorl. A spoon, a ring, and a hairpin were among the bone artifacts that were placed in a few burials. Probably of greater symbolic significance were jade objects, including jade axes (*yue*; 鉞), which were found in six burials.

To test whether the area of the burial and the number and the type of grave goods were directly related to the same sociocultural dimensions of the individual's life and death, we performed a number of nonparametric statistical tests. Spearman rank order correlation between the area of the burial and the number of grave goods was relatively high and statistically significant (0.68, 33 *df*,  $p = 0.00002$ ). A Mann-Whitney U test detected a statistically significant difference in the number of grave goods between burials with jade and those without jade objects ( $z = -2.49030$ ,  $p = 0.0128$ ). However, no statistically significant differences in area and linear dimensions were found between burials grouped according the presence or absence of jade objects. Burials were assigned status ranks in each category, based on size (0 = smaller than 8 m<sup>2</sup>; 1 = 8 to 10 m<sup>2</sup>; 2 = larger than 10 m<sup>2</sup>), number of grave goods (0 = no grave goods; 1 = two or fewer objects; 2 = more than two objects), and the presence of jade axes (0 = no *yue*, 1 = jade *yue* present), which altogether summed from 0 to 5. Thus, each burial was classified as Poor (1 or 2), Commoner (2 or 3), or Rich (4 or 5), in accordance with its total score.

#### Sex, Age at Death, and Burial Status at Xipo

Among the 34 individuals from Xipo available for study, 21 were identified as males, 11 were identified as females, and two juveniles were of indeterminate sex. Older adults were very common. Only five of the individuals



Table 7.1. Distribution of sex and age at death among status-score burial groups at Xipo

STATUS SCORE	Poor	Commoner	Rich	Nonpoor	Totals
	N individuals (%)	N individuals (%)	N individuals (%)	N individuals (%)	N individuals (%)
Males	14 (82.4)	4 (36.4)	3 (50.0)	7 (41.2)	21 (61.8)
Females	2 (11.8)	7 (63.6)	2 (33.3)	9 (52.9)	11 (32.4)
Indeterminate sex	1 (5.9)	0	1 (16.7)	1 (05.9)	2 (5.9)
Totals	17	11	6	17	34
AGE					
< 15	1 (5.9)	0	1 (16.7)	1 (05.9)	2 (5.9)
15-29	1 (5.9)	1 (9.1)	1 (16.7)	2 (11.8)	3 (8.8)
30-45	2 (11.8)	3 (27.3)	1 (16.7)	4 (23.5)	6 (17.6)
45+	13 (76.5)	7 (63.6)	3 (50.0)	10 (58.8)	23 (67.6)
Totals	17	11	6	17	34

had an estimated age at death of less than 30 years. Six apparently died between ages 30 and 45, while 23 had estimated ages at death of older than 45 (Pechenkina 2010).

The sex of the deceased appears to have had some influence on the size of the burial and the number of grave goods (Table 7.1). Most of the female burials (7 of 11) fell into the Commoner category, while male skeletons appear to have been slightly overrepresented in the Poor category (14 of 21). The dual burial of the probable adult female with a young child was among the richest, as it included twelve objects, including three jade *yue* axes. A  $\chi^2$  test (7.64, 2 *df*,  $p = 0.022$ ) confirms the significance of the uneven distribution of males and females among the three burial status groups. The median number of grave goods in male burials was one, while in female burials it was a statistically significant six items (Mann-Whitney U:  $z = -1.98$ ,  $p = 0.048$ ). Female graves tended to be larger than those of male individuals, with a median of 6.1 m<sup>2</sup> and 4.9 m<sup>2</sup> respectively. However, a Mann-Whitney U test detected no statistically significant difference between male and female burials in terms of the area of the burial pit ( $z = -0.73$ ,  $p = 0.463$ ).

Female burials also seemed to have received slightly preferential treatment in terms of particular types of grave goods. Only one male burial

contained a jade *yue*, while four of 11 female burials contained jade objects. This was statistically significant ( $\chi^2 = 5.46$ , 1 *df*,  $p = 0.019$ ). The average number of pots was also higher in female burials than in those of male individuals (3.36 and 2.33, respectively). *Hu* were almost twice as frequent in female burials as in male burials (45.5 percent of females were buried with at least one *hu* pot compared to 23.8 percent of male burials associated with a *hu*). The same was true for *gui*: the average number of *gui* per female burial was 0.90 and the average number was 0.40 for males.

Age at death had little, if any, effect on burial status. The proportions of individuals with different ages at death in the three status-defined burial groups closely corresponded to the overall demography of the Xipo collection, with only minor, statistically insignificant deviations ( $\chi^2 = 1.93$ , 4 *df*,  $p = 0.748$ ). Spearman rank order correlation between age at death and parameters of the funerary context were low and statistically insignificant ( $R = -0.16$ ,  $p = 0.39$ ). The relationship between age at death and the number of grave goods and area of the burial was also statistically insignificant ( $R = 0.06$ ,  $p = 0.72$ ).

#### Variation in Childhood Health at Xipo

Small sample sizes resulting from the often fragmentary nature of human skeletal remains were the main impediment to detecting differences related to burial status in the distribution of childhood stress markers. Table 7.2 summarizes the means and frequencies of various skeletal attributes that can be affected by quality of life and morbidity during childhood and adolescence. As seen from this table, none of these attributes exhibit a statistically significant difference among the burial status groups. While males in the Commoner group were much taller on average than those in the Poor and Rich groups (181.7 cm compared to 168.2 cm and 166.4 cm, respectively), the estimated mean for Commoners was based on the heights of only two individuals, one of which happened to be the remains of a very tall individual whose maximum femur length was 512 mm. Thus, this apparent difference in mean stature is driven by a single outlier. Spearman's R correlations between stature and both the number of grave goods and the area of the burial were not statistically significant.

Frequencies of porotic hyperostosis and cribra orbitalia were varied; they were the highest among the Poor, lower among Commoners, and was least common among the Rich burial groups. However, as the frequencies of these markers in the Xipo sample were low overall, these differences did not reach a level of statistical significance. The frequency of enamel hypo-

Table 7.2. Skeletal indicators related to childhood stress at Xipo

Burial status	Poor	Commoner	Rich	Nonpoor	Totals	Significance test:	
						F, p (df)	F, p (df)
Stature	Mean ±SD (n)	Mean ±SD (n)	Mean ±SD (n)	Mean ±SD (n)	Mean ±SD (n)		
Males	168.2 ±6.14 (12)	181.7 ±15.06 (2)	166.4 ±5.39 (3)	172.52 ± 8.1	169.4 ±8.10 (17)	3.50, 0.059 (2 df)	1.04, 0.325 (1 df)
Females	156.2 ±8.79 (2)	153.0 ±12.14 (4)	—	153.0 ±12.14 (4)	154.1 ±10.32(6)	0.10, 0.768 (1 df)	0.10, 0.768 (1 df)
Skeletal indicator	Freq. (n)	Freq. (n)	Freq. (n)	Freq. (n)	Freq. (n)	χ <sup>2</sup> , p (2 df)	χ <sup>2</sup> , p (2 df)
Porotic hyperostosis	0.31 (16)	0.22 (9)	0.00 (3)	0.17 (12)	0.25 (28)	1.37, 0.504 (2 df)	1.87, 0.171 (2 df)
Cribra orbitalia	0.19 (16)	0.11 (9)	0.00 (3)	0.08 (12)	0.14 (28)	0.83, 0.659	0.68, 0.435 (2 df)
Enamel hypoplasia	0.13 (15)	0.43 (7)	0.33 (3)	0.40 (10)	0.24 (25)	2.44, 0.295	2.34, 0.126 (2 df)

plasia was found to be lower in the Poor group than in the Rich or Commoner burials, again without reaching a level of statistical significance. Frequencies of porotic hyperostosis and cribra orbitalia were fairly similar among all status groups. An ANOVA test using the presence or absence of porotic hyperostosis, cribra orbitalia, and linear enamel hypoplasias as grouping factors, showed no significant association between the presence of these stress markers and the number of grave goods or the area of the burial and.

#### Indicators of Adult Health at Xipo

Table 7.3 summarizes age-corrected measures of oral health and degenerative joint disease for the Xipo sample. No statistically significant link between oral health indicators and burial status was found. Nevertheless, it is worth mentioning that skeletons from higher-status burials tended to exhibit lower frequencies of carious lesions and antemortem tooth loss than expected for their age (note the negative mean standardized residuals for dental caries and tooth loss). All three oral health indicators showed weak but consistently negative Spearman rank correlations with the size of the burial and the number of grave goods. Only the correlation between calculus and the number of grave goods was statistically significant ( $R = -0.38$ , 30 *df*,  $p = 0.034$ ).

Individuals from the wealthy burials were characterized by a somewhat lower degree of markers of degenerative joint disease than would be expected for their age, although again, in most cases the differences did not reach a level of statistical significance. On the other hand, differences between the status groups in the degree of development of degenerative changes in the vertebral column were of sufficient magnitude to produce statistically significant results (Table 7.3). These differences were particularly distinct in the thoracic and lumbar segments of the vertebral column. Spearman's R correlations between the number of grave goods and degenerative changes in the thoracic and lumbar areas were statistically significant ( $R = -0.41$ , 25 *df*,  $p = 0.035$ ;  $R = -0.38$ , 30 *df*,  $p = 0.034$ , respectively).

The Xipo skeletal series is characterized by an unusually high prevalence of postcranial fractures combined with a virtual absence of cranial injuries (Pechenkina et al. 2007). The specific suite of postcranial fracture types in evidence included several transverse fractures of the distal ulna (inferred parry injuries), fractures of the metacarpals with volar displacement (boxer-type injuries), and rib fractures (Table 7.4). Such injuries occurred exclusively among male skeletons (47 percent of the 21 male skeletons

Table 7.3. Residual results for age-related skeletal indicators at Xipo

Indicator	Mean standardized residual			5 status groups		3 groups	
	Poor	Commoner	Rich	F (4 df)	p	F (2 df)	p
Caries	0.135	-0.255	-0.215	0.561	0.577	1.087	0.391
Antemortem tooth loss	0.16	-0.173	-0.279	0.493	0.616	0.883	0.507
Calculus	-0.101	0.13	-0.199	0.227	0.799	2.059	0.105
All degenerative joint diseases	0.027	0.03	-0.166	0.06	0.94	1.88	0.14
Shoulder/elbow	0.055	-0.191	0.141	0.18	0.834	0.74	0.6
Hip/knee/ankle	-0.095	0.237	-0.116	0.32	0.733	1.54	0.221
Vertebral column	0.206	-0.211	-0.353	1.71	0.201	2.84	0.041

display at least one fracture, whereas none of 12 female skeletons display any fractured postcranial elements). This points toward male engagement in face-to-face interpersonal violence or some kind of combat.

Also, such postcranial fractures appear to have been more common among the skeletons from the Poor burials, where half of all male individuals displayed at least one fracture. The remains of five such male individuals (35.7 percent) displayed multiple injuries. None of the skeletons from burials classified as Commoner and only one from among those classified as Rich had fractured bones. However, as the number of male skeletons in these higher status categories is considerably less ( $N = 7$ ) than that in burials categorized as Poor burials ( $N = 14$ ), these differences were not statistically significant ( $\chi^2 = 2.52$ , 1 df,  $p = 0.112$ ).

Table 7.4. Individuals with postcranial fractures at Xipo

Indicator	Poor	Commoner	Rich	Among 5 status groups		Among 3 status groups	
	N individuals (%)	N individuals	N individuals (%)	$\chi^2$ (4 df)	p	$\chi^2$ (2 df)	p
With fractures	7 (41.2)	0	3 (60.0)	8.32	0.139	7.82	0.02
Fractures per individual	13 (76.4)	0	3 (60.00)				
N	17	11	5				

To summarize the relationship between burial status and various skeletal indicators in the Middle Yangshao series, it appears that the sex of the deceased individual had the greatest influence on funerary context; females often received a larger number of grave goods and had larger graves. As several juveniles and a number of older adults were buried in fairly large and wealthy graves, age at death does not seem to have played a determining role in burial treatment. No clear relationship between childhood stress markers and burial treatment was found, suggesting that most or all individuals buried at Xipo shared similar nutritional risks and benefits during their childhoods. The association between age-related indicators and burial treatment was weak. Nevertheless, a trend toward less development of degenerative changes than would be expected for a given age in skeletons from the wealthier burials is repeated through multiple independent skeletal/dental indicators. Therefore, we can tentatively infer that social status, as reflected in the specifics of funerary treatment, had some degree of influence on workloads and the quality of available food during adult life in this Middle Neolithic Yangshao community.

#### The Case of the Eastern Zhou (Terminal Bronze Age)

In 770 BC, during the terminal Bronze Age, the Eastern Zhou succeeded the Western Zhou dynasty when Zhou You (幽), the last of the Western Zhou kings, was killed and the dynastic capital moved to Luoyi (present-day Luoyang), on the northern bank of the Luo River (Di Cosmo 2002, 52). Although the Zhou nominally continued to govern the territory of the Wei and Yellow River basins, the political landscape of Eastern Zhou times was marked by disintegration and rivalry among local rulers (Di Cosmo 2002, 93). A string of localized wars followed, culminating in the Warring States period, when seven powerful regional overlords continuously renegotiated their influence in the Zhou territory. The unification of China in 221 BC under the rule of Qin Shi Huang, who had been king of the Qin state during the late phase of the Warring States period, marked the beginning of the imperial age.

An Eastern Zhou skeletal collection from Xiyasi (an archaeological site in Henan Province), is curated by the Henan Provincial Institute of Cultural Relics and Archaeology. This sample was excavated at Xinzheng (新郑), a satellite city located approximately 40 km south of Zhengzhou, the modern capital of Henan Province. Xiyasi is located outside and near the wall that surrounded the Zheng Han Ancient City (郑韩故城), so named



because during different periods of the Chinese Bronze Age it served as the capital of the Zheng State and then of the Han State. Established as the capital of the Zheng kingdom during the late Western Zhou period (1046–771 BC), the city became Han after the Han state overthrew the Zheng ruler in 375 BC.

The cemetery at Xiyasi (Fig. 7.1) is associated with the legendary Yufuzi Burial Mound (渔夫子冢), where an important Han king was buried during the Warring States era. It thus likely had symbolic significance for the populace of Zheng Han during ancient times. Based on the stylistic analysis of associated grave goods, the burials recovered from Xiyasi date to the Spring and Autumn era (春秋时代, 770–476 BC) of the Warring States (战国时代)(475–221 BC) of the Eastern Zhou dynasty (Fan 2012). The proximity of this burial assemblage to the city wall makes it seem likely that the people buried at Xiyasi were inhabitants of ancient Zheng Han.

#### Xiyasi Mortuary Patterns

Although 350 burials were excavated from the cemetery at Xiyasi, only eighty-five contained human skeletons sufficiently well preserved for analysis. Overall, burial treatment at Xiyasi was standardized: the body was placed into a rectangular grave in a supine position, typically facing north. Because many of the Xiyasi burials were looted, we based our assessment of status primarily on the nature of the burial architecture. Three classes of burials at Xiyasi can be recognized. By far the most common were burials in which the deceased was placed in a simple wooden coffin (i.e., burial M116; Fig. 7.2), often slightly elevated above the ground on small supports placed at each of the four corners so that a ceramic vessel or the body of a small animal could be placed underneath. The furnishings of a more elaborate class of interments included one or more outer coffins surrounding the actual burial container (i.e., Burial M69; Fig. 7.2). A third class of burials, in which the body was placed into a large rectangular chamber with brick walls (Fig. 7.2, Burial M192), appears to have been introduced during the Warring States period. While such labor-intensive tomb structures marked a trend in funerary fashion, the degree of labor investment suggests that those particular deceased individuals were of higher social status than most of their contemporaries.

Although many of the burials encountered at Xiyasi were partially looted, a considerable number of associated grave goods were recovered and provide a second criterion for evaluating the status of the interred individuals. Rare and elaborate grave goods included bronze tripod vessels,

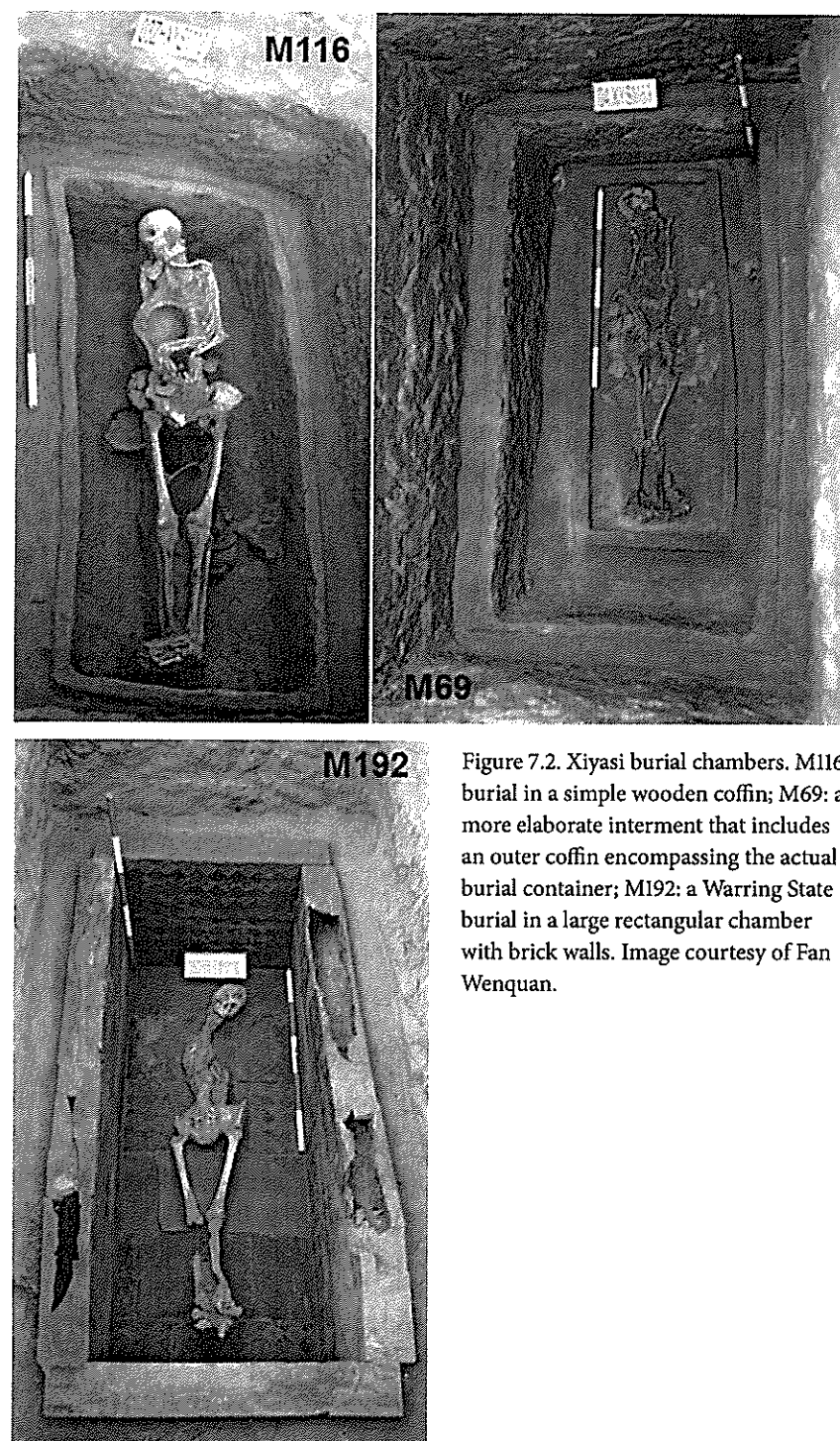


Figure 7.2. Xiyasi burial chambers. M116: burial in a simple wooden coffin; M69: a more elaborate interment that includes an outer coffin encompassing the actual burial container; M192: a Warring State burial in a large rectangular chamber with brick walls. Image courtesy of Fan Wenquan.

lavishly decorated pottery that imitated the bronze vessels, and carved jade ornaments, along with cowrie (*Cypraeidae*) shells and their bronze imitations. Some of the funerary offerings also included smaller bronze objects such as bells and knives and jewelry made of polished quartz. Among the most common grave goods were undecorated pottery, jewelry made of bone beads, and small bone implements.

We grouped the burials being considered into four categories or status levels, based on the complexity of grave architecture and associated funerary objects. The lowest status level, referred to as Poor or Underprivileged, was assigned to burials where the body of the deceased was placed into a single coffin with no grave goods. Burials were placed in this category only when there was no concrete evidence of looting in order to help ensure that grave goods were absent by original intent and not because of a postmortem act of robbery. A total of thirteen burials were assigned to this class. Commoner status was assigned to individuals from burials that were placed in a single coffin and either contained some grave goods or gave evidence of having been previously disturbed, so that grave goods could have been missing due to looting. Some of these burials might properly have belonged to the first category. The Commoner group was the most numerous and includes forty-one burials.

Burials with multilayered construction, (i.e., those that included inner and one or more outer coffins) and those placed into brick-walled enclosures were assigned to an Elite category. Here, we drew a distinction between two inferred elite groups: Elite 1 (N = 4), comprised of elaborate burials that also included high-status grave goods, and Elite 2 (N = 27), which have comparably elaborate construction but do not contain such objects.

#### Sex, Age at Death, and Burial Status at Xiyasi

Overall, the Xiyasi burial assemblage presents a demographic profile that is not representative of a living population's death assemblage (Table 7.5). There were no young children and very few subadults. Of the individuals whose sex could be identified, males comprised 62 percent of the series and appear to be overrepresented (Pechenkina 2012). Sex and age at death of the deceased appears to have had a strong influence on the amount of investment in a burial structure and its inventory of grave goods. The remains of females were found mainly in lower-status burials and their representation declines as apparent status level increases. All four individuals buried

Table 7.5. Distribution of sex and age at death among status-defined burial groups at Xiyasi

Burial status	Poor N individuals (%)	Commoner N individuals (%)	Elite 2 N individuals (%)	Elite 1 N individuals (%)	Total N individuals (%)
Males	4 (30.8)	25 (61.0)	20 (74.1)	4 (100)	53 (62.4)
Females	7 (53.8)	13 (31.7)	4 (14.8)	0	24 (28.2)
Indeterminate sex	2 (15.4)	3 (7.3)	3 (11.1)	0	8 (9.4)
	13	41	27	4	85
<b>Age</b>					
< 15	0	3 (7.5)	0	0	3 (3.6)
15–29	1 (7.7)	7 (17.5)	3 (11.1)	1 (25)	12 (14.3)
30–45	9 (69.2)	10 (25.0)	4 (14.8)	0	23 (27.4)
45+	3 (23.1)	20 (50.0)	20 (74.1)	3 (75)	46 (54.8)
Totals	13	40	27	4	84

in the Elite 1 tombs were male, and only 14.8 percent of skeletons from Elite 2 burials were identified as females. Among the simple burials with no grave goods, 53.8 percent of the corresponding skeletons were identified as female. A  $\chi^2$  test confirms the significant and nonrandom distribution of male and female skeletons among the status-defined burial groups ( $\chi^2 = 9.73, 3 df$ ).

Age at death also varied significantly in accord with burial complexity at Xiyasi ( $\chi^2 = 16.25, 6 df, p = 0.012$ ). The majority of the skeletons assigned to the Poor category were of middle age (30 to 45 years old at death). These individuals likely died before their own children were sufficiently mature to manage the funeral process. Perhaps their burial arrangements were made by others, perhaps by unrelated adult community members. Only 23 percent of the burials in this category belonged to people older than 45. The proportions of older adults in the other status groups were considerably higher: 50.0 percent in the Commoner group, 74.1 percent in the Elite 2 group, and 75 percent in the Elite 1 group. The proportion of young adults (15–29 years old at death) was also higher in burials with funerary goods: 17.5 percent, 11.1 percent, and 25 percent in the Commoner, Elite 2, and Elite 1 categories, respectively, compared to 7.7 percent young adults in the Poor category.

Indicators of Childhood Health at Xiyasi

The frequencies and average values of childhood skeletal health indicators at Xiyasi are summarized in Table 7.6. Because of the fragmentary nature of many of the remains, stature could be estimated for only a small proportion of the individuals. No clear pattern in stature variation between individuals from burial groups with different social status was apparent.

There were no statistically significant differences in the distribution of porotic hyperostosis and cribra orbitalia that was linked to some kind of chronic anemia (Walker et al. 2009; Oxenham and Cavill 2010) between individuals from different burial status groups (Table 7.6). However, this is probably a function of subsample sizes. The crude prevalence of these skeletal markers were considerably greater among remains from the non-elite burials. In the Poor burial group, porotic hyperostosis was evident on the remains of 4 of 10 individuals (40 percent) and cribra orbitalia was evident in two of nine (22 percent). In the Commoner group, the remains of 6 of 37 individuals (15 percent) displayed evidence of porotic hyperostosis and

Table 7.6. Skeletal indicators related to childhood stress at Xiyasi

Burial status	Significance test					4 groups <i>F</i> , <i>p</i> (3 <i>df</i> )	elite vs. non-elite <i>F</i> , <i>p</i> (1 <i>df</i> )
	Poor	Commoner	Elite 2	Elite 1	Total		
Stature	mean ±SD (n)	mean ±SD (n)	mean ±SD (n)	mean ±SD (n)	mean ±SD (n)		
Males	173.4 ±4.81 (4)	170.0 ±5.07 (12)	175.3 ±1.46 (6)	172.6 (1)	172.2 ±7.13 (23)	1.09, 0.376	2.408, 0.145
Females	155.9 ±7.35 (2)	153.0 ±3.51 (7)	—	—	153.7 ±4.49 (9)	0.63, 0.457 (1 <i>df</i> )	—
Skeletal indicator	Freq. (n)	Freq. (n)	Freq. (n)	Freq. (n)	Freq. (n)	$\chi^2$ , <i>p</i> (3 <i>df</i> )	$\chi^2$ , <i>p</i> (1 <i>df</i> )
Porotic hyperostosis	0.40 (10)	0.16 (37)	0.07 (14)	0.00 (4)	0.16 (65)	5.87, 0.128	2.28, 0.130
Cribra orbitalia	0.22 (9)	0.31 (29)	0.08 (12)	0.00 (2)	0.23 (52)	3.45, 0.328	3.05, 0.080
Enamel hypoplasia	0.36 (11)	0.63 (32)	0.69 (13)	0.75 (4)	0.60 (60)	2.08, 0.555	1.41, 0.235

9 of 29 (31 percent) showed evidence of cribra orbitalia. The frequencies of porotic hyperostosis and cribra orbitalia in the combined non-elite group were 21.3 percent and 28.9 percent, respectively. Only one cranium from the Elite 2 group and none from the Elite 1 group displayed evidence of an anemia-related pathology. Unfortunately, small sample sizes prevent use of tests of statistical significance to further evaluate these observed differences.

Minimal differences in the incidence of enamel hypoplasia were found among individuals from the different status groups. For individuals from the Poor status group, 4 of 11 individuals (36 percent) had at least one hypoplasia defect on anterior teeth. In the Commoner, Elite 2, and Elite 1 groups the frequency of this pathology was higher than in the Poor group, at 63 percent, 69 percent, and 75 percent, respectively, but these differences are not statistically significant. Taken together, these relatively high frequencies of enamel hypoplasia suggest that growth arrest during early childhood was fairly common among the population of Zheng Han.

Indicators of Adult Health at Xiyasi

Unlike skeletal indicators associated with childhood health, some of the pathological changes that progress with age did show statistically significant differences among status groups at Xiyasi, even after the effect of age was removed by linear regression. The number of carious lesions per tooth showed statistically significant differences among the four status groups ( $f = 5.36$ , 3 *df*,  $p = 0.003$ ) and when skeletons from all elite burials were pooled and compared with a combined sample comprised of the non-elite burials ( $f = 5.88$ , 1 *df*,  $p = 0.018$ ). Skeletons from the non-elite burials displayed less dental caries than would be expected for their age (note the negative mean standardized residuals), while individuals from the elite burials displayed more dental caries than would be expected (Fig. 7.3).

Other indicators of oral health showed statistically significant differences only when the combined elite group was compared to the pooled non-elite group. As was the case with carious lesions, antemortem tooth loss was more frequent among the individuals from elite burials than expected for their age at death; the rate was lower among non-elite burials. Calculus deposition was more pronounced among elites and less pronounced for non-elites. These differences in oral health between elite and non-elite individuals suggest the likelihood that certain foods were less available to the general populace than they were to wealthier or higher-status individuals. As dental caries development is tightly linked to the availability of dietary

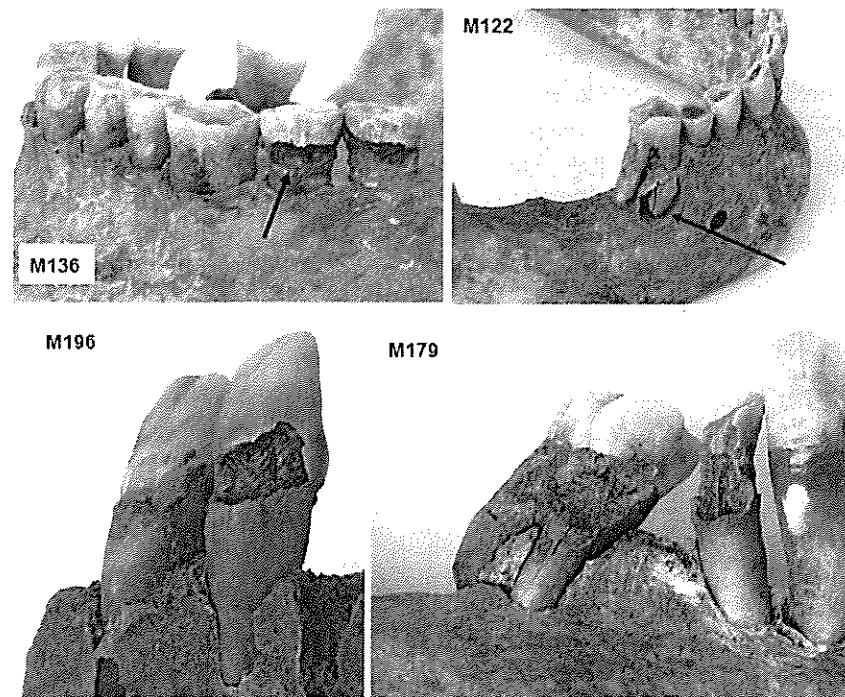


Figure 7.3. Examples of dental caries on dental roots (M136, M196, M179) and a periapical alveolar abscess (M122) in the Xiyasi skeletal series. Image by Kate Pechenkina.

carbohydrates, elite individuals seemed to have consumed an average diet consisting of greater proportions of starches and sugary foods.

The progression of degenerative joint disease (DJD) with age did not differ significantly between individuals from the different status groups (Table 7.7). While the progression of DJD occurred close to the age-based expectation for most status groups, as marked by mean standardized residuals close to zero, there were a few peculiar exceptions. For the Elite 1 group, the development of DJD was less than expected for age at death on all joint systems, but it was especially low for lower limb joints and the vertebral column. In contrast, individuals from the Elite 2 group were characterized by a more pronounced development of DJD, especially among leg and foot articulations. Upon closer examination, it appears that the majority of lower limb DJD in individuals from the Elite 2 group was secondary to minor traumatic injuries of the ankle joints, especially the tibiofibular syndesmosis, the tibiotalar and subtalar joints, and in the metatarsophalangeal joints. Degenerative changes in these joints can develop from stressful

Table 7.7. Residual results for age-related skeletal indicators at Xiyasi

Indicator	Mean standardized residual				Among 4 status groups		Elite vs. non-elite	
	Poor	Commoner	Elite 2	Elite 1	<i>F</i> (3 <i>df</i> )	<i>P</i>	<i>F</i> (1 <i>df</i> )	<i>P</i>
Caries	-0.26	-0.19	0.52	0.10	5.36	0.003	5.88	0.018
Antemortem tooth loss	-0.71	-0.20	0.80	0.71	2.12	0.107	4.07	0.048
Calculus	0.65	0.07	-0.37	-0.38	2.29	0.088	4.47	0.038
All degenerative joint diseases	-0.31	-0.03	0.18	-0.07	0.36	0.781	0.65	0.424
Shoulder/elbow	-0.10	-0.09	0.34	-0.03	1.01	0.399	2.55	0.119
Hip/knee/ankle	-0.03	-0.16	0.53	-1.08	0.73	0.545	0.88	0.355
Vertebral column	-0.06	0.36	-0.67	-1.17	0.52	0.677	1.56	0.229

postural behavior such as habitual squatting with an inverted foot and toes or simply from walking in rugged terrain.

One surprising aspect of the Xiyasi skeletal collection is the very low frequency of fractures of any kind. Only one skeleton from the Elite 2 group (Burial M220) displayed evidence of healed postcranial fractures. They consisted of a fracture of the fifth metacarpal in a pattern consistent with a pugilistic boxer's injury and a midshaft fracture of the clavicle. This low frequency of fractures in the Xiyasi skeletal assemblage implies infrequent exposure to acute interpersonal violence and a low level of occupational hazard of any type that could lead to bone injuries.

In summary, we would like to emphasize that for the Xiyasi assemblage, sex and age of the deceased seems to have been the most critical determinant of funerary treatment. Males were predominant among the wealthier burials, while average age at death increased in accord with higher burial status. No significant differences in the distribution of childhood stress markers were found, yet a lower frequency of both porotic hyperostosis and cribra orbitalia among the individuals from wealthier burials tentatively suggests that social differentiation affected access to resources, even at an early age. Social status as expressed in funerary contexts appears to have had a strong correlation with cariogenicity of the diet during adulthood,



as individuals from the higher-status burials had statistically higher rates of dental caries, antemortem tooth loss, and calculus accretion. The Xiyasi series as a whole is characterized by a low degree of degenerative joint disease development and a low prevalence of trauma, with no clear association between burial status and the progression of DJD.

### Discussion

A funerary ritual is often the final act in a person's life trajectory and can leave behind a snapshot taken through the lens of a particular cultural system and the people who surrounded the deceased. By means of the actions taken on behalf of the deceased by community members, including some who were probably unrelated in a biological sense, the funerary ritual may serve to express in shorthand form the complexities of an individual's life and his or her relationships with others. Some of these relationships are likely to have been constructed before birth, while others will have emerged through the course of a lifetime or even after death. Considering the complexity of the relationships that are distilled into a particular funerary context, the relatively weak associations found between specific skeletal attributes and various parameters pertaining to burial context is not unexpected.

Throughout the known entirety of human prehistory and history, societal roles have been negotiated to varying degrees with reference to the biological attributes that generally serve to assign an individual to a particular gender, whether it corresponds to binary notions of biological sex or not. Finding a correspondence between particular assemblages of grave goods and the sex of the associated individual as determined from skeletal or mummified remains is commonplace in anthropological research (e.g., Arriaza et al. 2008, 50; Binford 1971, 20; Hamlin 2001, 131; Lucy 1998, 32–34; Pechenkina and Delgado 2006; Snortland 1994, 63; Stoodley 1999, 29). In this study, strong and statistically significant associations were found between skeletally determined sex and aspects of funerary patterns from both the Middle Neolithic and Eastern Zhou.

Many prior archaeological studies have found significant correspondence between sex and specific types of associated material culture (e.g., Arriaza et al. 2008, 50; Hamlin 2001, 131), leading to the designation of certain grave goods as gender specific. In the present study, we discerned a more general association between the sex of the deceased and burial complexity. The differing relationship between sex and burial wealth in the two

societies we considered mirrors considerable differences in gender-related social roles that developed between the time of Middle Yangshao and the time of Eastern Zhou. In the Eastern Zhou, a greater proportion of male burials fell into the wealthier category, and those individuals tended to live longer. This information corresponds well with our context-based expectation of a patriarchal society. However, the relationship between sex and burial wealth at Xipo was more complex. The wealthiest burial excavated there was a dual interment of a female and a child, while the next richest was that of an adult male individual. Overall, a substantial proportion of the Xipo males were buried entirely without grave goods. This phenomenon resulted in Late Neolithic female burials that were wealthier on average than those of males.

Chinese archaeology from the 1960s–1980s was influenced by Marxist social theory and concepts of social evolution stemming from the work of Friedrich Engels (1884), which tended to envision Neolithic societies as egalitarian and organized around matrilineal clans (Gao and Lee 1993, 268). Wealthy female burials dated to various phases of the Neolithic were cited in support of a suggested prominent role for females in the pertinent early Chinese societies (Banpo Museum 1975; Wu 1961). However, in more recent times, this putative relationship between sex and burial wealth during the Neolithic has been less emphasized.

In the case of the Xipo assemblage, equating positive correspondence between sex and burial wealth with a specific form of social organization would seem to be a gross oversimplification. There is little, if any, skeletal evidence to suggest that females enjoyed a privileged position in the ancient Xipo community. Sexual dimorphism in stature is fairly pronounced in the Xipo series (Pechenkina et al. 2007, 2013). Stable isotope analysis of human bone collagen samples from Xipo (Gong 2007) indicates that males had a considerably greater proportion of animal products in their diet than females. The considerably higher rates of dental caries and other carbohydrate-driven pathologies among females imply that women's diets were largely based on millet. Overall, similar rates of bone lesions were found for males and females in the skeletal collection from Xipo, as has also been the case for collections from other Middle Neolithic sites on the Central Plain of China. Thus, the apparently privileged status accorded to females in death did not correspond with better health status during life.

A number of previous bioarchaeological studies reported more distinct correspondences between burial status and skeletal and dental health markers that progress during adulthood (Klaus et al. 2010; Cucina and

Tiesler 2003; Jankauskas 2003; Robb et al. 2001; Rodrigues 2004; Sakashita et al. 1997) than with those that reflect childhood health (Cucina and İşcan 1997; Robb et al. 2001; Tung and Del Castillo 2005). Likewise, we observed statistically significant correspondences between burial status and a number of age-related markers. In the Xipo case, these markers were related to activities, including the development of osteoarthritis in the vertebral column and postcranial traumatic injuries. These tended to show less progression than would be expected for age at death among individuals from burials with higher status, whereas all other diet- and activity-related indicators failed to yield statistically significant differences between burial status groups. Thus, it seems that achieving a certain status in life made possible a decrease in habitually strenuous activities and commensurately fewer risks of injury, even during the Chinese Middle Neolithic.

In the Eastern Zhou setting at Xiyasi, in contrast to what we found at Xipo, frequencies of oral pathological conditions related to food consistency and texture were quite distinct between burial status groups. These indicators were also more pathologically advanced than expected for age at death among individuals from wealthier Xiyasi burials. The initiation of dental caries infection involves consumption of sucrose by endogenous acidogenic *Streptococcus mutans*, *Lactobacillus acidophilus*, and related bacteria on tooth surfaces (Cury et al. 2000) and further progression requires water-soluble carbohydrates. Therefore, we can suggest that individuals whose remains were recovered from the wealthier burials at Xiyasi were able to indulge in the consumption of foods with higher sugar content than what was available to their poorer contemporaries. Furthermore, as the same individuals display a greater accumulation of dental calculus, which can be removed by edibles with an abrasive texture, individuals in wealthier burials likely had greater access to highly processed, softer foodstuffs. Such differences in oral pathology between people from the different status groups imply considerable differences in average dietary patterns between elite and commoners.

Although not statistically significant, a clear trend toward lower frequencies of porotic hyperostosis and cribra orbitalia in the higher-status burial groups implies that individuals of differing status in Eastern Zhou society were subjected to different degrees of anemic stress in childhood. The magnitude of those differences in the prevalence of anemia indicators between individuals from the elite and non-elite groups is somewhat surprising. While a diet poor in heme-bound iron increases the likelihood of anemia in children, the results of some recent bioarchaeological studies

have led to a suggestion that megaloblastic and hemolytic anemia, poor hygiene, contaminated drinking water, and consequent intestinal infections resulting in prolonged diarrhea was an important factor in shaping patterns of this pathology in prehistory (Klaus and Tam 2009; Blom et al. 2005; Wright and Chew 1999). Thus, the finding of even a weak correspondence between burial status and the prevalence of anemia in the sample from Xiyasi tentatively suggests that status differences apparently mediated differential access to resources and exposure to parasites during childhood.

The lack of any statistically significant correspondence between the progression of degenerative joint disease and burial status among the people buried at Xiyasi is likely to have been a consequence of the urban nature of this population, which probably included craftspeople and merchants but few, if any, people engaged in agricultural activities. Indeed, the virtual absence of postcranial trauma and the slow progression of DJD suggests that this group generally did not engage in physically demanding labor or physical confrontations.

## Conclusions

In this chapter, we examined the relationship between burial status and skeletal markers of sex, age, and health in two temporally distinct skeletal collections from China's Central Plain: the Middle Yangshao Xipo series and the Eastern Zhou Xiyasi series. In both cases, the sex of the deceased had its strongest association with burial wealth, although the direction of this relationship was inverted between the two cases. In the Neolithic series, female burials on average had a richer inventory and greater size, while the majority of male burials had minimal or no grave goods. In the Eastern Zhou case, the proportion of male skeletons in each subset increased with an increase in burial rank. Age at death was a significant factor in determining burial status for the Eastern Zhou but was not clearly related to funerary context in the Neolithic Yangshao case.

Aside from indicators of skeletal sex, skeletal markers of adult health showed a more direct association with burial status than attributes that develop during childhood. In comparing the two cases, such relationships were found to be somewhat distinct from one another, likely owing to the different physical demands and dietary opportunities presented to people in each of the time periods. The Xipo collection, which is likely representative of Neolithic farmers, reflected a significant association between burial status, DJD, and rates of traumatic injury. In the Xiyasi collection, which



probably represents urban dwellers at Zheng Han, higher-status burials were associated with significantly greater frequencies of dental caries, calculus accretion, and antemortem tooth loss. A clear association, albeit statistically insignificant, between burial status and the skeletal stigmata of childhood anemia tentatively suggests that in the city of Zheng Han, social status differences began affecting human health early in life and that these differences generally persisted through maturation and into adulthood.

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