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A comparative study of oral health in three Late Bronze Age populations with different subsistence practices in North China

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ABSTRACT

This comparative study aims to examine dental lesions of three skeletal populations from Late Bronze Age North China to examine relationships between subsistence patterns and oral health in the past. The skeletal remains represent a unique series of ancient human populations who adopted different subsistence practices: Chenjiagou (ca. 3000–2200 BP) from Henan, Central China, representing an intensified agricultural practice; Houtaomuga (ca. 2250–2050 BP) from Jilin, Northeast China, representing hunting-gathering-fishing with limited mixed agriculture; Jinggouzi (ca. 2530–2440 BP) from Inner Mongolia of China, representing pastoral economy. The prevalences of dental caries, antemortem tooth loss, abscesses, and pulp chamber exposure were investigated in this study to examine potential connections between oral health and subsistence strategies.

This study reveals that 1) overall, the worst oral health status was observed in the agriculturalists (Chenjiagou) when comparing with those of the mixed hunter-fisher-gatherers (Houtaomuga) and pastoralists (Jinggouzi); 2) dental pathological lesions (uncommon in subadults) were found to increase significantly with age in all three studied populations; 3) females were found to develop more severe dental lesions than males in all three sites, especially for the molars. This study demonstrates that high carbohydrate dietary intake can significantly worsen oral health, which is consistent with observations from many other parts of the world. More studies are needed to investigate the causes of sex differences in severity of dental lesions between agriculturalists and non-agriculturalists.

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1. Introduction

As often the only part of the body surviving from post-mortem degradation, dental remains from archaeological sites are commonly examined in bioarchaeological investigations. Oral health status has been considered one of the most informative biomarkers of diet and food preparation techniques in past societies, since dental pathological lesions are believed to be closely related to subsistence practices (Turner, 1979; Lukacs, 1992; Lubell et al., 1994). Numerous studies of dental caries, antemortem tooth loss, and other forms of dental and alveolar defects have been

associated with the transition to agricultural economies (Cohen and Armelagos, 1984; Powell, 1985). As a result, dental pathology has been used in addressing the temporal and chronological changes in patterns of subsistence practice (e.g. Pechenkina et al., 2002; Belcastro et al., 2007; Bernal et al., 2007; Klaus and Tam, 2010), as well as in inferring gender differences and status-related questions in many parts of the world (e.g. Lukacs, 1996; Sakashita et al., 1997; Cucina and Tiesler, 2003; Lukacs, 2011a; 2011b; DeWitte, 2012; Lopez et al., 2012; Petra et al., 2014).

A large body of research has shown that the subsistence transition from hunting and gathering to agriculture has had enormous but varying impacts on human health. In contrast to early views of agriculture's positive impact on health (for example Childe, 1951), researchers beginning in the 1970s and 1980s suggested that agriculture seems to negatively affect human health, especially dental health (e.g. Cohen and Armelagos, 1984; Armelagos et al.,

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1991; Steckel and Rose, 2002; Steckel et al., 2002; Larsen, 2006; Pinhasi and Stock, 2011). However, the relationship between agricultural practice and dental health is far more complex (Halcrow et al., 2013). More recently, researchers have found that dental pathology may not be a sensitive indicator of the initial shift to agriculture in some regions (e.g. Tayles et al., 2000; Oxenham, 2006; Willis and Oxenham, 2013) as many of these used health markers may have not undergone significant change until the development of intensive agriculture (e.g. Eshed et al., 2006; Stock and Pinhasi, 2011).

China is one of the major centers for the origins of agriculture (Zhao, 2011). While rice was cultivated in South China in the early Neolithic, millet and other dry-land agricultural crops, were cultivated approximately the same time along the Yellow River (Lee et al., 2007; Zhao, 2011) and then rapidly spread over the vast area of North China. Archaeological investigations reveal various degrees of human manipulation of plants and their environment and regional patterns of reliance on agriculture (Bar-Yosef, 2011; Cohen, 2011). Due to the acidity in soils, fewer human skeletons have been well preserved in archaeological sites in South China, whereas in North China the preservation of human remains is much better. In recent decades, large numbers of human remains have been recovered and collected from archaeological sites in North China. With diverse landscapes and various adaptive subsistence patterns, skeletal human remains from North China provide an excellent opportunity to investigate the impacts of different subsistence economies on ancient health.

In this paper, we report a comparative study of oral health of three skeletal populations from Late Bronze Age Northern China: Houtaomuga (ca. 2250–2050 BP) from Jilin Province, Jinggouzi (ca. 2530–2440 BP) from Inner Mongolia Autonomous Region, and Chenjiagou (ca. 3000–2200 BP) from Henan Province. Although they are all from North China geographically, each represents a quite unique regional ecosystem and subsistence practice.

2. Materials and methods

2.1. Archaeological sites

The samples evaluated in this paper come from three recently excavated archaeological sites in Northern China: Houtaomuga, Jinggouzi, and Chenjiagou (see Fig. 1). All are approximately dated to the same time period, equivalent to Late Bronze Age ca. 3000–2000 BP.

2.1.1. Houtaomuga

Houtaomuga site (45.39° N, 123.47° E) is located on the east bank of Xinhuangpao Lake, in Da'an County, Jilin Province, Northeast China (Fig. 1). The lake is in the western portion of the Nengjiang and Songhuajiang river valley system (Songnen Plain in Fig. 1). The mountain ranges: Daxing'anling to the west, Xiaoxing'anling to the north, and Changbaishan to the east surround the rolling terrain of this vast plain intersected with numerous rivers. The climate is typical of Northeast China (Li et al., 1982; Xia and Wang, 1987; Wu and Zhang, 2006): it is warm and wet in the summer with a mean air temperature 26–28 °C, and mean annual precipitation of approximately 400–500 mm; many lakes and swamps form along the Nenjiang riverbanks during the rainy season; in the winter, the dry season, this area becomes very cold with much less precipitation, and temperature drops to about –22 to –28 °C. Surface soil desertification has progressed drastically through time with the typical modern landscape being a lake-ridden, swampy, sandy desert plain (Qiu et al., 1992; Li and Lv, 1996).

The two initial excavations of Houtaomuga site were conducted in 2011 and 2012 by Jilin University and Jilin Provincial Institute of Cultural Relics and Archaeology (Wang, 2013, in press). With abundant natural resources, the site was continuously inhabited from Neolithic to Late Bronze Age (8000–2050 BP) in spite of the long and cold winter with which the ancient inhabitants had to deal. Human remains analyzed in this study (62 individuals) were unearthed from 57 burials of Hanshu Culture II (ca. 2250–2050 BP) that is contemporary with Late Bronze and Early Iron Age of Central Plain of China (Zhao, 2002; Qiao, 2005; B. Zhao, 2009). Since the majority of the culture components of Hanshu Culture II are started from the Late Bronze Age and the iron artefacts only had been found at the very late phase of Hanshu Culture, it would make more sense to consider the remains to be of a Late Bronze Age skeletal population. Dental materials are relatively well preserved, making it possible to examine oral health of the inhabitants.

The burials and middens at Houtaomuga site contain evidence for the consumption of both fresh water and terrestrial animal foods. The large amount of wild faunal remains including numerous fish bones provides great insight into their daily lives. The pottery assemblages strongly suggest that small-scale agriculture had been practiced while plentiful fish remains in faunal assemblages and in specialized fish pits in the cemetery indicate that fish were an important component of both diet and ritual activity (Wang, 2013, in press).

2.1.2. Jinggouzi

Jinggouzi site (43.23° N, 118.14° E) is located in the village of Jinggouzi, Linxi County, Inner Mongolia, North China (Fig. 1). It is situated on the upper reaches of Xar Moron River in the Mongolian–Manchurian grassland ecoregion on the northwest edge of Horqin Sandy Land. The region is typical of a semi-arid and sub-humid climate: with mean annual precipitation of approximately 385 mm falling predominantly between June and August; average temperature in summer is about 20–23 °C and in winter about –11 to –15 °C (Kong et al., 1991; Jia, 2010; Wang, 2012). At present land degradation in this region has spread rapidly as a result of intensive cultivation and over-grazing, in combination with extensive winds and loose sandy soil. The landscape is characterized by a mosaic of sand dunes, lowland meadows and savannas (Kong et al., 1991; Jia, 2010; Wang, 2012).

Excavation was conducted in 2002 and 2003 by Inner Mongolia Autonomous Region Archaeological Institute and Jinlin University (Wang et al., 2010). Fifty-eight burials including single and multiple burials, one house, and nine middens were recovered. The majority of the remains (58 burials and two middens) can be dated to ca. 2530–2440 years BP (Wang et al., 2010). Most had been disturbed in antiquity, likely from ancient looting (L. Zhang, 2005). Although such disturbance may have created some commingling of the individuals within a multiple burial, care was taken to avoid assigning skeletal elements of multiple people to the same individual. Sixty-four individuals well preserved with dentition were included in this study.

There is strong evidence to suggest that animal husbandry was the main subsistence practice at Jinggouzi since about 86% of burials are associated with domesticated animal bones such as horse, cow, and sheep as funerary goods (Wang et al., 2010; Wang, 2012). No pig bones have been found in any of these burials probably suggesting a lack of long term sedentary lifestyle (Gao, 1996; Zheng, 2003). Many of the bronze and bone artifacts are related to animal husbandry though tools for agriculture practice have not been recovered (Wang and Hu, 2013). Most of bronze items were made for decorative purposes, and only a few were tools such as knives and arrowheads. The most abundant bone tools,

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