Assembling Çatalhöyük

Edited by Ian Hodder and Arkadiusz Marciniak

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Cover image(s): *Left*: Ochre hand prints on the north wall of Building 77; *Middle*: Bucrania and horned bench associated with the northeast platform of Building 77 (both taken from Taylor pp. 127–50, this volume); *Right*: The incised panel above burial 327 in TP Area (taken from Marciniak et al., pp. 151–66, this volume).

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An Integrated Approach to Reconstructing Activity Patterns at Neolithic Çatalhöyük

JOSHUA W. SADVARI, CHRISTINA TSORAKI, LILIAN DOGIAMA AND CHRISTOPHER J. KNÜSEL

INTRODUCTION

Ten years ago, in a *Scientific American* article titled 'Women and Men at Çatalhöyük', Hodder (2004) synthesized various lines of evidence that yielded clues to the roles of the sexes in this early farming society (see also Agarwal et al., 2015). Analyses of the human skeletal remains up to that point—burial practices, diet, and workload—implied little difference in the daily lives and relative status of women and men. This contrasted sharply with figurative representations from the site—the few paintings depicting humans appear to be concentrated on men clad in leopard skins hunting or baiting wild animals, while unique figurines of female forms indicate connections with domesticated plants, as one figurine has a seed embedded in her back while another, Mellaart's famous seated 'goddess' figurine, was found in a grain bin (Mellaart, 1967: Plate IX; Hodder, 2004, 2006).

Since the publication of Hodder's (2004) article, we have learned much more about Çatalhöyük than we have ever known before, not only from increasingly comprehensive analyses of the human skeletal assemblage, but also from detailed studies of other archaeological datasets, including the ground stone and projectile point assemblages. The time is ripe, then, for a re-examination of the activities of women and men at Çatalhöyük. One aim of the present study is to integrate analyses of material culture and human remains to uncover whether activity-related divisions existed between the sexes at Çatalhöyük, and, secondarily, to assess the extent to which these divisions align with the types of activities depicted in or alluded to among figurative representations found at the site.

More recently, Hodder (2014a) has provided a detailed summary of the latest phase of the Çatalhöyük Research Project, with a focus on evidence for change throughout the occupation of the site. The integration of diverse datasets reveals that substantial changes occurred through time at Çatalhöyük in a number of spheres, including community ties, ritual and symbolic elaboration, landscape use, domestic production, technological practice, and material entanglement (Hodder, 2014a). A second aim of the present study, following along these same lines, is an integrated analysis of the Çatalhöyük human skeletal, ground stone, and projectile point assemblages, with a focus on patterns of grinding and hunting activities in temporal perspective.

The integration of people, objects, and practices in a single study has the potential to greatly clarify our understanding of the socioeconomic roles of the sexes at Çatalhöyük and allows us to explore how changes in technological manufacture and use correspond with changes in human activity over the course of the lengthy occupation of the site. The next section of this chapter provides a broad overview of the human skeletal, ground stone, and projectile point assemblages, as well as the materials and methods associated with the analyses undertaken for each. Following this examination of the assemblages, these separate analyses are integrated to paint a more complete picture of activity patterns between the sexes and through time at Çatalhöyük.

EXAMINING THE ASSEMBLAGES

Human remains

Excavations undertaken by the Çatalhöyük Research Project between 1993 and 2014 have afforded researchers with one of the largest human skeletal assemblages available for studying health and lifestyle during the Near Eastern Neolithic, with over four hundred individuals categorized as 'primary', 'secondary', or 'primary-disturbed' burials (for detailed definitions of burial categories at Çatalhöyük, see Boz & Hager, 2013). Through rigorous bioarchaeological analysis and contextualized interpretation of the remains of the dead, much can be learned about these individuals while they were living, as their skeletal remains provide a record of

the stresses exerted upon them and the activities in which they engaged during their lifetimes (Larsen, 2015). Indeed, we have learned much about the population of Çatalhöyük through such analyses (Hillson et al., 2013; Larsen et al., 2013, 2015), and the present study seeks to build upon this understanding through the integration of the human skeletal, grinding tool, and projectile point assemblages to address the topic of activity patterns among inhabitants of the site.

The activity patterns of archaeological populations are sometimes inferred from the material culture and artistic representations associated with these past societies. Differences in grave goods between male and female burials may be taken as an indication of different social or economic roles for the sexes, while changing technologies throughout the occupation of a site may be seen to coincide with changes in human activity. Although artefacts and figurative representations may provide indirect evidence of differences in activity between the sexes or over time, human skeletal remains provide more direct evidence of past behaviour in the form of markers of habitual biomechanical stress.

The present analysis considers two markers of habitual biomechanical stress: osteoarthritis and entheseal changes. Although multifactorial in aetiology, a major determinant of the frequency, severity, and distribution of osteoarthritis is localized and repetitive biomechanical stress and physical activity (Radin, 1982; Jordan et al., 1995; Felson, 2000; Larsen, 2015). Osteoarthritis manifests in the form of bony lipping (osteophytes) around the joint margins (Figure 1), porosity on the joint surface and, in more severe cases, a polishing of the joint surface known as eburnation and indicative of a complete breakdown of articular cartilage

Figure 1. *Osteoarthritis of the knee joint as indicated by the presence of marginal lipping and fine porosity on the articular surface of the right and left patellae.*
Photograph by Joshua W. Sadvari; reprinted from Larsen et al. (2015).

followed by prolonged bone-on-bone contact (Rogers & Waldron, 1995; Ortner, 2003; Larsen, 2015). Frequency (presence/absence) and severity of osteoarthritis were scored for the appendicular joints of the upper (shoulder, elbow, wrist, hand) and lower (hip, knee, ankle, foot) right and left limbs using the system outlined in Table 1.

Entheseal changes refer to irregular alterations at the site of the attachment of a tendon to bone, the enthesis. These changes can manifest as a raised margin, surface rugosity, micro- or macroporosity, and distinct bony projections called enthesophytes (Hawkey & Merbs, 1995; Peterson, 2002; Villotte et al., 2010a; Henderson et al., 2013). The presence of entheseal changes was scored for two upper limb entheses in this study, the common extensor origin at the lateral epicondyle of the humerus and the common flexor origin at the medial epicondyle of the humerus using the criteria outlined by Henderson et al. (2013). Lateral epicondylosis, or an entheseal change present at the lateral epicondyle, is generally more common than medial epicondylosis, such that the ratio of lateral to medial epicondylosis (L/M ratio) is usually greater than one (Villotte & Knüsel, 2014). However, unilateral medial epicondylosis (Figure 2), usually of the right side, results in an L/M ratio of less than one and is considered to be a good skeletal marker of a repetitive overhead throwing motion, having previously been used to address the topic of a sexual division of labour in prehistoric populations (Dutour, 1986; Villotte et al., 2010b; Villotte & Knüsel, 2014). In modern clinical populations, this condition is often seen in athletes involved in throwing sports (Bramhall et al., 1994; Jobe & Ciccotti, 1994; Ciccotti et al., 2004; Ouellette et al., 2008), but in the past, the presence of such a condition may provide a means of interpreting other human behaviours, such as use of an overhead throwing motion in games, hunting, or warfare (Villotte & Knüsel, 2014).

Total sample sizes for the present study consist of one-hundred and six adults for whom age and sex could be determined and eighty-eight adults who could be assigned to one of the two periods used in

Table 1. *Scoring system for frequency and severity of osteoarthritis*

Frequency	Severity	Criteria
Absent	0—Absent	No degenerative changes observed on the joint margin or surface
Present	1—Slight	Slight marginal lipping (osteophytes <3 mm)
	2—Moderate	Severe marginal lipping (osteophytes >3 mm) OR Slight marginal lipping and porosity on the joint surface
	3—Severe	Severe marginal lipping and porosity on the joint surface OR Eburnation

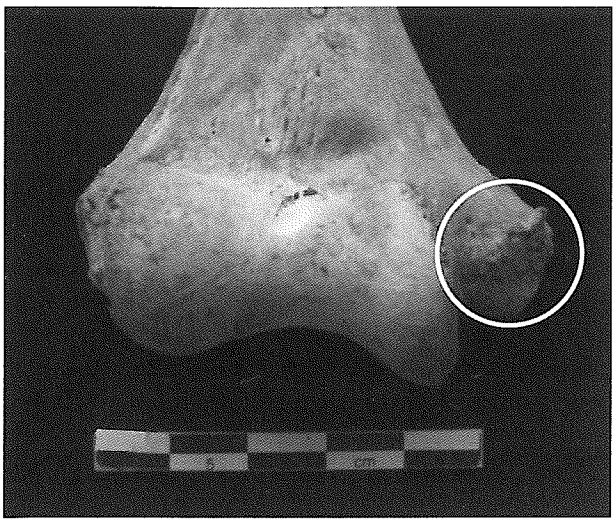

Figure 2. *Medial epicondylosis of the right humerus as indicated by the presence of surface porosity and enthesophytes at the common flexor origin (circled).*
Photograph by Joshua W. Sadvari.

temporal comparisons (detailed further below). As the development and progression of osteoarthritis and entheseal changes are both known to be age-related, analyses of these skeletal markers were controlled for age by assigning all adults to one of the following three categories: Young Adult (20–29 years), Middle Adult (30–49 years), or Older Adult (50+ years). In the analyses presented in subsequent sections, the Cochran–Mantel–Haenszel statistic was used to test the null hypothesis that the frequency of osteoarthritis for a particular joint is independent of sex or time period, while controlling for age to minimize the effect of this confounding variable.

Ground stone

Excavations between 1993 and 2014 by the Çatalhöyük Research Project have yielded a large ground stone assemblage with the estimated number of tools, rough-outs and debitage exceeding 5500 objects[1] (Baysal & Wright, 2005; Tsoraki, 2012, 2013, 2014; Wright, 2013). The Çatalhöyük ground stone assemblage presents great variability in object types and raw materials used. The repertoire of ground stone artefacts includes, among others, percussive and grinding tools of varied forms, axes and adzes, grooved abraders, polishing tools and palettes. Tools used in different types of grinding and abrasive activities are well represented within the assemblage and are found within buildings, middens, and external yards. Rocks attributed to all three geological categories (igneous, metamorphic, and sedimentary) as well as minerals are present within the assemblage, but there is a clear tendency towards the use of volcanic rocks, schist, metamorphosed limestone, marble, and different types of greenstone (Tsoraki, 2013, 2014; Wright, 2013). While the exact sources of these materials have yet to be located in the wider landscape, there are indications that certain materials, such as volcanic rocks, and certain forms (e.g. large boulders) would have been procured from substantial distances (Wright, 2013).

Ethnoarchaeological research (Hayden, 1987; Horsfall, 1987; Baudais & Lundström-Baudais, 2002; Searcy, 2011) and empirical studies (Adams, 1988, 2002; Risch, 2002; Dubreuil, 2004; Hamon, 2008; Van Gijn, 2008) have revealed considerable variability in the activities for which ground stone artefacts were employed within different geographical areas and time periods. Activities identified include cereal grinding and the processing of other plants, nuts, and dried meat, as well as the processing of non-edible products such as pigments and animal skins. Ground stone tools also played an important role in other craft activities such as the production of pottery, stone vases, bone tools, and shell ornaments. Similarly, at Neolithic Çatalhöyük, systematic analysis of macroscopic and microscopic wear traces on the surfaces of different ground stone categories under low and high power magnification suggests variation in the activities for which these tools were used. Activities identified so far at Çatalhöyük include plant processing, wood working, skin processing, plastering, and mineral processing (Tsoraki, work in progress).

For the purposes of this study, only grinding tools —mainly made of andesite—employed for processing activities that involved the simultaneous use of an upper and lower grinding tool were selected (i.e. grinders/handstones and grinding slabs/querns, respectively, Figures 3 and 4).[2] During the 2014 field season, the ground stone team re-visited material excavated prior to 2009 and collected data for the size, weight, and morphology of grinding tools. A morphometrical analysis of such tools and of their use faces provides insights into processing techniques and motor habits adopted during the execution of grinding tasks. Overall, grinding technologies at Çatalhöyük seem to have entailed the simultaneous use of both tools (upper and lower) operated with one hand and most likely in a rotary motion, as well as larger-sized tools that would have been operated using both hands in a reciprocal (i.e. back and forth) motion. Preliminary results of the microwear analysis conducted on grinding tools suggest their use for the processing of

[1]In total, *c.* 39000 stones have been assessed by the previous and current ground stone teams, but the vast majority of these are natural stones with no apparent use in ground stone technologies (Baysal & Wright, 2005; Tsoraki, personal observation; Wright, 2013).

[2]These broadly correspond to Wright's type 'Coarse grinding tools/Class B' (Wright, 2013: 373).

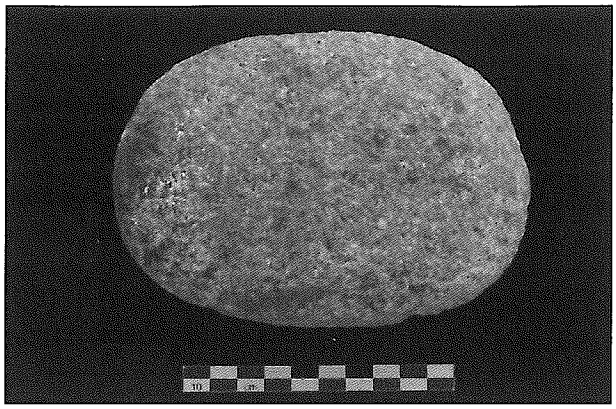

Figure 3. *Example of a grinder from the Çatalhöyük assemblage.*
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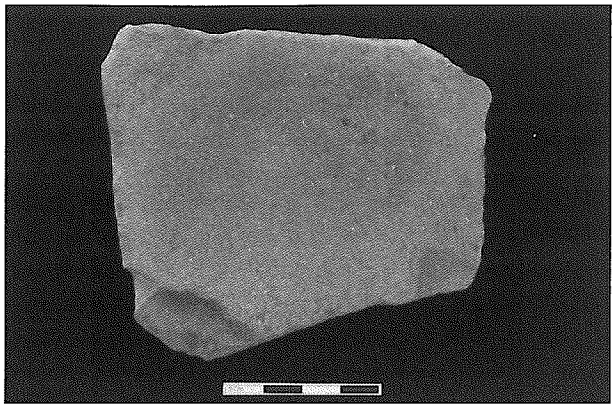

Figure 4. *Example of a grinding slab/quern from the Çatalhöyük assemblage.*
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different plant materials and mostly cereals (Tsoraki, work in progress). The ground stone findings presented in subsequent sections derived from an analysis of one hundred and fifty-two artefacts in total. As noted elsewhere, one of the main characteristics of the Çatalhöyük grinding tool assemblage is the high degree of fragmentation (Tsoraki, 2013; Wright, 2013). For a more accurate picture of the size and weight distribution of these tools, only complete specimens or those with complete dimensions were included in the current analysis.

Projectile points

Chipped stone projectile points have long been a focus of archaeological studies due to their stylistic elaboration, and they have been used extensively in the development of regional chronologies and in defining the boundaries of cultural groups around the world (e.g. Wright, 1977; Warburton & Duke, 1995; Kozłowski & Aurenche, 2005). Their characteristic form has led many archaeologists to accept their function as weapons, even though that might not have been their sole purpose (for an overview of projectile multifunctionality, see Greaves, 1997). Determining point function can offer tremendous insight into hunting techniques and strategies, information which still eludes us to a large extent, and especially so for the Near Eastern Neolithic period (Müller-Neuhof, 2014).

The term 'projectile point' is generic and encompasses all 'chipped stone broadhead [artefacts] incorporating converging edges on a relatively flat body' (Corliss, 1972: 11), which are used as 'launched weapons in hunting or warfare' (Knecht, 1997: 3). This term has generally been adopted in order to avoid making assumptions about specific functions. The bow and arrow and the hand-held spear are two very different weapons that require different sets of skills and that can be used in different contexts or situations. Arrowheads are the stone tips, which were mounted on an arrow shaft and launched using a bow, whereas spearheads are hafted on a longer shaft and propelled with a spear-thrower, thrown as a javelin, or used as a thrusting spear.

North American archaeologists concerned with the timeframe for the invention of the bow first identified the problem of distinguishing among arrowheads and spearheads (for a comprehensive literature review, see Knecht, 1997). Establishing when this new technology first appeared was crucial in understanding profound socioeconomic changes and establishing chronologies. An array of methods have since been developed using one or more variables to distinguish between the two weapons (for a review of such methods, see Hughes, 1998). The method used in this analysis derives from the recent work of Hildebrandt & King (2012: figure 1) and utilizes two projectile attributes that are least susceptible to change resulting from use, impact damage, and/or re-sharpening. These are neck width, a measurement taken at the base of the point just above the tang, and maximum thickness. For untanged projectiles and bifaces that do not have neck width, only maximum thickness was used following Hildebrandt's recommendation (pers. comm., 2013) to one of the authors (L.D.). Using these variables instead of length, weight, or any combination that includes them, maximizes sample sizes because both complete and fragmented artefacts can be used in the analysis.

The projectile point assemblage excavated by the Çatalhöyük Research Project consists in its entirety of approximately one-thousand two-hundred artefacts[3] coming from both external areas, mainly middens, and houses (Figure 5). The Çatalhöyük projectiles were

[3]These include projectiles, their preforms, projectiles in secondary use (e.g. projectiles used as *pièces esquillées*) and impact byproducts (e.g. burin-like spalls and fluting-like flakes).

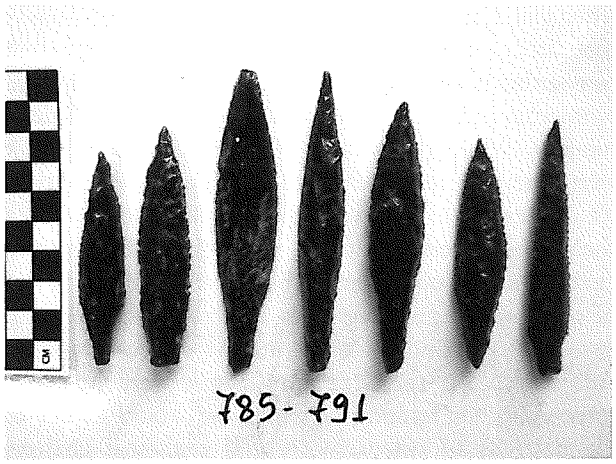

Figure 5. *Examples of projectile points from the Çatalhöyük assemblage.*
Photograph by Lilian Dogiama.

made of excellent quality obsidian, a very clear and sharp black volcanic glass. Obsidian can be found in a number of locations in Turkey, but the obsidian used at Çatalhöyük came from sources at Göllü Dağ and Nenezi Dağ in central Anatolia, some 190 km away from the site (Carter et al., 2006; Carter & Shackley, 2007). For the purposes of this analysis, fragmentary points (i.e. tips or stems) that did not preserve the neck width were excluded, while some of the material excavated by James Mellaart was included to increase sample size. The results presented in the following sections were obtained through analysis of a total of 633 projectile points.

Integrating the Analyses

Activity patterns between the sexes

Ethnographic research and iconographic sources tend to support the idea that grinding grain is primarily a female activity and that in the course of these activities, different postures can be adopted, such as standing or kneeling (cf. Roux, 1985: Plate 12; Searcy, 2011: figures 5.6 and 5.13). Variation in bodily positions adopted during grinding can also be observed between experienced and less experienced/novice grinders. For example, experienced Hopi women in the American Southwest emphasize the importance of using rhythmic strokes during grinding activities, with the whole body being used, not only the upper limbs (Adams, 2002). The preferred bodily position during grinding activities tends to be a seated/kneeling position with the tool being placed in front of the user and the use of a reciprocal motion that involves the extension of the upper limbs.

Querns at Çatalhöyük were set directly on the plastered floor surfaces and platforms as suggested by examples of querns found *in situ* in Building 77 in the North Area (House, 2014) and Building 89 in the South Area (Taylor, 2014). This, in tandem with the lack of evidence for the use of querns mounted on raised structures, suggests that grinding on the ground in a kneeling position seems to have been the standard method employed at Neolithic Çatalhöyük. Adopting a kneeling position requires considerably more effort 'to push off from the toes, to bear down with the arms, and to support the body in the correct position, and stress is placed on the knees, wrists and lower dorsal vertebrae' (cf. Molleson, 1989; Samuel, 2010: 467). In her study of the human skeletal assemblage from Abu Hureyra, Molleson (1994) noted that grinding grain in a kneeling position on a daily basis and/or for prolonged periods put considerable stress on the toes and lower back, as well as the hips and knees, as the body pivots alternately around these joints during the grinding motion. In addition, daily or at least regular grinding is a process that would have required sufficient upper limb strength to endure prolonged periods of constant, rigorous motion.

Turning to hunting activities, the ethnographic record is replete with accounts of male hunters, with female hunters being only a rare exception. Multiple ethnographic accounts from agricultural societies across the Americas, Asia, and Africa show that hunting is an almost exclusively male activity (e.g. among the Cree [Brightman, 1996], the Navaho [Hill, 1938], the Sharanahua [Siskind, 1973], the Siriono [Holmberg, 1969], the Yafar [Juillerat, 1996], the Sambia [Herdt, 1987], the Baruya [Godelier, 1986], the Ndembu [Turner, 1967], and the Nuer [Evans-Pritchard, 1940]). The wall iconography of Çatalhöyük also suggests that hunting was an activity primarily performed by males, as the hunting scenes uncovered during the excavations of the 1960s (Czeszewska, 2014; Mellaart, 1967: Plates 54 and 61) seem to lack any hunters with female characteristics, such as the voluptuously depicted features on the few female figurines found at the site (Nakamura & Meskell, 2013). Although the paintings are not naturalistic in style, individuals depicted as bearing bows and arrows or hand-held spears appear to be men.

The spear and the bow and arrow each have their own distinct advantages and disadvantages as weapons employed in hunting activities (Table 2), all of which would have been considered (or taken into account) by those making and using them. The use of javelin/throwing spears and thrusting spears is attested already in the Palaeolithic, making it one of the earliest weapons used in hunting and violent conflict (Shea, 2006). The hand-thrown spear requires 'skill and a good deal of muscular effort' in order to 'fell a relatively

Table 2. *Comparison of the spear and the bow and arrow as hunting weapons*

Feature	Spear	Bow and Arrow
Weight	Heavier	Lighter
Velocity	Lower	Higher
Accuracy	Less accurate	More accurate
Range	Short to mid-range • *c.* 10–50 m	Long range • *c.* 100–200 m
Lethality	High • Heavier weight allows for deeper penetration of target and graver internal injuries • Nature of injuries requires less tracking time by hunter	High • High velocity allows for through and through wounds of the target • Requires longer tracking time by the hunter following strike
Danger	Higher • Shorter range would require hunter to be in close proximity to dangerous prey	Lower • Longer range allows for hunter to maintain safe distance from target
Energy	Higher • Heavier weight requires a greater level of muscular effort by the hunter	Lower • Lighter weight makes it a more energy-efficient weapon for the hunter

Sources: Odell & Cowan (1986); Bergman et al. (1988); Cotterell & Kamminga (1990); Hughes (1998); Shea (2006).

distant and fast-moving target' (Cotterell & Kamminga, 1990: 164), while the bow can shoot an arrow much faster, more accurately, and at a greater distance than the human hand can throw a spear. Despite their differences, both the spear and the bow and arrow are governed by the same engineering principles—the upper limb transfers energy to the projectile, which in turn propels it towards the target (Hughes, 1998).

The ethnographic record of a diverse sample of populations and the figurative representations at Çatalhöyük suggest that we should expect to see some differences in activity patterns between males and females. If women and men at Çatalhöyük were engaging in broadly different physical activities, associated with grinding and hunting, respectively, we anticipate seeing these differences reflected in patterns of osteoarthritis and entheseal changes related to habitual biomechanical stress and observed in their skeletal remains. More specifically, if women at Çatalhöyük were primarily responsible for grinding activities, then we may expect to observe high levels of osteoarthritis in their hips, knees, and feet, as well as degenerative changes in the upper limbs that correspond to the use of one-handed grinding tools in a rotary motion and two-handed grinding tools in a reciprocal motion. Additionally, if males at Çatalhöyük were primarily responsible for hunting activities, we would expect to see patterns of osteoarthritis and entheseal changes consistent with the use of the hand-held spear (with stresses concentrated in one limb and unilateral medial epicondylosis at the elbow), consistent with the use of the bow and arrow (with stresses distributed across both limbs and including all joint groups), or some combination of both patterns.

Turning first to the frequency of osteoarthritis (Table 3), significant differences between males and females were observed for the hip ($p < 0.01$), ankle ($p < 0.01$), and foot ($p = 0.02$), while results for the hand approached statistical significance ($p = 0.10$). Females displayed a higher frequency and severity of osteoarthritis for the hip (Figure 6), while males displayed a higher frequency and severity of osteoarthritis for the ankle (Figure 7), foot (Figure 8), and hand (Figure 9). Beyond examining the frequency and severity of osteoarthritis across joint groups, it is also useful to examine whether the expression of osteoarthritis appears to be more unilateral (i.e. affecting mainly one side) or bilateral (i.e. affecting both sides similarly). For the Çatalhöyük human remains assemblage, it is clear that a difference in the pattern of laterality exists between males and females for the upper limb (Table 4). In males, the right side is affected to a greater degree for all joints of the upper limb: the shoulder, elbow, wrist, and hand. In females, the pattern is less consistent and

Table 3. *Age-controlled frequency of osteoarthritis (% joints affected) for females and males at Çatalhöyük*

	Young (20–29 years)		Middle (30–49 years)		Older (50+ years)		
Joint	Females	Males	Females	Males	Females	Males	*p*-value
Shoulder	17.7	0	12.5	26.3	58.1	25.0	0.52
Elbow	7.1	0	13.6	29.3	54.1	30.8	0.84
Wrist	23.5	15.0	25.0	33.3	64.1	30.0	0.56
Hand	17.7	26.3	26.2	38.6	59.5	75.0	0.10**
Hip	18.2	0	37.1	14.6	46.0	25.0	<0.01*
Knee	18.8	22.7	29.7	25.0	53.1	42.9	0.58
Ankle	12.5	33.3	15.9	50.0	55.0	61.5	0.02*
Foot	25.0	50.0	22.0	48.8	76.5	71.4	<0.01*

**Statistically significant at α=0.05.*
***Statistically significant at α=0.10.*

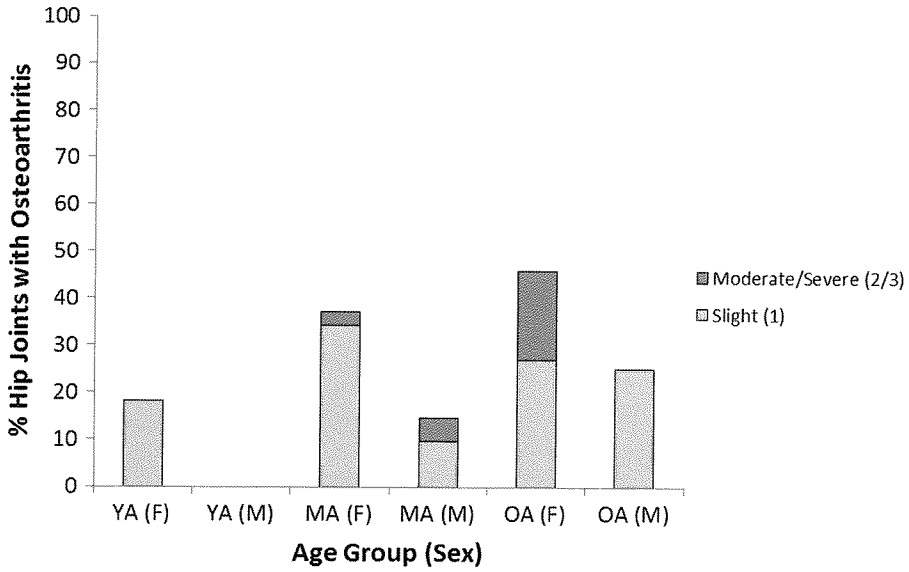

Figure 6. *Frequency and severity of hip osteoarthritis between males and females at Çatalhöyük.*

not particularly right-side dominant, with the left wrist being affected to a greater degree than the right wrist. This suggests that men engaged more regularly in activities that favoured the use of the right limb over the left, while women engaged more frequently in activities that required the use of both limbs.

The same pattern of right-side dominance in males also holds when the L/M ratio is examined. The L/M ratio for both arms in females and for the left arm in males is greater than one, whereas for the right arm in males, the L/M ratio falls below one at a value of 0.87 (Figure 10). This L/M ratio highlights a specific pattern of right arm use among males, suggesting that men were more likely than women to engage in activities that favoured the use of the right arm and a repetitive overhead throwing motion, such as hunting with a hand-held spear. The higher frequency of osteoarthritis in the ankles and feet of males compared to females may also be related to hunting activities, as walking, running, and quick changes in direction on rugged terrain during hunting trips may have contributed to a heightened frequency and severity of degenerative changes in these lower limb joint groups. The patterns of osteoarthritis and entheseal changes in the upper limbs of males support the use of hand-held spears in hunting, with the right arm affected to a greater degree than the left. Nonetheless, both limbs and all joint groups are affected, indicating that males

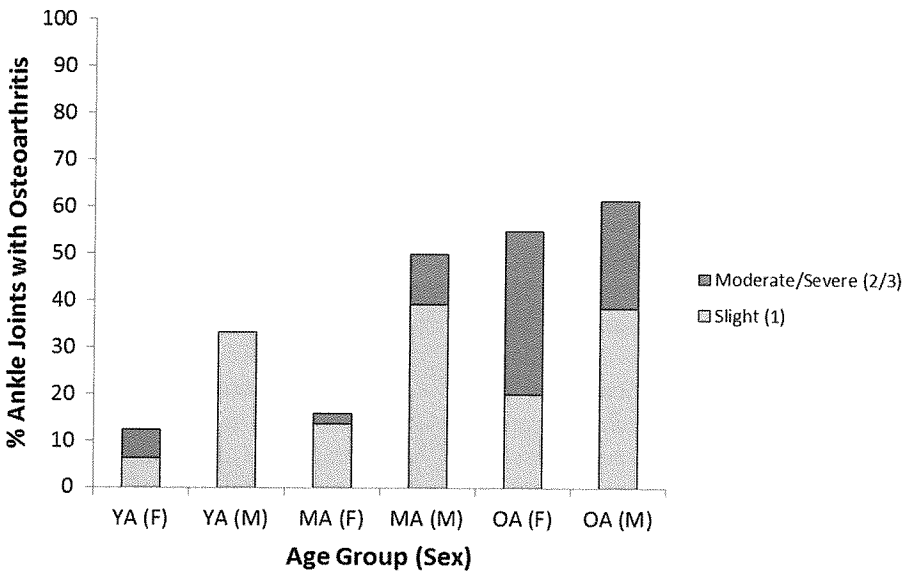

Figure 7. *Frequency and severity of ankle osteoarthritis between males and females at Çatalhöyük.*

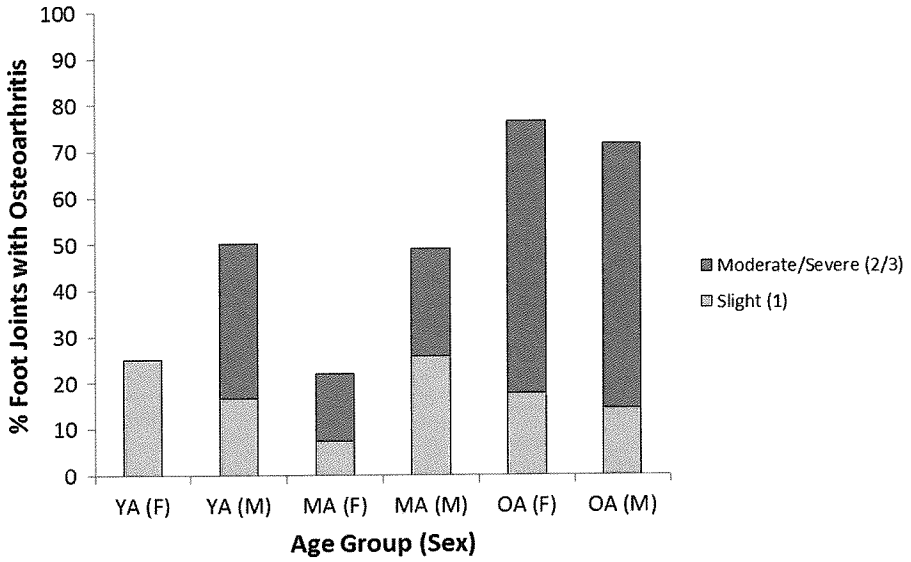

Figure 8. *Frequency and severity of foot osteoarthritis between males and females at Çatalhöyük.*

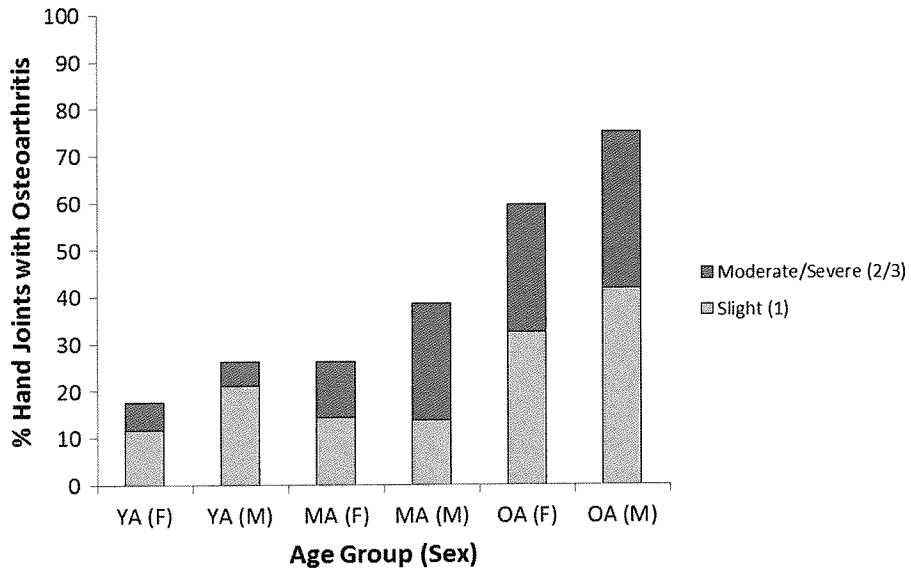

Figure 9. *Frequency and severity of hand osteoarthritis between males and females at Çatalhöyük.*

Table 4. *Ratio of osteoarthritis (% joints affected) in the right and left upper limbs of females and males as a measure of laterality*

Joint	Sex	Right side (R)	Left side (L)	R/L ratio
Shoulder	Females	34.1	25.0	1.36
	Males	20.6	19.4	1.06
Elbow	Females	29.4	27.3	1.08
	Males	25.0	18.9	1.32
Wrist	Females	36.7	43.1	0.85
	Males	35.1	21.1	1.67
Hand	Females	45.8	29.2	1.57
	Males	42.9	40.0	1.07

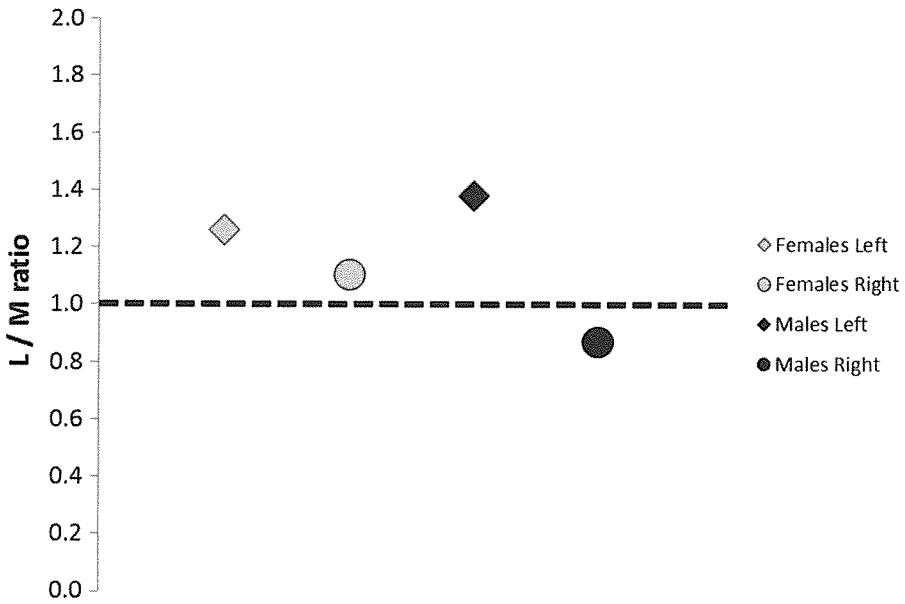

Figure 10. *Ratio of lateral to medial epicondylosis (L/M) in the right and left arms of males and females at Çatalhöyük.*

also broadly engaged in activities involving the use of both upper limbs. The projectile point assemblage indicates the use of both the hand-held spear and bow and arrow in hunting activities throughout the occupation of the site, and the pattern observed in the skeletons of the men of Çatalhöyük may also reflect the use of different types of weaponry to various extents —thus, the expectations outlined above for males appear to be validated.

The same is broadly true for the expectations related to female activity patterns as reflected through their skeletal remains. The frequency of hip osteoarthritis is significantly higher in females compared to males, and the frequency of knee osteoarthritis is also higher, though not statistically significant, when compared to that of males (see Table 3). These are two joint groups of the lower body that are heavily stressed in grinding activities, during the use of two-hand *manos* and querns when a kneeling position is adopted. The degree of laterality in the upper limb is also less consistent among women compared to men, suggesting the more regular use of both upper limbs in the course of habitual or daily activities. Furthermore, the relatively high degree of wrist osteoarthritis in females compared to males could be attributed to twisting, rotary movements in the course of grinding activities with one-hand grinding tools. Both of these results are consistent with the nature of the Çatalhöyük ground stone assemblage, as both one-hand and two-hand *manos*[4] are present in varying proportions during the occupation sequence of the site.

[4]The terms 'one-hand *mano*' and 'two-hand *mano*' are borrowed from archaeological studies of the American Southwest and are widely used in ground stone studies (Adams, 2002).

Given the myriad activities in which the people of Çatalhöyük regularly engaged beyond grinding and hunting, there are certainly many other habitual movements and motions that contributed to the patterns observed in women and men described above. However, the expectations generated on the basis of the ground stone and projectile point assemblages, as well as the ethnographic record, are broadly supported. Women and men at Çatalhöyük did engage in different activities—women assumed a greater role in grinding activities and men a greater role in hunting activities—and these differences in daily life are also alluded to in wall paintings and figurines (Hodder, 2004; Czeszewska, 2014). Although ongoing analyses still support the earlier assertion that mortuary practices, diet, and relative status did not greatly differ among women and men at Çatalhöyük (Agarwal et al., 2015; Hodder, 2004), the present study reveals that their daily lives and habitual activity patterns may not have been so similar.

Activity patterns through time

Numerous datasets excavated and analysed during the most recent phases of the Çatalhöyük Research Project provide evidence for substantial change throughout the course of occupation (Hodder, 2014a and references therein). In this chapter, we approach the question of temporal change with a focus on the ground stone, projectile point, and human skeletal assemblages. Do the ground stone and projectile point assemblages signify a shift in emphasis on different types of grinding and/or hunting technologies over the

course of time and, if so, are these differences also seen in activity-related stress markers observed on the human skeletons? For the purposes of this analysis, we divide the site into two broad temporal periods (Table 5): Period 1 is represented by levels South M, N, and O and North F and G, which roughly correspond to the growth and peak size of the Neolithic population, while Period 2 is represented by levels South P through T and North H, I, and J, which correspond with a post-peak decline in population size (and see Hodder, 2014a for a detailed discussion of temporal changes at Çatalhöyük).

There are apparent differences in the Çatalhöyük ground stone assemblage between Period 1 and Period 2. While there is a tendency towards the use of lighter grinders in both periods, 31.6 per cent of the grinders attributed to Period 1 weigh more than 1250 g, whereas in Period 2 this drops to only 10 per cent (Figure 11). When the size distribution of grinders is considered, it becomes evident that grinders dated to Period 1 tend to cluster into two groups: Group 1 has an average size of *c.* 11 cm, and Group 2 *c.* 15 cm (Figure 12). Thus, the grinders used in Period 1 tend to be larger and heavier than those used in Period 2. This suggests that during Period 1, two modes of grinding were in place that entailed the use of grinders operated with one hand and two hands, respectively (i.e. one-hand/two-hand *manos*), while the grinders of the subsequent phases seem to have been operated with one hand only. This pattern is also replicated when the size of querns is considered. Overall, querns attributed to Period 1 tend to be larger than those of Period 2 (Figure 13), confirming that two modes of grinding were regularly employed during Period 1 and one mode was predominant in Period 2.

Table 5. *Levels corresponding to the two time periods used in this analysis (modified from Hodder (2014a))*

Time Period	Levels		Years cal BC
	South	North	
Period 2	T	J	6400–6000
	S	J	
	R	I	
	Q	H	
	P	H	
Period 1	O	G	6500–6400
	N	G	
	M	F	6700–6500
Not included due to small sample sizes*	L	F	7300–6800
	K	—	
	J	—	
	I	—	
	H	—	
	G1, G2, G3, G4	—	

**Sample sizes for the assemblages of interest here- especially the human skeletal assemblage- were too small in levels earlier than South M or North F to allow for their inclusion in the present analysis.*

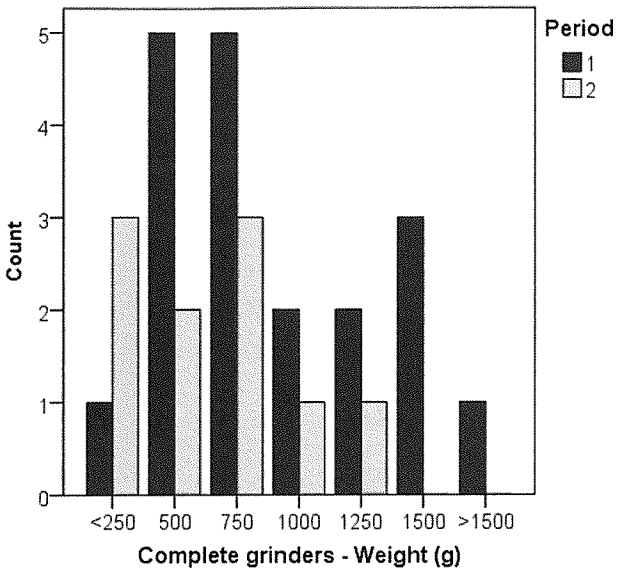

Figure 11. *Weight distribution of complete grinders (n=29) during Period 1 and Period 2 at Çatalhöyük.*

The use of larger and heavier tools during grinding activities has implications for the strength and energy invested and would have made the task a more demanding physical activity. Another issue to take into consideration is the frequency with which grinding tasks were performed at Çatalhöyük. Ethnographic research highlights that grinding activities could take place either daily or at less regular time intervals such as once every other week depending on the properties of the product being processed, cultural ideas about the texture of the product to be processed (i.e. if there is a preference for flour of a fine texture, cereals must be ground multiple times), and food recipes (cf. Searcy,

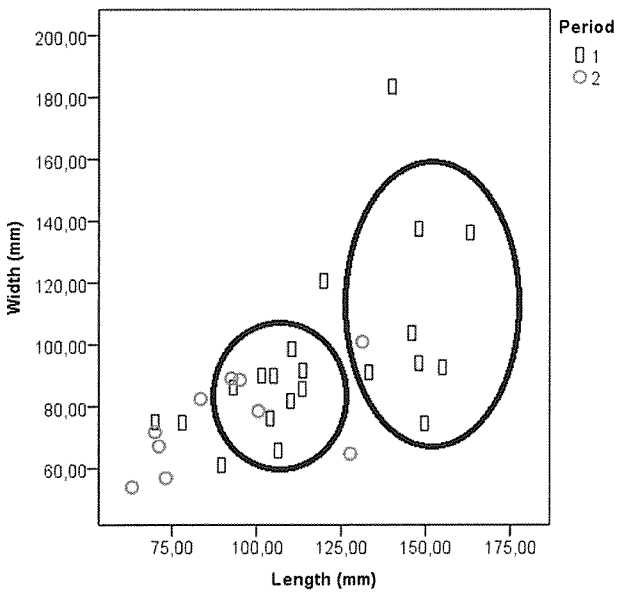

Figure 12. *Size distribution of complete grinders (n=31) during Period 1 and Period 2 at Çatalhöyük. The circles indicate the two size groups present in Period 1.*

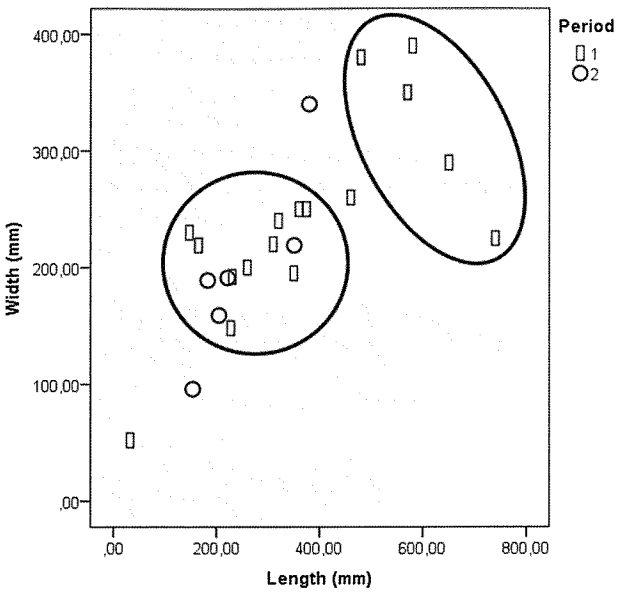

Figure 13. *Size distribution of complete grinding slabs/querns (n=23) during Period 1 and Period 2 at Çatalhöyük. The circles indicate the two size groups present in Period 1.*

2011). In the case of Çatalhöyük, grinding tools from both Period 1 and Period 2 tend to have been used moderately such that there is no significant variation in the degree of wear (and by inference, the frequency of grinding activities) between the two periods.

Just as with the ground stone assemblage, the projectile point assemblage differs between Period 1 and Period 2. During Period 1, spearheads seem to dominate the assemblage, comprising almost 60 per cent, while in Period 2 the reverse is true, with arrowheads becoming more frequent at 60 per cent (Figure 14). Thus, both the hand-held spear and bow and arrow were in use throughout the Çatalhöyük occupation sequence, but a shift in the preferred hunting technology occurred between Period 1 and Period 2. The wall paintings uncovered by Mellaart during the 1960s excavations that depict hunting scenes were found later in the occupation sequence (Levels V and III), corresponding to Period 2 in the present analysis (Mellaart, 1967: Plates 54, 57, and 61; Czeszewska, 2014). These levels and the hunting scenes within them are thus associated with a period when the use of the bow and arrow predominated, as reflected by the projectile point assemblage, and indeed, use of the bow and arrow is emphasized over the spear in the wall iconography as well. Most of the males depicted in these hunting scenes are shown using the bow and arrow, with only one possible spear-bearer depicted.

The ground stone and projectile point assemblages, as well as the wall iconography, point to changing technologies and grinding and hunting practices through time, but are these changes reflected in activity-related stress markers observed on the human skeletal remains? Given that the use of larger and heavier grinding tools is mainly concentrated in Period 1, we would expect to see a higher frequency of osteoarthritis in both the right and left upper limbs during this time, reflecting the use of both limbs in a reciprocal motion when grinding with a two-hand *mano*. We would also expect higher frequencies of osteoarthritis in Period 1 more generally,

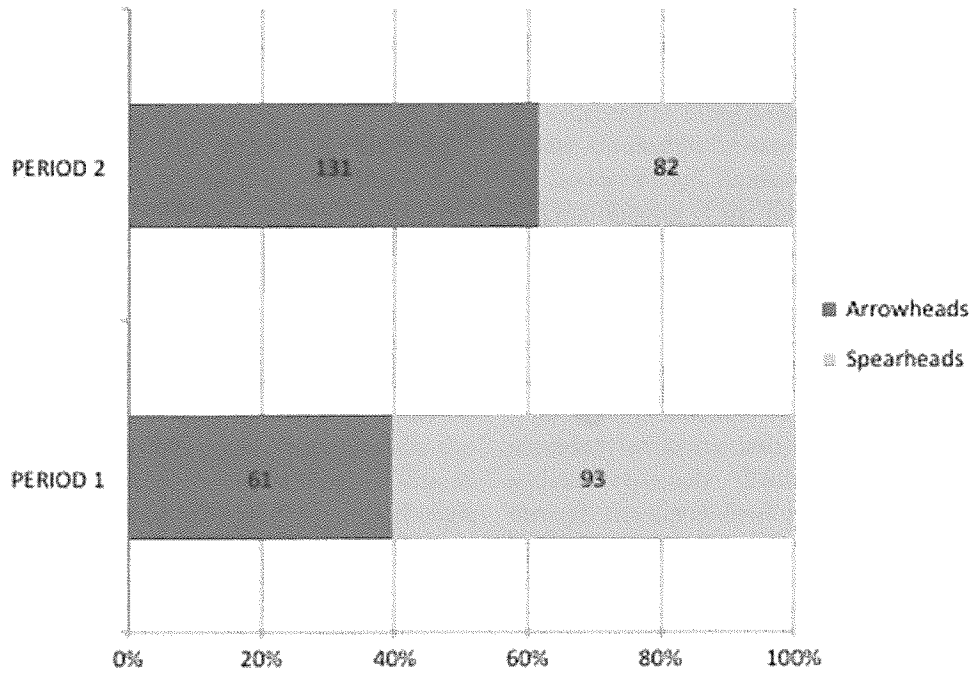

Figure 14. *Distribution of arrowheads and spearheads between Period 1 and Period 2 at Çatalhöyük based on projectile point analysis using the Hildebrandt and King method (2012).*

Table 6. *Age-controlled frequency of osteoarthritis (% joints affected) for Period 1 and Period 2 at Çatalhöyük*

	Young (20–29 years)		Middle (30–49 years)		Older (50+ years)		
Joint	**Period 1**	**Period 2**	**Period 1**	**Period 2**	**Period 1**	**Period 2**	***p*-value**
Shoulder	11.1	14.3	16.7	4.6	46.2	0	0.02*
Elbow	0	9.1	21.1	13.0	61.5	20.0	0.08**
Wrist	0	41.7	25	22.2	60.7	10.0	0.66
Hand	5.0	40.0	33.3	15.4	51.7	55.6	0.93
Hip	6.7	22.2	18.9	16.7	50.0	22.2	0.52
Knee	11.1	28.6	18.0	18.1	44.4	27.3	0.98
Ankle	23.8	9.1	30.0	21.4	60.0	41.2	0.11
Foot	41.2	45.5	33.3	25.0	71.4	54.6	0.38

**Statistically significant at α=0.05.*
***Statistically significant at α=0.10.*

as the procurement of raw materials for, manufacture of, and use of larger and heavier grinding tools puts a greater degree of physical stress on the body than the same tasks associated with one-hand *manos*. In terms of hunting activities, we would expect to see a specific signature of right arm use in Period 1, demonstrated by a higher degree of medial epicondylosis (L/M ratio <1.0) and reflecting the repetitive overhead throwing motion characteristic of hunting with a hand-held spear, the predominantly used weapon during this period.

The frequency of shoulder osteoarthritis is significantly higher in Period 1 compared to Period 2 (p = 0.02), while differences observed in the elbow also approached statistical significance (p = 0.08). Furthermore, there is an overall trend towards higher frequencies of osteoarthritis in Period 1 compared to Period 2 reflecting a higher degree of rigorous, physically demanding activities during this period (Table 6). Interestingly, two joint groups for which this trend appears to be the least pronounced are the wrist and hand. As grinding technologies shifted away from the use of two-hand *manos* in Period 1 to the almost exclusive use of one-hand *manos* in Period 2, grinding techniques would also have shifted from a reciprocal motion to a rotary motion. Thus, differences in the patterning of osteoarthritis across the upper limbs between Period 1 and Period 2 could, in part, reflect changing biomechanical stresses in the course of grinding activities.

An examination of the L/M ratio of the right and left upper limbs between Period 1 and Period 2 reveals a signature of changing hunting practices through time, as the L/M ratio of the right arm for Period 1 is the only value to fall below the threshold of one, at 0.89 (Figure 15). This result indicates a specific pattern of right arm use in Period 1 likely

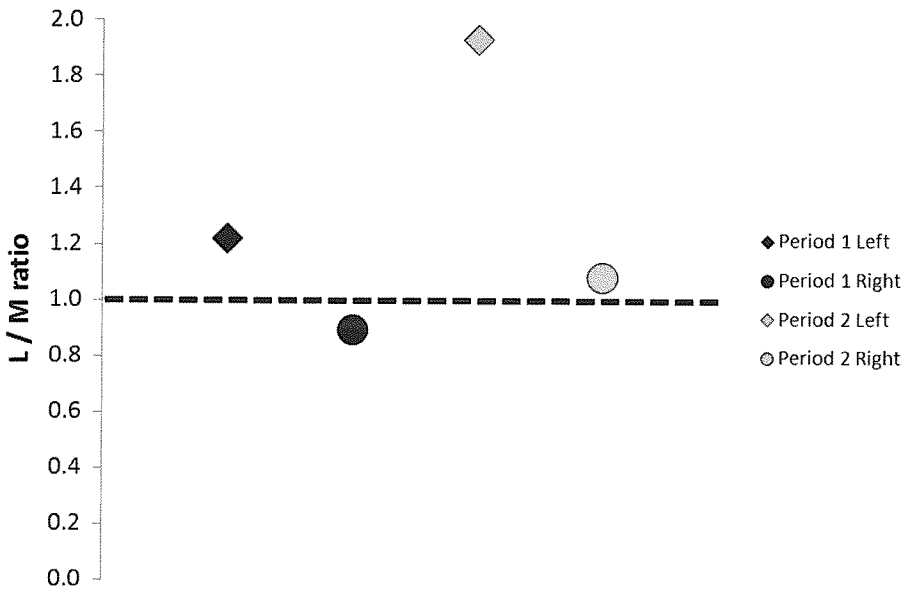

Figure 15. *Ratio of lateral to medial epicondylosis (L/M) in the right and left arms of individuals dating to Period 1 or Period 2 at Çatalhöyük.*

associated with the predominant use of hand-thrown projectiles in hunting activities during this time, a pattern that is less evident in Period 2 when use of the bow and arrow becomes predominant at Çatalhöyük. Overall, then, changing practices associated with grinding and hunting activities, as inferred from technological changes observed in the ground stone and projectile point assemblages between Period 1 and Period 2, are also reflected in varying frequencies and patterns of activity-related stress markers observed on the human skeletal remains.

Conclusions

The present study, like others in this and other volumes (Hodder, 2014b), illustrates the interpretive power generated through the integration of multiple archaeological datasets within a single analysis. In this case, integration of the ground stone and projectile point assemblages with the human skeletal remains, along with consideration of some of Çatalhöyük's best-known figurative representations, has led to a fuller understanding of social practices and activities at the site than could have been achieved through interpretation of any of these datasets in isolation. Habitual activities among women and men at the site differed to a measureable extent, not just in the wall paintings and figurines as was previously known, but also in the lived experiences of the people who created them. Furthermore, changes in grinding and hunting technologies over the course of the occupation sequence correspond to changes in human activity, which in turn left unique signatures on the skeletal remains of Çatalhöyük's people.

A point worth noting, but one that is beyond the scope of this paper, is the nature of the alignment between the human skeletal, ground stone, and projectile point assemblages and the figurative representations. Differences revealed through the integrated analyses of these three datasets, with regard to differences in activity patterns between the sexes and changing activity patterns through time, fit very neatly with the interpretations made through wall paintings and figurines at the site (Hodder, 2004). It could be argued, then, that these figurative scenes, especially the hunting scenes, are genuine representations of life at Çatalhöyük created by those who lived there. Although most of the wall paintings uncovered to date at Çatalhöyük show geometric or abstract patterns, a recent geochronological analysis has indicated the possibility that a very well-known mural, described as depicting a volcanic eruption by Mellaart (1964, 1967: Plates 59 and 60), could indeed be an artistic representation of an eruption of Hasan Dağ that chronologically overlaps with the occupation of the site (Schmitt et al., 2014). The alignment between the hunting scenes and the different datasets integrated in the present analysis, then, could point to these paintings also being representational of specific events, and even particular individuals within the community, a proposition worth considering in relation to the social and ritual aspects of life and the idea of history-making at Çatalhöyük (cf. Hodder, 2012), and one that may someday be clarified through new discoveries and other integrative analyses at the site.

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