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ENTHESEAL CHANGE OF THE UPPER LIMB IN A MYCENAEAN POPULATION FROM ATHENS

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ABSTRACT

Entheseal changes are potentially useful tools through which the daily activity patterns of individuals within a population may be interpreted through the perspective of a biocultural framework. Studying these patterns in Mycenaean Athens may assist in comprehending intensity of daily behavior of males and females. The upper limb bones of thirty four individuals from the skeletal collection of the Athenian Agora were studied in order to ascertain sex- and age-based differences in entheseal change patterns. The methodological approach implemented in this study differs from most previous studies in its analysis, as entheseal change scores were aggregated in groups that correspond to muscle movements. The results indicate that there is little significant overall sexual dimorphism of musculoskeletal entheseal change for this population sample when entheseal change is observed in individual muscle attachment sites. However, when the results are aggregated into groups that correspond to upper limb movements, some differences in behavior between males and females emerge in the youngest available age category, which indicates a differentiation of roles without necessarily a significant difference in degree of rigor. This is consistent with existing knowledge of Mycenaean era Greek settlements. Further research into the utility and application of the aggregation utilized in this study is necessary.

KEYWORDS: entheseal change; enthesopathy; occupational stress; Bronze Age; Greece

1. INTRODUCTION

Entheseal changes are frequently studied by bioarchaeologists in order to ascertain the behavioral trends of past populations. In this context, they are potentially useful tools through which the daily activity patterns of individuals within a population may be interpreted through the perspective of a biocultural framework.

The study of entheseal changes in Greek populations is lacking from the international bibliography. Until now, scholars working with Greek populations have focused on other pathologies such as osteoarthritis, or systemic stress associated with disease or nutritional disruptions. The Late Helladic III skeletal remains associated with burials of the Athens Agora offer an opportunity to examine trends in physical activity from the perspective of division of labor and labor intensity.

The present study attempts to document and interpret activity related changes, and possible sexual dimorphism of their expression, in muscle and tendon attachment sites of the bones of the upper limb in individuals of the Mycenaean era burials of the Athens Agora. The remains were studied in terms of sex and age based differentiation of entheseal change patterns. These remains have been studied extensively by J.L. Angel (1945). Initial findings of this current study were reported by the authors at the 19th European Meeting of the Paleopathology Association (Mountrakis 2012).

Much attention has been given to the proper study of entheseal changes recently. Many authors have contributed to the multifactoral etiology of the formation and presence of entheseal variation such as age (Robb,1998; Mariotti et al., 2004, 2007, 2009; Alves-Cardoso & Henderson, 2009; Villotte, 2009, 2010, 2013; Milella 2012); body size, sex, metabolic, genetic and pathological influences (Wilczak,1998; Weiss, 2003, 2004), the categorization of attachment sites and their anatomy (fibrocartilaginous vs. fibrous entheses) (Villotte, 2006, 2009; Alves-Cardoso & Henderson, 2010; Villotte et al.,2010). Up until recently, it was common to come across the terms musculoskeletal stress markers, entheseal changes, activity related entheseal change markers, occupational stress markers, or enthesopathies, used interchangeably in the bibliography. For the purposes of this study, entheseal change is defined as any morphological change on the surface of bone as a direct result of physical exertion, or repetitive/habitual activities.

While this study explores differences on occupational behavior that can be attributed to role differentiation and thus gender, the terminology utilized in this work will reflect biological sex, as is established by bioarchaeological metho-dology. Reference to the gender and social rank of the individuals that make up the skeletal sample is not possible as the artefactual data associated with the burials is limited and not utilized in the data analysis. Any references made to social gender will be done so in the context of relevant cited work where the authors utilize social terminology. Social rank cannot be used.

2. MATERIALS AND METHODS

2.1 Materials:

The remains that make up the skeletal assemblage originate from several discrete excavations within the Athenian Agora, of Mycenaean era /Late Helladic III, (Shelmerdine, 1997) graves that are located throughout its grounds, and are housed in the Museum of the Agora (Stoa of Attalus), Athens, Greece. The graves attributed to the Mycenaean period have been categorized into four principle groups: a. those along the north slope of the Areopagus, b. those along the east slope of the Kolonos Agoraios, c. those under the Temple of Ares and the Odeion, and d. those under the north end of the Stoa of Attalos (Thompson, a, b; Townsend, 1955; Vermeule & Travlos, 1966).

Of the 140 individuals recorded in the collection, 34 were included in the study. Only adult skeletons of discernable age at death and sex were included, and within those criteria, only those that had upper limb bones in good condition (where the surface of the bone in the muscle and tendon attachment sites was in good enough condition to be observed). All skeletons that did not meet these criteria were excluded from the sample. Age at death and sex of these individuals were on record in the archives of the Athens Agora, and were taken from a collections list compiled by Lisa M. Little and confirmed using standard techniques, specifically using Lovejoy's method for the auricular surface of the ilium and the Todd method for the pubic symphysis, whenever possible (Buikstra & Ubelaker, 1994). The sample thus consists of 19 males and 15 females, with 13 individuals of both sexes in the age category *20-35*, 17 individuals in the category *36-49*, and 4 individuals in the category *50+*. Table 1 displays the demographic information for the sample that was examined. As an aside, one of the challenges of conducting a study such as this is the relative difficulty in obtaining sufficiently large skeletal samples from discrete burials in good condition from Greek archaeological collections.

Table 1 Sample Size (N), Age and Sex

Age Group	Males	Females	Total
20-35	8	5	13
36-49	9	8	17
50+	2	2	4
Total	19	15	34

A number of the graves from which skeletal samples were observed contained grave goods that may be an indication of social status, but many other graves contained no such goods. Therefore, the parameter of social status by grave goods will not be included in the statistical analysis of the sample.

2.2 *Methods*

Kennedy (1989, 1998), Hawkey & Merbs (1995) were among the first to examine entheseal change patterns in an anthropological context. Since then, entheseal changes have been defined by a number of researchers in the past twenty years, with a degree of variation in these definitions (and hence the terminology utilized by each). This variation is mostly due to differences of opinion as to the nature of morphological change on the surface of bones at muscle and tendon insertion sites, and to what extent they can be interpreted (Jurmain, 1999; Stirland, 1998; Weis, 2012; 2007). Therefore it is common to come across the terms *enthesopathy*, *musculoskeletal stress marker*, *occupational stress marker,* interchangeably.

Entheseal changes refer to the morphological changes that occur on the surface of bones at and around muscle and tendon insertion sites, or *entheses*, that result from physical activity. It is therefore hypothesized that the morphological features of an enthesis may reflect a degree of interaction with the environment, and comparison between defined subgroups (age groups, sexes, etc) can provide insights into behavioral differences between these subgroups. The anatomy and categories of entheses have been described by Benjamin (a,b), Dutour (1986), and Villotte (2006). Villotte and Knusel (2013) assert that the changes of fibrous entheses may not be good indicators of activity and that changes observed in these sites may be related to growth and development, or inactivity. Further exploration of this issue is necessary.

The method for evaluating and recording these changes is based on the method initially described by Hawkey and Merbs (1995) and has been since reproduced with modifications by other researchers (Godde, 2011; Havelkova, 2011; Lieverse, 2009; Molnar, a, b; Nagy, a, b; Weis, a, b; Wilczak, 1998). Due to the limitations of the initial method, two types of morphological change are examined and analyzed separately: robusticity and stress (pitting) lesions. The scale ranges from 0-3, from least to most pronounced and scores surface features of the entheses and stress lesions separately. Fibrous and fibro-cartilaginous sites are identified and recorded separately (Villotte, 2006).

The method implemented in this study focuses on a total of 33 attachment sites on the bones of the upper limb: humerus, radius, ulna, scapula, and clavicle (Table 2).

Table 2. Attachments Included in Study

Muscle	Location	Type
Biceps brachii	*Radius*	Fc
Supinator	*Radius*	F
Pronator Quadratus	*Radius*	F
Flexor Pollicus Longus	*Radius*	F
Extensor Pollicus Brevis	*Radius*	F
Pronator Teres	*Radius*	F
Brachialis	*Ulna*	Fc
Triceps	*Ulna*	Fc
Anconeus	*Ulna*	Fc
Flexor Dicitorus Profundus	*Ulna*	F
Supinator	*Ulna*	F
Trapezius	*Scapula*	F
Pectoralis Minor	*Scapula*	F
Deltoidius	*Scapula*	F
Triceps	*Scapula*	F
Teres Minor	*Scapula*	F
Teres Major	*Scapula*	F
Bi cor br	*Scapula*	F
Costal Tuberosity	*Clavicle*	F
Conoid Tuberosity	*Clavicle*	F
Subclavian Tuberosity	*Clavicle*	F
Deltoid	*Clavicle*	F
Trapezius	*Clavicle*	F
Pectoralis Major	*Clavicle*	F
Teres Minor	*Humerus*	F
Teres Major	*Humerus*	F
Pectoralis Major	*Humerus*	F
Deltoidius	*Humerus*	F
Flexors common origin	*Humerus*	Fc
Infraspinatus	*Humerus*	Fc
latissimus dorsi	*Humerus*	F
Suprasinatus	*Humerus*	Fc
Coracobrachialis	*Humerus*	F
Brachioradialis	*Humerus*	Fc
Extensors common origin	*Humerus*	Fc

Fc = Fibrocartilaginous , F = Fibrous

As with other studies of this nature, the objective is not to associate entheseal change patterns with specific activities, but rather to analyze differences of activity level between subgroups in order to evaluate the usefulness of the method in comparing socioeconomic roles of sexes and age-groups.

In order to examine the results in terms of actual movements performed, an analysis was also carried out in which the attachment sites were organized in aggregates that correspond to muscle movements of the upper limb. These aggregates are further categorized into shoulder movements and elbow movement. Tables 3 and 4 indicate which attachments were included in each of the movement aggregates.

Table 3. Muscle Movements of Shoulder and Arm

Flexion	**Extension**	**Abduction**
Deltoid	Deltoid	Deltoid
Pectoralis major	*Teres major*	Supraspinatus
Coracobrachialis	*Lattissimus dorsi*	
Biceps brachii	*Pectoralis major*	
	Triceps brachii	
Adduction	**Medial Rotation**	**Lateral Rotation**
Pectoralis major	*Pectoralis major*	Deltoid
Latissimus dorsi	*Teres major*	Infraspinatus
Teres major	*Lattissimus dorsi*	*Teres minor*
Teres minor	Deltoid	
Triceps brachii	Subscapularis	
Coracobrachialis		

Table 4. Muscle Movements of Elbow & Forearm

Elbow	
Extension	**Flexion**
Triceps	Brachialis
Anconeus	brachioradialis
Forearm	
Pronation	**Supination**
Pronator Quadratus	*Biceps Brachii*
Pronator Teres	Supinator

This is done primarily because it is challenging to interpret score data of individual attachment sites in the context of actual motor behavior. Weis (2003) and Milella (2012) also used aggregates to sum muscle markers over 7 insertion sites of the humerus radius and ulna. The present aggregation differs in that it reflects movements, while their aggregations reflect muscle groups. In either case, aggregations are potentially useful, as it is more difficult to discern actual motor behavior from the data of single discrete attachment sites.

A series of statistical tests were carried out using SPSS statistical software in order to examine score relationships between sex and age subgroups. These tests were:

1. Kruskall-Wallis test in order to examine differences in score distribution between the three age groups.
2. Mann-Whitney U/WilcoxonW test of un-pooled attachment sites and pooled ages in order to examine sexual dimorphism.
3. Mann-Whitney U/WilcoxonW test of un-pooled attachment sites by age group in order to examine sexual dimorphism by age group.
4. Mann-Whitney U/Wilcoxon W test of attachment sites pooled by muscle movement type in order to examine the differences in score distribution between males and females by age group.
5. Mann-Whitney U/Wilcoxon W test for "Pitting" stress lesions. (Pitting is recorded and analyzed separately, because its characteristics and development differ from appositional stress).

3. RESULTS

When observing robustness scores by attachment within each sex an interesting pattern of muscle use emerges. Again, means are used for bibliographic consistency, even though it has been noted by other authors that the mean is not ideal for use with non-parametric (ordinal) data. While the mode or median would be more appropriate, the small number of values used in this type of method would conceal trends, rather than reveal.

Mean scores of individual attachment sites by sex are reported in Table 5. For females, the highest scoring attachment sites are the common origin of the extensors common origin (1.93), Pectoralis major (1.80), brachialis (1.77). Pitting lesions are relatively infrequent in this population sample and so the values are much lower than robusticity values (Table 6). This is also due to the fact that pitting is more common in ligament and fibrous attachment sites. Therefore, the highest values observed in females are the costal tuberocity of the clavicle (0.67) and the biceps brachii attachment, a fibrocartilaginous attachment, (0.14). For males the highest values are recorded for extensors common origin, biceps brachii, and brachialis.

The Mann-Whitney U test results for all ungrouped attachment sites indicates that there are statistically significant differences between male and female scores in 2 of the 33 sites (Table 6), the conoid tuberosity (p= 0.018) and pectoralis major (0.042).

For the Kruskal-Wallis age-group test, in which sex is pooled, the results indicate statistically significant differences in 11 of 33 attachment sites (Table 6). As is expected, mean ranks indicate that the higher scores are concentrated in older age groups. With some attachments, the middle age group displays the highest mean ranks, but this is possibly due to the small sample size from individuals of the third age group.

Results from the Mann-Whitney U/Wilcoxon W test in individual attachments per age group indicate that, in the first age category, statistically significant differences were observed in 4 of the 33 attachment sites, while only 1 out of 33, the common origin of the extensors (0.04) showed significant differences in the second age group. The third age when separated by sex does not give sufficient samples, and shows a rather even distribution of scores, but this shouldn't be considered indicative of a pattern. Ideally, to carry out such an analysis, a larger data set would be necessary, but again, this is an ongoing issue with skeletal materials in Greece, especially from this time period.

One way to overcome this obstacle would be to pool sexes, including both males and females in each age category.

Analysis of differences in score distribution by muscle movement categories was carried out both by age group and with age groups pooled. The test of pooled ages yielded no statistically significant results in any of the categories. However, the same test carried out within the three age-groups showed statistically significant differences between males and females in the 20-35 category in three out of the 11 categories tested (Table 5). These categories were abduction (0.05) and lateral rotation (0.002) of the shoulder, and elbow flexion. The fact that these results emerge from the youngest age group raises some questions of social status within sample, which unfortunately cannot be answered due to a lack of artefactual data.

For pitting, statistically significant sexual dimorphism was observed in three attachment sites: biceps brachii, pectoralis major of the clavicle, and the attachment of the costal tuberosity, also of the clavicle. In all three attachment sites, males scored higher.

Table 5. Mean Attachment Scores

Males			**Females**		
Attachment Site	**Robustness**	**Pitting**	**Attachment Site**	**Robustness**	**Pitting**
Extensors	1.87	0	*extensors*	1.93	0
brachialis (i)	1.82	0.07	*pectoralis minor (i)*	1.8	0
biceps brachii (i)	1.77	0.32	*brachialis (i)*	1.77	0
deltoid (i)	1.59	0.02	*extensor poll. brevis (o)*	1.71	0
anconeus (i)	1.54	0	*flexor Dig.Prof.*	1.7	0
flexor Dig.Prof.	1.52	0	*Pectoralis Major (i)*	1.67	0
Teres Minor (i)	1.5	0	*anconeus (i)*	1.64	0
Flexor Poll. Long.	1.5	0	*biceps brachii (i)*	1.63	0.05
Teres Major (i)	1.48	0	*deltoid (i)*	1.6	0
pectoralis Major (i)	1.48	0.11	*flexor Poll. Long.*	1.52	0
extensor poll. brevis (o)	1.44	0	*biceps & coracobrachialis (o)*	1.5	0
brachioradialis (o)	1.44	0	*infraspinatus (i)*	1.45	0
triceps (i)	1.31	0	*Teres Major (i)*	1.44	0
Subclav.tub.	1.29	0	*trapezius (i)*	1.38	0
pectoralis minor (i)	1.29	0	*conoid tub.*	1.36	0
supinator(i)	1.26	0	*triceps (i)*	1.34	0
trapezius (i)	1.26	0	*teres Minor (i)*	1.33	0
costal tub.	1.25	1.08	*suprasinatus (i)*	1.33	0
infraspinatus (i)	1.17	0	*costal tub.*	1.3	0.3
biceps & coracobrachialis (o)	1.14	0	*brachioradialis (o)*	1.29	0
suprasinatus (i)	1.12	0	*supinator(i)*	1.19	0
flexors (o)	1.1	0	*pron. teres (i)*	1.17	0
pron. teres (i)	1.09	0	*subclav.tub.*	1.14	0
conoid tub.	1.05	0	*pronat. quadratus (i)*	1.05	0
coracobrachialis (i)	1.04	0	*flexors (o)*	1.05	0
pronat. Quadratus (i)	1	0	*lat.dorsi (i)*	1.04	0
lat.dorsi (i)	0.86	0	*coracobrachialis (i)*	1.04	0
Total	1.38	0.06	Total	1.41	0.01

Table 6. Report of Statistically Significant Results (p>0.05), all tests

Tests conducted	**Attachment**	**Age**	**P**	**Mean Rank M/F**
All Attachments, pooled ages	Conoid tuberocity	-	0.02	17.58/23.95
	Triceps	-	0.05	20.47/25.32
All attachments	Supinator	20-35	0.05	19.39/13.55
by age	Conoid Tuberocity	20-35	0.002	5/10.5
	Pectoralis major	20-35	0.01	15.16/24

	Deltoid	20-35	0.02	21.26/12.9
Muscle Movement	Shoulder abd.	20-35	0.05	26.31/19.07
Aggregates by age	Lateral Rot.Sh.	20-35	0.02	33.58/20.44
	Elbow Flexion	20-35	0.03	28.22/20.67
Pitting, all attachments, pooled ages	Biceps Brachii	-	0.035	23.52/18.08
	Costal tub	-	0.014	26.38/17.85
	Pectoralis Maj	-	0.038	47.59/43.50
	Supinator	-	0	50+
	Brachialis	-	0.003	50+
	Anconeus	-	0.04	50+
Kruskall Wallice	teres major	-	0.034	50+
Age Test	flexor pol.brevis	-	0.002	36-49
	flexor dig.profundus	-	0.02	50+
	Deltoid	-	0.036	50+
	Infraspinatus	-	0.02	36-49
	latissimus dorsi	-	0.035	36-49
	Biceps brachii	-	0.015	36-49

4. DISCUSSION

It is of interest to examine the patterns that arise from the data in the context of archaeologically documented behaviors and cultural norms that are known for Mycenaean Athens.

The results of the analysis indicate that, in Mycenaean Athens, males and females did not show significant overall variation in the degree of physical activity in which they engaged but perhaps did vary in particular types of upper arm movement, which is underscored by the results of the muscle movement aggregation as well as the means results. Indeed, the results indicate that for the population subsample under study, sexual dimorphism of MSM expression exists in two movement groups, when attachments are grouped into movements. Sexual dimorphism is noted for the areas, and movements, of the shoulder girdle and one attachment of the elbow, where the male subsample displayed a higher concentration of higher entheseal change scores for shoulder abduction, lateral rotation of the shoulder, and elbow flexion. It is therefore possible that males were engaged in activities that required greater use of the upper arm and shoulder girdle. Military activity is possible but difficult to verify (Kirkpatrick-Smith, 2009). Within the female sample, the sites with the largest frequency of high scores (Table 5) are associated with the distal upper limb, and specifically with the extension and flexion of the elbow and hand. Pitting lesions also associated with the shoulder girdle and elbow also display higher values for males than females. However, it was not possible to control for occupation category, after Villotte et al (2010).

The fact that the above findings were recorded in the youngest age group is significant. While there is a lack of sufficient data from older individuals in the sample, there is evidence that in early life scores are higher in groups that engage in heavy labor, but there is less age-related increase in these scores while labor intensity is not reliably recorded in older individuals (Niinamiki 2009).

Recent studies have called into question the reliability of entheseal changes as markers of activity (Milella 2012; Mariotti et al.,2004, 2007; Alves Cardoso and Henderson,2010) as they find no clear relationship between entheseal changes and social behavior. Other studies (Villotte,2009; Niinimäki,2011; Villotte et al.,2010) indicate a greater degree of entheseal change in individuals engaged in rigorous professions

(Niinimäki,2011; Villotte,2009,2010b). In the present study, age was found to have the strongest relationship with degree of change, and these studies also stress the importance of age, as entheseal differences between professions tend to vanish with increasing age. These finding are hard to reproduce however, as archaeological sets that contain a sufficient amount of older individuals are hard to find, especially in Greece. Furthermore, some studies have called into question the usefulness of comparing male and female entheseal change patterns, as there are underlying biological (hormal, genetic) differences between males and females. While hormonal differences affect bone density and size, it is unclear how the mechanisms of entheseal change are affected by sex, and this is something that certainly must be addressed. Generally, it is not possible to compare and test the results of these other authors. Furthermore, lack of clear evidence for a relationship between entheseal change and profession/social role cannot be taken as an indicator of the small utility of this approach to reconstructing behavior. In the case of Mycenaean society, it should be taken into account that what may appear as a lack of clear evidence may in fact be a reflection of social conditions.

Social roles, stratification and division of labor in Bronze Age societies has been well studied (Gilman, 1981; Graziadio, 1991; Porcic, 2009), and it has been established that while there are categorical similarities, Bronze Age cultures are not characterized by a uniformity of socioeconomic roles for males and females. In fact Sosna (2008) argues that the model of a male dominated community cannot be seen as universally true throughout the broader (both temporally and spatially) Bronze Age world, as findings from the Rebesovice cemetery do not refute the existence of gender specific activities or roles that were viewed as having different values. Instead, it appears that males and females had access to the same resources from which they drew power.

While social status/roles are absent from our data, it has been noted in the bibliography that only under certain conditions can entheseal changes in males be associated with social roles, and the relationship is less obvious in women (Havelkova et al, 2013). Therefore, while the data clearly indicates that the distal upper limb shows greater labor trend, associating the data with specific activities, while the archaeological record remains vague, is not presently possible.

According to Olsen (1998), Linear b records indicate that the Mycenaean culture was highly gendered, with a clear differentiation of tasks between the sexes in a domestic context. This differentiation is also reflected in the variation of upper limb entheseal change observed in the current sample.

Compared to other Mycenaean centers, the available archaeological record associated with division of labor in Athens is somewhat limited. Kirkpatrick Smith (2009) indicates that it is highly likely that Athenian social structure would have been similar to those of other Mycenaean centers for which the archaeological evidence is more abundant. Therefore, the presence of high and low status individuals, as well as military personnel of various ranks is very likely, and the use of the available labor information from Pylos is not only possible but necessary.

Billigmeier & Turner (1981) state that public occupations of females fall within two categories: a. craftswomen and skilled/unskilled laborers, and b. sacerdotal women, with a small minority of women who belong to the elite not fitting into either. For the women that fall into the two occupational categories, more than thirty occupations are listed, and of those, the majority is associated with textiles or clothing, and is associated solely with females. The Pylos tablets indicate that most women of the center (numbering approximately 1400) were skilled workers. How does Mycenaean Athens compare to Pylos in terms of the demography of occupation? No doubt Athens was a smaller urban center than Pylos, and so the need for a high number of craftswomen skilled workers was not as high as that of a major palatial center.

The record of ration distribution in Pylos indicates equality between the two sexes as the basic wheat ration for both males and females is recorded as T2 (according to the Mycenaean depiction of capacity). However, the fact that females tend to display a slightly higher mean rates of entheseal change may indicate that they tended to work harder than males in order to secure the same resources.

Mycenaean era males and females performed different sets of tasks, usually in same sex work groups. The Linear b tablets of Pylos list 35 occupations for females, out of which only four are shared with males (Lupack, 2011; Olsen, 1998; Billigmeier & Turner, 1981).

Using this interpretive model on musculoskeletal entheseal change data, we may arrive at a similar conclusion of the performance of different tasks. If it is assumed that physical exertion corresponds to time invested in occupational activities through which resources become available, the fact that neither sex displays overall higher degrees of activity related entheseal change, then this corresponds to a trend of relatively equal physical investment for procurement of resources with a dimorphism of specific behavior-related movements.

According to Iezzi (2005), who examined the general health status of the Late Bronze Age populations of East Lokris by looking at pathologies such as anemia and osteoarthritis, males and females did not differ significantly, although males did have greater access to higher statues goods. This reinforces the current findings.

The current study faced two significant obstacles. The first being that is difficult to know for certain what the labor practices of the individuals in the sample were, due to limitations in the archaeological evidence. Another obstacle is perhaps the sample size. However, this is a challenge that cannot be overcome when considering archaeological skeletal assemblages that come out of Greece. One possible solution that may be addressed by the authors in the future, is to pool assemblages that originate from similarly sized settlements from the same era and geographic region, in order to match socioeconomic conditions as closely as possible.

5. CONCLUSION

Studying the patterns of sexual dimorphism of entheseal changes in Mycenaean Athens may assist in comprehending intensity of daily behavior of males and females. The methodological approach implemented in this study differs from previous studies in its analysis, as entheseal change scores were aggregated in groups that correspond to muscle movements. The results indicate that there is little significant overall sexual dimorphism of musculoskeletal entheseal change for this population sample when entheseal change is observed in individual muscle attachment sites. However, when the results are aggregated into groups that correspond to upper limb movements, some differences in behavior between males and females emerge in the youngest available age category, which indicates a differentiation of roles without necessarily a significant difference in degree of rigor. There is ongoing debate as to how entheseal change should be interpreted, especially in light of its apparently multifactoral development. Further research into the utility and application of the aggregation utilized in this study is necessary.

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