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Three-Dimensional Analysis of the Development of Upper Arm Musculoskeletal Stress Markers in Late Adolescents and Young Adults of Archaic and Mississippian Populations of Tennessee

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THREE-DIMENTIONAL ANALYSIS OF THE DEVELOPMENT OF UPPER ARM MUSCULOSKELETAL STRESS MARKERS IN LATE ADOLECENTS AND YOUNG ADULTS OF ARCHAIC AND MISSISSIPPIAN POPULATIONS OF TENNESSEE

by

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ABSTRACT

THREE-DIMENTIONAL ANALYSIS OF THE DEVELOPMENT OF UPPER ARM MUSCULOSKELETAL STRESS MARKERS IN LATE ADOLECENTS AND YOUNG ADULTS OF ARCHAIC AND MISSISSIPPIAN POPULATIONS OF TENNESSEE

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This study compares three methods for the evaluation of morphology of musculoskeletal attachment sites. Two methods were macroscopic and the third was microscopic, utilizing three-dimensional laser scanning and fractal analysis The morphology of 19 upper limb attachment sites was observed in 33 males aged 15 and 30+ years, dating to the Archaic and Mississippian periods from the southeastern U.S. It was hypothesized that 1) the microscopic method would identify subtler differences than the macroscopic methods; 2) enthesis development would be greater in the Mississippian population due to the increased subsistence workload, even among younger individuals; and 3) late adolescents would show similar patterns of enthesis development as their older counterparts.

The microscopic method failed to show the same patterns observed with the macroscopic methods. The majority of variation was between the two macroscopic methods but little difference was seen between the two methods. In the Archaic sample most activity was found among the older age sets whereas in thee Mississippian sample, it was found in the younger age sets, including late adolescents. Most differences seen

were in scoring Robusticity rather than Osteolytic or Osteophytic Activity. In all instances, late adolescents in this study followed the general pattern set by the other age sets. The results of this study suggest that three-dimensional scans at this point may not be optimal for MSM research. Additional research scrutinizing the way MSM are scored and how bone response to mechanical strain is needed before more confident interpretations can be made based on the data.

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DEDICATION

To my family who got me where I am and my husband who has stood by me and supported me throughout this journey.

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CHAPTER I - INTRODUCTION

Reconstructing the lives of ancient peoples is a daunting task, especially when written documents are scarce or nonexistent. Archaeologists and bioarchaeologists must rely on the archaeological record to gather data on the populations they wish to study. Despite the incomplete nature of the record, a skilled researcher can glean a vast amount of information regarding habitation, subsistence patterns, technology, and burial practices from the objects left behind by those who came before us. Analysis of human remains also allows us a more detailed view of the lives of past populations, including health, migration, demographics, violence and warfare, and daily activities. Archaeological and bioarchaeological data complement one another, allowing for the most comprehensive cultural view of ancient peoples.

Bioarchaeological studies have been increasingly turning to the investigation of the physical activities of a group, with the analysis of musculoskeletal stress markers (MSM) having become a recent focus. MSM, or entheses, are areas on the skeleton where tendons or ligaments attach to the periosteum or directly to the bone. This interaction can help us understand how mechanical stress from muscles affect the skeletal elements to which they are attached. Deviations from what is considered to be healthy normal enthesis development are considered to be the result of continuous strenuous activities. Rooted in Wolff's law of bone adaptation, which states "overtime, the mechanical loading applied to living bone influences the structure of bone tissue" (Cowin, 2001, pp. 30-31), these morphological changes have been employed to give us a direct view into aspects of the lifeways of past populations that may not be forthcoming through the archeological record. For example, the importance of the use of a canoe for travel and trade in the southeastern U.S. is difficult to determine as the soil tends to be acidic, quickly breaking down organic material (Hartmann, 1996). Although precious few canoes have survived to the present (Hartmann, 1996), they offer us little contextual information as they are often isolated finds. This makes discovering the cultural importance of this watercraft difficult to ascertain. Fortunately, the activity of rowing is strenuous and leaves distinct and recognized marks on the upper limbs of the paddler; it is possible therefore to determine which populations employed canoes and how many in that population were participating. Bioarchaeologists have also used MSM to answer questions relating changes in subsistence strategy (Churchill & Morris, 1998; Eshed, Gopher, Galili, & Hershkovitz 2004; Molnar, 2006; Peterson, 1998; Shuler, Zeng, & Danforth 2012), socioeconomic status and cultural influences (Chapman, 1997; Lieverse, Weber, Bazaliiskiy, Goriunova, &Savel'ev, 2007; Havelková, Hladik, &Veleminský, 2013), sexual division of labor (Villotte et al., 2010), social stratification (Eshed et al., 2004; Havelková et al., 2013; Porčić & Stefanović, 2009), daily activities (Steen & Lane, 1998) and occupation (Villotte et al., 2010).

An important factor to consider when conducting an MSM study is the type of scoring method that will be used. The standard described by Hawkey and Merbs in 1995 has been the most widely used method for this type of analysis. However, this method has some shortcomings the most notable being the descriptions of the stages tend to be general and are applied to all enthesis. Researchers have tried to compensate for this by adding additional 'half steps' between the stages when one marker does not quite fit in a single stage for a category. Other methods have included different descriptions for the two different types of attachment sites, fibrous and fibrocartilaginous (Havelková &

Villotte, 2007). More recently Mariotti, Facchini, and Giovanna Belcastro (2007) have created detailed descriptions of the stages of robusticity specific for each attachment site included in their study. However, inherent with any of the above methods is a certain level of subjectivity. In order to circumvent this, previous studies have employed three-dimensional scanning and fractal analysis on animal (Zumwalt, 2005) and humans (Noldner, 2013) subjects, potentially providing a more accurate and objective way to evaluate MSM.

However, the utilization of three-dimensional scanning has shown somewhat mixed results in regard to MSM research. In Zumwalt's 2006 study, the entheses of two groups of sheep were scanned and analyzed with the Benoit 1.3 fractal analysis software (Trusoft International, 2015). Zumwalt found that sheep that were exercised on a treadmill showed muscle hypertrophy but no bony reaction when compared to the control group. Noldner (2013) and Noldner and Edgar (2011) found that the use of three-dimensional scanning to measure surface area of fibrous entheses agreed with data taken from two dimensional images and correlated with ordinal data.

In order to test the effectiveness of different scoring methods using both fibrous and fibrocartilaginous attachment sites, two different types of scoring methods were used. Macroscopic analysis of the entheseal sites was conducted employing the standards developed by Hawkey and Merbs (1995) and Mariotti, Facchini, and Giovanna Belcastro (2004) and Mariotti et al. (2007). The method of Hawkey and Merbs is currently the most widely used among bioarchaeologists and provides the greatest opportunity to compare with findings from other populations; however, it is not without its limitations. Therefore, in order to identify more slight variations of the MSM surface morphology, fractal analysis of the surface of the attachment site was conducted using a method modeled after Zumwalt (2005). This was intended to provide a less subjective score for the attachment site and allow for subtler variation to be observed.

As a corollary to this study, the role of age in MSM assessment was also investigated. Among the factors affecting enthesis change, age has been shown to be particularly important (Cardoso & Henderson, 2010; Molnar, 2010; Weiss, 2012). The most common age range to be used in MSM research is 20-50 years. The upper limit of 50 years is given because it has been suggested that enthesopathic activity would most likely be the result of a degenerative process rather than activity. Indeed, Villotte and colleagues (2010) showed that the differences could be observed between the MSM expression of two labor groups begins to disappear in individuals of 50+ years.

While the justification for the upper age limit has been demonstrated, no study has been found to justify the lower age limit of 20 years. Villotte et al. (2010) argue that the four zones of the fibrocartilaginous entheses are not clearly distinguishable until after adolescence. A more commonly used rationale is osteoblast activity of growing bone would obscure the effects of mechanical stress (Zumwalt, 2006). While these are important factors to consider, they might not necessarily be reasons to exclude from MSM studies later adolescents whose epiphyses have fused or are in the final stages of fusion and thus have stopped most if not all growth.

This often excluded age set could hold useful information regarding shifts in activity, providing clues to about the transition of the social and economic role of older child to adult. Studies exploring the relationship between exercise and skeletal change using animal subjects have shown that the skeletons of younger animals are generally more sensitive to mechanical stress caused by strenuous exercise (Buhl et al., 2001); whereas studies using mature animals tend to show little to no changes to the skeleton (Zumwalt, 2006). Other investigations have suggested that mechanical stress in young animals is important in the proper development of an entheseal site (Thomopoulos et al., 2007). These findings would suggest that human adolescent bone would be well-suited for MSM analysis, and Martin (2015) recently advocated their use.

In order to explore how data among the three methods being tested compare, I analyzed the morphology of 17 attachment sites of the upper limbs in late adolescents and adult males between the ages of 15 and 40 years. A total of 30 individuals were selected for this study: 19 from Archaic sites and 11 from Mississippian sites. These two groups represent contrasting subsistence strategies which require different workloads and will represent contrasting levels of stress. It was hypothesized that the use of the three-dimensional scanning and Benoit 1.3 fractal analysis software (Trusoft International, 2015) would show more subtle differences between the age sets and time periods that might not have been detected with macroscopic methods. It was also believed that the results from the Hawkey and Merbs (1995) method would differ from the methods developed by Mariotti and colleagues (2004, 2007), especially the scores for robusticity as the two scoring methods are significantly different. It was also hypothesized that MSM scores in both groups would increase with age, but because the groups practiced vastly different subsistence strategies, it was expected the rate of development would be different between the groups studied. Lastly, it was hypothesized that MSM scores would be greater in the Mississippian population due to the increased workload, even among younger individuals associated with this cultural period.

This study offers the potential to demonstrate the usefulness of the three- dimensional scanning in the use of MSM research. By comparing the results of multiple methods, it will be possible to see how the newer macroscopic method developed by Mariotti and colleagues (2004, 2007) compares to the more widely used method of Hawkey and Merbs (1995); it will also test whether findings from either of the macroscopic methods correlate with those of microscopic analysis using three-dimensional scanning and fractal analysis software. This study can also show that adolescents are a valuable and rich research area for bioarchaeologists investigating activity reconstruction using MSM. The use of this particular age set may allow us the chance to look at a little explored time in lives of later adolescents when they are likely to be adopting their gender roles as adult males and females in their communities.

CHAPTER II – LITERATURE REVIEW

Bioarcheologists have been attempting to explore the behaviors of past populations for over a century. Over the years, research in activity reconstruction has increased; however, there has been a shift from a primary emphasis on the evaluation of osteoarthritis to areas of muscle attachment on bone, commonly referred to as Musculoskeletal Stress Markers (MSM). Recently, however, several studies have challenged the utility of MSM data to reflect habitual activities of past populations. Critics state that biological factors such as body size, sex, hormonal shifts, genetics, and age significantly influence the development of MSM, and, if not accounted for, can affect the analysis and interpretation of the data (Jurmain, 1999; Zumwalt, 2006). The methodology used to gather data has also come into question, noting issues such as subjectivity, lack of clinical research (Havelkova & Villotte, 2007) and a higher level of interobserver error than previously thought (Davis, Shuler, Danforth, & Herdon, 2013). These criticisms have led to shifts in scoring techniques and utilization of MSM data. Nevertheless, studies of MSM remain a prominent part of bioarchaeological inquiry.

In this chapter a brief review of clinical literature relating to entheses and entheseal changes is given. Then the methodologies used to analyze MSM in bioarchaeological studies as well as outline the major criticisms are discussed.

Clinical Research Concerning Enthesis Development

The study of muscle attachment sites involves the analysis of the area on a skeletal element where muscle tendons or ligaments attach directly to bone or indirectly through the periosteum. These areas are referred to in the medical literature as entheses and typically in bioarchaeological studies as MSM. In order to accurately interpret the data collected from musculoskeletal marker analysis in bioarchaeological studies, it is first important to understand the structure and function of entheses as well as the tendons they are anchoring. The structure of an enthesis is determined by its location in on the skeleton and its histological makeup. It serves as a unique junction between soft and hard tissue and works to dissipate stress and anchor muscles. Bone and tendons have very different tensile strengths and elastic moduli; tendons have a high tensile strength, a relatively low shear stiffness and compressive strength, and a much smaller elastic modulus. Bone, on the other hand, has a higher shear stiffness and comparable tensile strength (Schlecht, 2012). Balance between the different tensile strengths and elastic moduli of these two very different tissue types must be kept in order to maintain muscle attachment to bone (Benjamin et al., 2002; Schlecht, 2012). The enthesis identified on dry bone is the result of this interaction between both bone and tendons. Therefore, the roles that both of these tissues play in transferring and responding to mechanical stress must be appreciated in order to fully understand the development of entheses and enthesopathies.

The Anatomy of a Tendon

Tendons anchoring a muscle to bone have several functions. These are to store energy, direct forces around corners, provide some distance between the muscles and joint (Currey, 2002), and distribute mechanical forces from muscles to bone (Schlect, 2012). As will be discussed, early scoring methods of MSM, such as the one developed by Hawkey and Merbs (1995), rarely considered the tendon function and evaluated all entheses in the same manner. Within the past ten years, however, bioarcheologists have started to recognize the difference between the function and structure of the two main enthesis types (Havelková & Villotte, 2007; Mariotti et al., 2004, 2007).

Tendons, like muscles, are comprised of bundled fibers. Six levels of a tendon can be observed (Figure 1). The first level is the collagen fibril, which makes up the primary collagen fiber. These fibers are then bundled together by connective tissue to form subfasicles, which are grouped together to form fasicles. Fasicles are bundled together to form tertiary fiber bundles. Bundles of the tertiary fibers make up the tendon. The connective tissue which binds these bundles together allows them to glide easily over one another during movement. Tendons have a wide variety of shapes; some fan out over a wide area of bone in order to distribute stress while others to be more localized, such as the round tendons of the wrist.

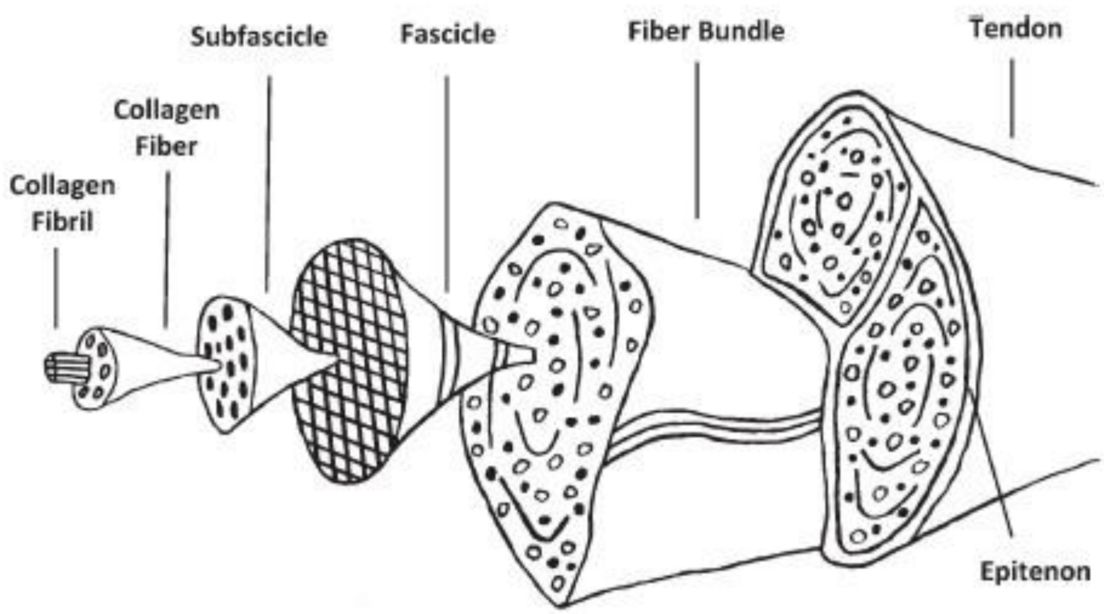

Figure 1. The Six Levels of Tendon Structure

(Schlecht, 2012, p. 1214)

Many think of entheses simply as where tendons anchor muscles to bone, but the enthesis is a much more unique and complex area where two very dissimilar materials come together, something that cannot be easily replicated. Two types of entheses can be identified, fibrous and fibrocartilaginous. The fibrous enthesis is considered to be the structurally simpler of the two, as they attach to bone in one of two ways, either directly to the bone itself or to the overlying periosteum. However, there has been relatively little research, medical (Benjamin et al., 2002; Henderson & Cardoso, 2013) or otherwise, investigating the details of this type of enthesis. This may be because fibrous entheses, being located primarily on the diaphysis of long bones, are less likely to suffer injury from overuse (Benjamin et al., 2002) or disease (Claudepierre & Voisin, 2005), and therefore do not catch the attention of clinical researchers.

Fibrous entheses can be further divided into periosteal and bony types depending on where the tendon attaches. Periosteal fibrous attachments can ossify with age as the skeleton matures (Benjamin et al., 2002). Periosteal fibrous attachments tend to be short and distribute mechanical stress over a wide area of bone, which limits the elasticity of the tendon (Benjamin et al., 2002; Schlecht, 2012). There is little information available regarding the early stages of the development of the fibrous tendon. It has been suggested that the Sharpey's fibers, usually associated with attaching tendons, ligaments and even periosteum to bone, are a unique characteristic of the fibrous enthesis (Benjamin et al., 2002; François, Braun, & Khan, 2001). However other researchers will still discuss Sharpey's fibers when discussing fibrocartilaginous entheses.

In contrast, fibrocartilaginous entheses are typically found at the epiphyses of long bones and attach to small, usually well-defined areas (Benjamin, Evans, & Copp

1986). This type of enthesis site has four distinct zones that gradually shift from tendon to calcified fibrocartilage. It is believed that these zones help to balance the different moduli of elasticity between the bone and tendon. The four layers consist of tendon, uncalcified fibrocartilage, calcified fibrocartilage, and finally bone (Benjamin & Ralphs, 1998; Cooper & Misol, 1970; Schlecht, 2012). The uncalcified fibrocartilage and the calcified fibrocartilage are separated "by a basophilic line called the tidemark that represents a calcification front, i.e., the mechanical boundary between soft and hard tissues" (Benjamin et al., 2002, p. 936). The tidemark can be observed on dry bone specimens (Villotte et al., 2010). It is fairly straight, which Benjamin et al. (2002) argue is "important for minimizing the risk of damage to the soft tissues at any enthesis where tendons change their insertional angle with joint movement" (Benjamin et al., 2002, p. 937). It is also important to note that the smooth and avascular surface typical of a fibrocartilaginous enthesis is usually restricted to the center of the attachment site. At the edges the collagen fibers begin to merge with the surrounding periosteum, and vasculature may be present in this area. The anatomical boundary between the calcified fibrocartilage and the subchondral bone has a much more irregular surface that the mechanical boundary of the tidemark. Benjamin et al. (2002) have suggested several explanations as to the function of the tidemark. The layer of calcified fibrocartilage "provides a gradual transition in force transmission across the enthesis and a barrier against diffusion from blood vessels in the underlying bone" (Benjamin et al., 2002, p. 937). Benjamin and colleagues suggest that this also helps to prevent the spread of infection between the bone and the tendon.

Etiology of Enthesopathies

Osteophytic activity at an enthesis can be identified by the projection of calcified ligament, usually called osteophytes or enthesophytes, and can present itself in various degrees of severity. It is generally accepted that the presence of osteophytes is pathological and not part of the normal or healthy development of a musculoskeletal marker. Macro/microtrauma is typically singled out as the major factor in the formation of osteophytes at an entheseal site (Hawkey & Merbs, 1995; Mariotti et al., 2004). Clinically there has been a correlation observed between greater development of osteophytes and strenuous athletic activity (Benjamin et al., 2000). Hawkey and Merbs (1995) link the formation of osteophytes directly to the healing of macrotrauma (bone avulsion fractures are specifically mentioned), stating that "new bone formation may be incorporated into the ligament or muscle tissue, and result in an exostosis, or bony 'spur'" (Hawkey & Merbs, 1995, p. 329). It has been proposed that osteophytes which develop on the calcaneus form in response to microtrabecular stress fractures in the underlying bone (Benjamin et al., 2000, p. 576) and act to stabilize microcracks in the bone. Osteophytes may also form in response to microtears or inflammation of an enthesis. However, not every instance of microtrauma to the tendon will give rise to osteophyte formation. "Transverse microtears at the bone – fibrocartilage junction become filled with adipose tissue, whereas longitudinal fissures within the fibrocartilage cause some proliferation of fibrocartilage cells and become filled with amorphous material that subsequently calcifies" (Benjamin et al., 2000, p. 580). Given the traumatic nature of the origin of osteophytes, they are usually scored separately from robusticity and osteolytic activity.

A positive correlation between age and presence of osteophytes has been observed as well (Benjamin et al., 2000; Mariotti et al., 2004). This has been explained by the fact that the variables causing the trauma have more time to affect the enthesis. Mariotti et al. (2004) did note that when osteophytes were present on young (20-29 years) and mature (30-39 years) adults, they appeared more frequently on one side while older adults (>40 years) tended to be bilaterally affected. The authors suggest that this may be due to greater workloads of young and mature adults. However degenerative processes and various pathologies have been known to cause osteophytic activity at joints and entheseal sites, but fortunately most osteophytes develop in healthy individuals not as the result of a disease but as a response to mechanical stress (Benjamin, Rafal, & Ralphs 2000).

In 2000, Benjamin, Rafal and Ralphs published a study investigating the formation of bony spurs in normal enthesis development. They looked at histologic samples taken from the Achilles tendons of rats of various ages between two and twelve months old. Rats sacrificed at four weeks had fully ossified calcanei, and fibrocartilage cells could be easily distinguished in the tendon. At this stage, the bone was highly vascular and "formed an irregular interface with the uncalcified fibrocartilage, and vascular invasion occurred simultaneously into both the Achilles tendon and the plantar aponeurosis along the rows of fibrocartilage cells" (Benjamin et al., 2000, p. 579). This was seen in rats up to three months of age at which point osteophytes were observed in the inferior part of the tendon. These osteophytes "contained a prominent central capillary surrounded by newly deposited bone" (Benjamin et al., 2000, p. 579). This study was able to track the nonpathologic formation of osteophytes at a fibrocartilaginous enthesis. The formation of these osteophytes was the result of vascular invasion of the tendon by the underlying bone marrow.

While a large amount of literature exists discussing the formation of osteophytes, there is little literature discussing the formation of osteolytic lesions and examining the cause of osteolytic reaction at entheseal sites. Hawkey and Merbs (1995) attribute the formation of stress lesions or osteolytic activity to necrosis of the bone brought on by activity induced microtrauma in the form of small muscle fibers tearing and reattaching to the periosteum which would disrupt the blood supply to the bone. In a more recent osteological study, Mariotti et al. (2004) suggest that osteolytic formation is "due to the strong remodeling processes accompanying growth, during which there is a continuous 'migration' of the enthesis in the growing bone" (Mariotti et al., 2004, p. 156). The authors also recognize that age appears to play a large part in the appearance of these lesions. Unfortunately, the majority of the clinical literature discussing enthesopathies focuses on the formation of enthesophytes.

As with osteolytic activity, little clinical literature is available investigating the etiology and development of the robusticity of entheseal sites. Hawkey and Merbs (1995) describe robusticity as the normal response to daily activity and the level of surface complexity at the markers a reflection of the level of mechanical stress placed on the enthesis. However, this assumption has been contradicted by experimental studies (Zumwalt, 2006). It has been hypothesized that bone in adults will not respond to mechanical strain unless it is significantly different from the typical stress placed on the bone. There is some evidence that the mechanical strain must surpass a 'threshold' before the bone will respond by laying down new bone (Currey, 2002). Unfortunately, it is unclear when this threshold is set and how, if at all, it can be measured. It is possible that the threshold is established before skeletal maturity as juvenile bone is much more susceptible to stress than mature bone.

Bone is a complex living tissue; *in vivo* bone must respond to a variety of stimuli, including pathology, degeneration, trauma, and mechanical stress, in what can seem to be simplistic ways, either resorption of bone or the laying down of new bone cells. However, the way in which bone responds to the various stresses of life is complex and several factors must be taken into consideration. It is because of this false simplicity that researchers must fully understand the mechanics that govern how and to what a bone will respond.

The Evaluation of MSM in Bioarchaeology

Entheses can usually be identified from the surrounding bone through texture change of the cortex. Attachment sites will generally feel rougher and more elevated than the surrounding bone but can sometimes be depressed or difficult to discern from the surrounding bone. Entheses are typically analyzed by the researcher visually and tactilely with or without the aid of magnification; however, recently three-dimensional scanning has been utilized to measure the surface of the enthesis (Noldner & Edgar, 2011, 2013; Nolte & Wilczak, 2013; Zumwalt, 2005). The methods most commonly used in their observation are reviewed here.

Early Methods of Scoring MSM

Although we can trace the study of what we would refer to as MSM as far back as the sixteenth century, it was only in the nineteenth century that scientists began to associate irregularities at muscle attachment sites with different occupations or daily habitual activities (Havelková & Villotte, 2007). In the late twentieth century, the first serious proposals were made at standardizing the way in which entheses were scored. Angel along with Parrington and Printer in 1987 evaluated MSM in a study intended to describe the lives of those in an early 19th free Black community in Philadelphia. Occupation in this population was determined through analysis of 'muscle crests'. The method developed by Angel used an ordinal system which observed the 'muscle crest' as being absent or present and also ranked its severity. (Angel, Kelley, Parrington, & Pinter, 1987). Osteolytic and osteophytic reaction, described as ridging and furrowing, was noted when present but not systematically scored. The same standard was used for all markers. They compared the development of the 'muscle crests' of individuals from the First African Baptist Church (FABC) with those of slaves at Catoctin, Maryland. In doing so Angel and colleagues argued that muscles utilized by the FABC individuals could be tentatively linked to a specific occupation. In the FABC collection, one female was identified as a possible laundress based on the rugose development of the pectoralis major attachment on the humerus, a conclusion supported by historic records which suggested that it was a common occupation of free black women in Philadelphia. In the Catoctin collection, possible spear throwing and horseback riding were suggested.

The interest in activity reconstruction through the analysis of musculoskeletal makers continued to grow, leading to more systematic and detailed standards. An unpublished method developed by Dr. John Robb and summarized by Churchill and Morris (1998) measured the robusticity of the markers on a scale of 1-5. Osteolytic and osteophytic reactions were not scored separately from robusticity but were considered to be on the extreme end of entheseal development. Churchill and Morris used this method to examine the intensity of labor among the prehistoric Khoisans in South Africa. After scoring attachment sites in 75 skeletally mature men and women from three different geographic regions, the mean score was calculated for the upper limb and lower limb. Using the optimal foraging model, the authors predicted that robusticity would be greatest in the individuals from the forested area followed by the individuals found in the fynbos, or shrub heathland, with individuals from the savanna showing the least robusticity. Their results, however, did not reflect the order of robusticity predicted. No statistically significant differences were found among the regions. The authors did suggest that there could be "differences in the expression of rugosity at tendinous verses fleshy muscle attachments" (Churchill & Morris, 1998, p. 407).

In 1995 a more detailed methodology was published for analyzing MSM by Hawkey and Merbs, which was based on Hawkey's (1988) master's thesis. This method divided MSM expression into three categories: robusticity, stress lesions and ossification. Each of these categories was scored separately on a scale of 1 to 3, with 1 being weak expression of the trait and 3 being strong expression. The authors suggested that this method would establish a clear delineation between stages which would standardize scoring as each the observer should mark the trait based on the descriptions given by the authors instead of relying on his or her own experience (Hawkey & Merbs, 1995).

In this method, robusticity involves the normal reaction of the bone to daily activities that produce rugged markings on the bone at and around the attachment site and in their most extreme state showing as "sharp ridges or crests of bone" (Hawkey & Merbs, 1995, p. 328). Stress lesions are defined as "a pitting or 'furrow' into the cortex to the degree that it superficially resembles a lytic lesion" (Hawkey & Merbs, 1995, p. 329).

The authors suggested that stress lesions begin to form when the muscle has been overworked and the bone can no longer adequately absorb the stress of daily activity (Hawkey & Merbs, 1995). Ossification at muscle attachment sites is attributed to microtrauma such as a muscle tear or rupture in which “new bone formation to be incorporated into the ligament or muscle tissue” (Hawkey & Merbs, 1995, p. 329). Because ossification was believed to be caused by acute trauma and not the everyday use of the muscle, these scores were analyzed separately from the robusticity and stress lesion scores.

This landmark study examined the MSM of males and females from two sites from the Thule culture, located in northwest Hudson Bay, Canada, in order to better define the daily activities carried out by the individuals in the populations. The patterns of development found by the authors suggest that there were gender-specific behaviors that may not be evident in the archeological record. The use of kayaks was also suggested through the presence of the “kayaker’s clavicle” as well as “strong bilateral use of the muscles utilized in paddling with a double-bladed paddle” (Hawkey & Merbs, 1995, p. 334). However, no kayak or canoe has been found in an archaeological context at the sites. This work continues to be an important paper in the study of MSM in anthropological contexts as one of the first attempts to standardize how MSM are scored and recorded. Its broad usage among researchers allows for comparison between different studies as well as highlighting how study of MSM can complement the archeological record.

Although the method described by Hawkey and Merbs (1995) continues to be widely used, some researchers have voiced concerns that it is not able to accurately represent the supposed effects that physical activity has on an enthesis. Therefore, investigators sometimes adjust the method, usually with the addition of intermediate stages (Chapman, 1997). Other modifications researchers have made include treating stress lesions as an extension of robusticity (Molnar, 2006; Weiss, 2007) and combining all categories into one continuum (Hagaman, 2009). The collapse of all three categories treats the presence of stress lesions and ossification as a continuation of robusticity; this may be problematic as some have argued that the etiology of stress lesions is related to regular microtrauma at the insertion point (Hawkey & Merbs, 1995), which would suggest the development of these enthesopathies is independent of robusticity. Higher frequencies of stress lesions or osteolytic reaction have also been noted among younger adults and have been attributed to growth (Mariotti et al., 2004; Martin, 2015); however osteolytic activity seen in older adults is usually attributed to degenerative processes associated with advanced age. Unfortunately, the etiology of osteolytic activity is unclear and is likely not as straightforward as we would like.

More Recent Methods of Scoring MSM

In 2006 Villotte, later described in Havelková and Villotte (2007), introduced a new method for scoring entheses which incorporated anatomical and histological knowledge of entheseal sites and boasted a low interobserver error rate (Havelková & Villotte, 2007). Unlike the current methods available, Villotte’s method distinguished between fibrous and fibrocartilaginous entheses and incorporated anatomical and histological studies into the development of his methods. Eighteen entheseal sites were analyzed on males, females, and individuals of an indeterminate sex from an archaeological collection from Charente - Maritime, France. Villotte identified four stages of development: two describing appendicular fibrocartilaginous remodeling, one describing spinal fibrocartilaginous remodeling and the last describing the remodeling of fibrous enthesis. The stage of development for each group has its own scoring system.

Entheses of the upper and lower limb were examined by Havelková and Villotte (2007). They were divided into four groups. Groups one through three contained fibrocartilaginous entheses and the fourth fibrous entheses. Group one and group two describe the remodeling of fibrocartilage entheses in the appendicular skeleton. The remodeling may involve the border or center, although both groups are described as having enthesophytes. The first group may also include bone deformation. For both the first and second groups, different scales were developed for the center and the border of the enthesis. The third group describes the remodeling of the fibrocartilage entheses of the spine; with these enthuses, it is difficult to differentiate between the border and the center, and they are evaluated by measuring the size of the enthesophyte projecting from the surface of the attachment site. The fourth group concerns fibrous entheses on the diaphysis of long bones. As with the fibrocartilaginous enthesis on the spine, it was found to be difficult to distinguish between the center and border. Remodeling was identified as an increasing roughness of the surface and presence and size of a cortical gap; these characteristics were evaluated independently.

This method was later simplified by Villotte (2010). The scoring system was condensed into a binary system, 1: healthy enthesis and 2: slight or major enthesopathy. A healthy enthesis was described as “a smooth, well-defined imprint on the bone, without vascular foramina, and regular margin” (Villotte, 2010, p. 226); any deviations from this, such of the presence of irregularity, entheophytes, or foramina, were considered enthesopathies. This study was conducted only using fibrocartilaginous MSM of the upper limbs of 367 males from the 18th and 20th centuries from four European collections. A statistically significant difference was found between the MSM development of individuals who had occupations involving heavy manual labor compared to those seen in light manual and non-manual workers; however, the difference was weaker in individuals over the age of 50.

Another method for scoring MSM was developed by Mariotti et al. (2004, 2007) and discusses enthesopathies (2004) and robusticity (2007) separately. It is set apart from the methods described previously by providing a standardized evaluation for scoring robusticity in both the upper and lower limb. Instead of having a set of criteria for all attachment sites, each of the 23 attachment sites described in the study has its own criteria for the stages of development. Using two collections, one from the early twentieth century the other from the late nineteenth century, five levels of morphology were identified for each enthesis by lining up the number of elements in order of development. The characteristics for each stage of each enthesis were then described. However, difficulty arose with the ordering since for some entheses several different variations were seen. For example, “the radial tuberosity, insertion of m. biceps brachii, can be very prominent but with a smooth surface, or not prominent, but with a rough surface” (Mariotti et al., 2007, p. 293). The stages were later reduced from five to three. The method of Mariotti and colleagues provided detailed descriptions of each of the stages of the enthesis studied along with clear pictures of each stage, which is useful in reducing the subjectivity that may be present in other methods.

In 2005, Zumwalt described a new method for analyzing MSM in which the surface of the attachment site itself is measured through the use of a three-dimensional scanning and fractal analysis software (Zumwalt, 2005). Zumwalt examined the entheses of 20 adult female sheep, which were exercised for an hour on a treadmill for ninety days and then sacrificed. The surface of the attachment sites was scanned, and the scans were then exported to ArcGIS 8.3 where six profiles were taken at equidistant points along the attachment site. Lastly, the profiles were evaluated with Beniot 1.3 fractal analysis software to measure the surface complexity of the bone. Zumwalt found that the sheep who were exercised had muscle hypertrophy, but the surface morphology of the attachment site was not significantly different than those of the unexercised sheep.

Over the years the general trend of the methods used to measure MSM has been moving away from general categories delineating the development of robusticity, osteolytic, and osteophytic activity that are used for all entheses (Hawkey & Merbs, 1995) to ones that include different criteria based on the various types of enthesis involved (Villotte, 2006) and more detailed categories describing the stages of individual markers (Mariotti et al., 2007). With this shift in methodology, there has been increasing concern about other factors that might influence the development of enthesis, such as body size, age, sex, and genetic factors. The inclusion of more medical information and how various factors play into the development of an enthesis can only make the methods used more precise and the conclusions we draw from them more accurate. However, despite these improvements, Hawkey and Merbs (1995) still remains the most widely used scoring system.

Application of Methods

With the major methods used to score MSM presented, the studies that have utilized these methods will be discussed. As it is beyond the scope of this thesis to describe all the work involving MSM research, only those that highlight both the positive and/or negative aspects of using entheses to answer archeological questions will be presented in detail. Research utilizing MSM data typically investigates questions relating to occupation and habitual activities (al-Oumaoui et al., 2004; Angel, 1966; Angel et al., 1987; Campanacho & Santos, 2013; Chashmore & Zakrzewski, 2011; Hagman, 2009), social status (Chapman, 1997; Havelková et al., 2013; Molnar, 2010; Porcic, 2009) and subsistence strategies and division of labor (Churchill & Morris, 1998; Doying, 2010; Eshed et al., 2004; Molnar, 2006; Peterson, 1998; Shuler et al., 2010).

Subsistence Strategies, Division of Labor, Habitual Activites

The study of MSM of the upper limb can give researchers clues about the subsistence strategies and division of labor among prehistoric and historic populations. In many areas around the world the archaeological record is lacking representation of organic artifacts due to factors such as soil acidity, weather or looting. These unfortunate occurrences mean that artifacts providing details of certain activities, such as canoes, food processing tools, or paleobotanical remains, can be lost.

In 1998 Peterson attempted to determine the type of weapon technology the people from prehistoric southern Levant were employing through analysis of MSM. Although weapons used for warfare and hunting often leave traces in the archeological record in the form of lithics or microlithics, in the case of prehistoric southern Levant "material culture associated with hunting is far from unequivocal due to the vagaries of preservation and tool function assignments" (Peterson, 1998, p. 380). Despite this lack of archeological evidence, it had been argued that the people of southern Levant utilized the bow and arrow (Peterson, 1998). To help shed light on the issue, Peterson turned to MSM. Fortunately, the muscles and movements used when practicing archery as well as overhand throws have been well described in sports medicine, providing a good point of reference when comparing data from the Natufian collections.

Seventy-two individuals, 45 males and 27 females, across five sites were examined. Nineteen MSM of the shoulder girdle and upper limb were evaluated, including both muscle and ligament attachment sites. Only robusticity and stress lesions were scored, using the method developed by Hawkey and Merbs (1995). Statistical analysis of the data showed that it was very likely that male MSM scores were more lateralized than female scores. The author attributes this sexual dimorphism to males participating in hunting activities. Using other statistical methods, namely rank order profiles and significant mean differences, Peterson (1998) suggested that the males of prehistoric Levant were engaging in activities that involved overhand throwing motions. This indicated a reliance on spears and atlatls for hunting.

Eshed and colleagues in 2004 compared the MSMs of four Natufian hunter-gatherer populations and four Neolithic farmer populations from Levant. In this study 21 muscle and ligament attachment sites of the upper limb and shoulder (humerus, radius, ulna, scapula, and clavicle) were scored using the system defined by Hawkey and Merbs (1995). The authors believed that the data from this analysis could possibly document a change in workload that was believed to have occurred during the shift to agriculture. Specifically, they sought to identify distinct patterns of division of labor as well as shifts in habitual activity between the Neolithic and Natufian periods. In order to achieve this, the differences between males and females between both populations and the level of asymmetry in MSM development were examined. The results of this study showed that the Neolithic and Natufian populations had a similar MSM “rank order” among the most utilized muscles (pectoralis major, the brachialis and the deltoideus) as well as the least utilized (the pronator quadratus and the supinator). However, in six of the 15 MSM sites in the upper extremity, the Neolithic populations produced statistically significant higher scores than those of the Natufian populations. In both groups, entheses were found to be stronger on the right side in males, and females from both populations showed no side dominance (Eshed et al., 2004). After comparing the level of sexual dimorphism between populations, it was shown that there was no significant difference. When comparing the MSM scores between the females of both populations, they were clearly higher in the Neolithic population. However, when looking at the MSM individually it is seen that some muscles were highly utilized in Natufian female populations that were not by the female Neolithic population.

Using these results, Eshed and colleagues (2004) reached the following conclusions; “1) Daily life in the Neolithic period (agriculture) in the southern Levant was more physically demanding than in the preceding Natufian (hunter-gather); 2) the shift in subsistence in the Neolithic of the Levant promoted a change in the sexual division of labor; and 3) females in the Neolithic took over a greater proportion of the subsistence activities compared to Natufian females” (Eshed et al., 2004, p. 314). These results were not unexpected as the archeological evidence suggests shifts in activity between the two periods. This evidence coupled with the MSM data reveals a clearer picture of the daily activities of the both populations.

The studies described above demonstrate how MSM data can be utilized to reconstruct the daily activities and types of tools used by prehistoric peoples, but entheseal changes can also be used to help us see who may have been performing various activities. In 2010 Doying investigated the division of labor between ‘white collar’ workers and laborers. Some 69 individuals aged 30 and older of known sex and occupation were chosen from the Maxwell Museum’s Documented Skeletal Collections at the University of Tennessee-Knoxville. These individuals were divided into the two occupation categories based on the U.S, Office of Personnel Management’s Handbook of Occupational Groups and Families (2008). The author selected 14 sites of muscle insertion sites on the upper and lower limbs which were analyzed using methods developed by Hawkey and Merbs (1995) and Mariotti et al. (2004). Doying found that individuals classified as ‘white collar’ workers showed more asymmetric patterns of MSM expression while those under the label ‘laborers’ showed symmetric patterns of MSM expression, suggesting that ‘laborers’ were performing work that involved both sides of the body. Results have also shown that “laborers tend to exhibit MSM at slightly higher frequencies at more insertion sites than white collar workers, and the site-specific pattern is consistent with the use of muscles in a way which is closely associated with movement (adduction) towards the midline of the body” (Doying, 2010, p. 64). However, the results of the non-parametric test using the aggregated z-scores failed to show a correlation between the occupation categories and MSM development or a significantly significant difference between male and female MSM scores. These results suggest that

MSM data cannot predict the occupation of an individual when the principle of aggregation is used.

Dutour in 1986 used sports medicine to interpret the pattern of ‘enthesopathies’ in the long bones of two Neolithic Saharan populations, one whose diet mainly consisted of marine life and the other who were hunter-gatherers. Dutour defined enthesopathies as “rough patches, irregularities, or osteophytes” (Dutour, 1986, p. 222), and his choice of term implies that he believed them not to be the result of normal processes that formed MSM. They were identified through visual observation in adult males and females and those of indeterminate sex, and then the lesions noted on the Saharan populations were compared to those found on radiographs from modern subjects suffering from enthesopathies of known etiology.

The upper limb was found to be the most affected with the foot having the next highest frequencies. Muscles that the author associated with the enthesopathies, namely pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum superficialis and flexor carpi ulnaris, were linked to modern javelin throwers or golfers. Attachment sites associated with triceps brachii were assumed to occur in modern wood cutters, blacksmiths and some baseball players. One individual with biceps brachii affected was suggested to have MSM indicating archery. Achilles tendon lesions were observed in one adult male from the population from Niger, which has been found in modern marathon and long-distance runners. Three other individuals (two adults and one “juvenile adult male”) had enthesopathies of the adductor hallucis longus. This type of enthesopathies has been linked to people who walk or run on hard surfaces.

Although Dutour (1986) was able to associate the observed lesions in the two Neolithic Sahran populations with similar lesions seen in a modern population, he cautions that associations drawn with specific activities were speculative. This may be problematic as the activities and health of a modern population are likely to be drastically different from those in an archaic one, even if they are from the same genetic group. Also problematic is that no age ranges are given for individuals included in the study, including for “juvenile adult”.

Social Status and Variation in Habitual Activities

The investigation of social status and cultural shifts is generally carried out through analysis of material culture in the archeological record and mortuary practices. However, sites are often disrupted either through human interference or natural processes. Therefore, many researchers have turned to MSM to help answer questions of social status when the archeological record is incomplete or the artifacts recovered are insufficient.

One study investigating the relationship between entheses and grave goods on the island of Gotland off the coast of Sweden was conducted in 2010 by Molnar. The Pitted Ware Culture (3400 – 2300 BC) people were hunter-gatherers with a strong reliance on marine resources. Grave goods reflecting hunting and fishing subsistence activities were found including (Molnar, 2010). Other grave goods included “pottery, flint and stone axes, flint chisels and blades, bone awls, boar's tusks and jaws, perforated seal teeth, amber beads, and beads and from bird diaphysis...mother-of-pearl, bone flutes, perforated bone plates, hedgehog pins and mandibles, a comb made of antler” (Molnar, 2010, p. 2). The high frequency of grave goods with children suggested that status was inherited rather than achieved. However, among adults there is a question of whether grave goods represented the individual interred or representative of that individual's place in the community (Molnar, 2010).

To answer this question, 51 muscle attachment sites along with the accompanying grave goods of 126 individuals from five Pitted Ware sites were evaluated. Entheses were scored according to Hawkey and Merbs (1995). Differences in the mean MSM score were observed among all five sites, indicating that there was local diversity in physical activity. Molnar found that "activity patterns, material culture and faunal remains, contribute to a complex image of great diversity and individuality between and within the different Pitted Ware sites" (Molnar, 2010, p. 12). An individual's place in the community can be seen through the grave goods found in the grave while the occupation or habitual activities of the individual can be seen through the development of MSM.

Molnar's study shows how entheses can be used to test whether grave goods placed within a grave represents the individual or the culture or social group of which they are a part, which can help researchers to better interpret the archaeological record. MSM can also be used in a historical context when there is a major cultural shift caused by foreign invasion or contact with foreign cultures, as well as help describe socioeconomic status. Chapman (1997) looked at the upper limb entheses in order to test several hypotheses regarding the change in activity among the indigenous population of Pecos Pubelo, New Mexico after Spanish contact. The hypotheses tested revolved around the Spanish interest in acquiring maize, animal hides, and woven cotton mantas as well as the use of indigenous groups for labor. It was "hypothesized that a comparison of MSM data from pre- and post-Spanish contact groups at Pecos would display evidence of intensification of activities relating to the procurement of these goods" (Chapman, 1997, p. 497). For the men, this would mean an increase in the agricultural activities surrounding maize production as well as an increase in the weaving of mantas, and for women, an increase in the processing of maize.

In order to test this, the upper limb and hand MSM of 185 individuals between the ages of 18 and 50 from the post- or pre-Spanish contact time period were scored using the method developed by Hawkey and Merbs (1995). Statistical analysis of the data showed only a small number of attachments with a statistically significant difference between the pre- and post-Spanish contact period. When rank orders of mean MSM values were determined, there was apparent sexual dimorphism as well by an increase in development of MSM development throughout time, which Chapman concluded were the consequences of Spanish influence. Results from this study could only be applied to the activities surrounding maize agriculture and processing as no evidence was found osteologically to support the hypothesis that there was a significant increase in the demand for woven mantas after Spanish contact.

Havelková et al. (2007) explored the relationship between entheseal changes and the socioeconomic status of an Early Medieval Central European population. For this study, 115 individuals, males and females between the ages of 20-50 years, were selected. The authors chose to only score fibrocartilaginous sites of both the upper and lower limbs using the method developed by Villotte (Havelková & Villotte, 2007). Multivariate statistics were used to identify patterns among the MSM data and grave goods found with the individuals. Among the males, two main patterns were seen. One pattern associated artifacts involved in daily use (textile iron, flint and razors) with entheseal changes of the flexors or extensors of the wrist. The second linked warrior equipment with loading of the triceps brachii and the gluteus medius. It is suggested based on the character of the mortuary contents that these individuals were members of a higher social class than those in the first group. Patterns found among the female sample were not as clear, but the most important factors found to indicate high social status were the presence of jewelry and depth of the grave. The authors of this study concluded that the "relationship between elements of burial right and the incidence of EC [entheseal changes] in individuals from the Klášteřisko burial site does exist" (Havelková et al., 2007, p. 249).

Criticisms of the Utility of MSM in Activity Reconstruction

There are several factors that have not been accounted for in most previous studies that could impact the expression of MSM, including intensity of the activity, the skeletal maturity of the individual, and in the individual's life when the activity may have taken place (Schlecht, 2012). Some of these issues, such as the skeletal maturity of the individuals being analyzed are easily rectified, but others may be more difficult if not impossible to ascertain from the archaeological record.

Others have argued that there can be a problem of over-interpretation with musculoskeletal markers (Jurmain, 1999; Jurmain & Roberts, 2008). In Jurmain and Robert's (2008) review of the article *Equids and an Acrobat: Closure Rituals at Tell Brak* by Oats et al. (2008), they cite that previous researchers have had difficulty pinning down the musculoskeletal stress marker development of one or more entheses, even with historical documents relating to what activities the individual participated in during his lifetime. They state that there is there is just too much variation in order to accurately pinpoint a specific activity. While the premise may be correct, it can be counter-argued that caution must be used when employing historical documents. If not careful, a researcher could get a false sense of accuracy about the correlation between the development of specific entheses and specific activities. It is important to keep in mind that historical documents do not give the whole picture of an individual's activities during his or her life; often they do not record how long the individual has been engaged in the activity or occupation reported or what he or she did previously. It is also prudent to remember that historical documents may not always be accurate, frequently having specific agendas that could skew expectations for activities. Jurmain (1999) also cautions against relating all entheseal changes to any one specific activity because many factors may have influence the development of an attachment site. Many of the issues that Jurmain (1999) brings up, such as factors relating to age, sex and size, are being addressed.

Another factor that can influence the results of a study involving MSM is the type of statistical analysis used to evaluate the data. Weiss (2003) used the principle of aggregation to "sum muscle markers over seven insertion sites (4 humeral, 2 radial, and 1 ulnar) and examine the effects on them of body size, age, sex, and cross-sectional properties." (Weiss, 2003, p. 230). The 91 adult individuals selected for this study included 66 males and 25 females between the ages of 18 and 69. Weiss employed the method described by Hawkey and Merbs (1995) to score the seven entheses. Z-scores were then used to create three composite variables: Aggregate Muscle Marker, Humeral Size, and Robusticity (Weiss, 2003). The use of aggregation in this study was chosen for four reasons "1) interobserver and intraobserver rates were low for the method of data collection used, which suggests that each item of data is reliable (Hawkey & Merbs, 1995); 2) aggregation made sense biologically because muscles work in groups; 3) general patterns were being examined rather than a specific phenomenon; and 4) aggregation streamlined the data analyses." (Weiss, 2003, p. 237).

The individual scores in Weiss's study did not produce significant results. It was only when multiple measurements were used that the results were statistically significant. This study found that the best indicator of "Aggregate Muscle Marker" was age for both sexes. Weiss argued that the effects of age and sex on MSM development were significant and must be accounted for when attempting to reconstruct past activity. It was also stressed the use of "aggregate measures may be useful (when appropriate and possible) to reduce error variance and enhance construct validity" (Weiss, 2003, p. 239). Although many have addressed the effects of body size and sex when using musculoskeletal stress markers in attempts to reconstruct the past activities of a population, very few if any have used the statistical approach Weiss has suggested. The choice of statistical method is an important one that can have a dramatic impact on the outcome of the study. It is clear that significant challenges remain when attempting to compare male and females in the same population. It could be that a more quantitative scoring method is required.

A more recent study conducted by Weiss et al. (2012) investigated the relationship between musculoskeletal stress markers and sex. Typically, males show more developed entheses than do females in a population. In this analysis Weiss and colleagues looked at the MSM in a variety of populations to determine if this pattern was consistent across the groups. If so, then likely inherent genetic difference such as hormonal differences and body size or type and location MSM location were in operation. However, if sex difference were found between the populations tested, then this would reflect intrapopulational variation. Some 105 individuals from the Ryan Mound (164 BC – AD 1766) - a central California coastal - site were used, consisting of 53 males and 52 females. Individuals from this site were believed to be hunter-gatherers with a heavy reliance on acorns. The musculoskeletal stress markers of the humerus, ulna and scapula were analyzed, using the method described by Hawkey and Merbs (1995). Their results showed that the deltoideus muscle score was different between the tested populations. Because the scores of this musculoskeletal stress marker are different among populations, Weiss et al. (2012) suggest that this enthesis may be affected by activity more than genetics when size and age are controlled. Ultimately they found that most musculoskeletal stress marker scores could be explained at least partially by body size. The issue of body size is an important one to consider when analyzing MSM data especially when comparing scores between males and females of the same population. One way to avoid this type of bias would be to not compare the MSM scores of males and females without compensating for the size difference. Another way to decrease this bias would be to only analyzed and compared MSM scores between individuals of the same sex.

Another challenge when dealing with MSM data is the paucity of clinical knowledge regarding the etiology of the characteristics of an attachment site that are being scored, including robusticity, osteophytic activity and especially osteolytic activity. The lack of medical literature surrounding these features is due to the fact that they do not pose any real health threat nor do they cause any debilitating side effects; in other words, clinicians have no real reason to be concerned with these kind of entheseal changes. Although literature exists discussing the way in which bone responds to mechanical stress, very few papers focus specifically on the entheseal site but instead discuss the bone as a whole.

One investigation that demonstrates how a lack of understanding can hinder the interpretation of MSM results is Zumwalt's (2006) study. This study, discussed in more detail earlier in this section, used sheep as a way to study how increased exercise can affect bone, specifically at the sight of attachment. Ultimately she found no difference in MSM development between the exercised populations when compared with a non-exercised population of sheep. Because little knowledge exists as to the development of MSM, it is difficult to tell whether or not this was because 1) there is no correlation between entheseal development and increased mechanical stress, 2) the exercise time for the sheep needed to be longer in order to overcome the body's buffers against stress, or 3) the exercise was something that sheep normally would not do placing stress on muscles that the body is not used to. Experimental research in this area is difficult because animals that are typically used in these kinds of studies are quadrupeds and the majority of the MSM research focuses on the markers of the upper limbs. More clinical research regarding the development of MSM and enthesopathies is needed in order to most accurately interpret the results from MSM studies.

Use of Juvenile Remains in MSM Research

For the majority of the MSM studies examining habitual activity, juveniles are excluded in favor of skeletally mature adults. The typical reason given for this exclusion is that osteoblastic activity in the juvenile skeleton would obscure any effects of mechanical stress on the bone (Zumwalt, 2006) as some enthesis attach to the periosteum in juvenile mammals and during skeletal maturation the attachment moves to the cortex of the bone (Matyes et al., 1990). This may suggest that the enthesis will be more greatly affected by the mechanical strain from the tendon after it has anchored itself to the cortex of the bone. However, a study by Shaw and Stock in 2009 looking at habitual activities, including swimming and throwing, in a group of males between the ages of 19 and 29 corresponded to upper limb skeletal morphology that typically characterized athletic individuals. The study found that the athletic individuals had stronger resistance to torsion deformation, compression, and bending deformation when compared to sedentary groups. It has also been suggested that it is during the stages of growth and development when these forces most greatly influence the shape of the adult bone; therefore by examining entheseal changes in skeletally mature individuals, researchers are in fact seeing the influence activity had on the bone development during late adolescent and early adulthood (Mann & Hunt, 2012).

The inclusion of juvenile age sets has the potential to provide a great deal of information regarding past activities as much of cortical bone morphology of an adult is a reflection of the activity during adolescence (Pearson & Leiberman, 2004). It is also during adolescence when individuals begin practicing the roles they will play in adulthood (Horlow & Laurence, 2002; Janssen & Janssen, 2006; Martin, 2015). A recent PhD dissertation by Martin (2015) investigating the changes in workload in response to environmental and cultural differences between three Nubian groups (2,500 - 1,500 BC) included juvenile remains in his analysis. Martian found that the enthesis changes of the juveniles from the three Nubian groups studied did reflect habitual behavior.

A major question concerning the inclusion of adolescents in the study of activity reconstruction is when adult activities were adopted. In cases where historical or ethnographic information is available it is suggested that individuals as young as 12 years old may have been engaging in adult activates in certain regions (Martin, 2015). Unfortunately, there is little ethnographic evidence of the same nature for the prehistoric southeast U.S. However, it may possibly be inferred through mortuary patterns when adolescents entered into adulthood. For example, at the Warren Wilson site, a Mississippian village in North Carolina where grave goods were found with 61 burials, it was observed that juveniles (>8 years) were interred with shell beads and gorget (Rodning & Moore, 2010). The authors suggested that this reflected the associative status of the children. Males aged 15 and above had fewer instances of grave goods, while two elderly males had largest and most diverse arrays of grave goods. Although the authors do not offer an explanation for this, one likely interpretation is that males older than age 15 were no longer given associative status and had to earn their place in society, which would place them among the adults in the society. While the use of juveniles, especially those approaching adulthood may provide insights to habitual activity, it is important to keep in mind that juvenile bone will not respond in the same manner as adult bone. Therefore, a reaction that would be attributed to enthesopathy, i.e., osteolytic activity, in an adult may be the result of normal entheseal formation. Martin (2015) suggests that further research into how juvenile bone reacts to mechanical loading will provide a clearer picture of muscle use.

The use of MSM analysis has found an important place in the bioarcheologist's tool box for reconstructing past life ways. The most common methods to score entheses, those of Hawkey and Merbs (1995) and more recently Mariotti et al. (2004, 2007), require little if any equipment and take a reasonable amount of time to implement. Unfortunately, it can be argued that these methods are based on an oversimplification of the complex process of bony response to stimuli. That is not to say that research done with using the above methods are not valid since many have data from the archeological and sometimes historical records to support their findings. However, it is important to be aware of the methods shortcomings and to be critical of interpretations that rely entirely on them. Recently more attention has been given to the importance of other confounding factors, such as subjectivity, age, and sex. Accounting for these factors along with a more clinical focus on why, how, and when bone responds to mechanical strain will strengthen future research done with MSM data.

CHAPTER III - MATERIALS AND METHODS

In this chapter the bioarchaeological samples analyzed are presented. The methods used to assess the upper limb entheses are described as are the types of statistical testing employed.

The Sample

The individuals used in this study date to the Archaic and Mississippian periods in the Tennessee River Valley (Table 1). Populations during the Archaic period (8700-1400 BC) were mobile, moving between seasonal camps, although they became more sedentary in the later portion of the period. Arboreal seeds, such as hickory nuts, make up a major portion of ethnobotanical data (Smith, 1982), and maize, acorns, and fruits were also consumed. Archeological evidence suggests the use of spears or possibly atlatls were the main form of hunting during this time. The Mississippian period (AD 1000-1500) was largely defined by the shift to reliance on cultivated crops, such as maize, beans, and squash, as well as an increasingly complex social structure. Hunting and gathering supplemented the diet. In contrast to the Archaic time period, foodstuffs in the consumed in this time period involved a narrower range of plant materials and were more highly processed. Mississippian populations were more sedentary with most activity revolving around horticulture. Previous studies investigating the changes in the long bone dimensions of Archaic and Mississippian samples from the Southeastern United States suggested that individuals from the Mississippian sample participated in more strenuous activities than individuals from the Archaic time period (Bridges, 1989).

Table 1

Individuals in Sample by Time Period, Site and Age

Site Name	Site Number	15-20y	20-25y	25-30y	30+y
		Archaic			
Eva	6BN12	1	1		5
Cherry	84BN74		1	1	3
Ledbetter	9BN25	1			
Big Sandy	25HY18	1			1
Kays Landing	15HY13				2
Robinson Site	40SM4	1			
Oak View Landing	1DR1			1	
		Mississippian			
Mouse Creek	4MN3		1		
Dallas Site	8Ha1 and 7Ha1	5	2	1	2

Individuals from ten archeological sites, seven Archaic and three Mississippian, were chosen for analysis; all are housed at the University of Tennessee-Knoxville. The Archaic sites were pooled into one sample as were individuals from the Mississippian sites. The ages were divided into four categories; late adolescent (15-20 years), young adult (20-25 years), middle adult (25-30 years) and old adult (30+ years). Age was determined from burial reports and confirmed with examination of epiphyseal fusion, eruption of the third molar, and surface erosion of the pubic symphysis when available. If an individual's age ranged spanned two categories (e.g., 15-25 years), that individual was placed in the older age category. Information from both the left and right side were collected and analyzed when preservation allowed. Individuals who showed evidence of healed or healing trauma or pathology which would affect normal use of the upper limb were excluded. The final sample used is given in Table 1. The morphology of 17 muscle attachment sites (Table 2) of the upper limbs (humerus, radius, and ulna) was evaluated. These entheses were chosen because the arm typically is involved in a wider variety of activities than is the lower limb, making them a more common focus of activity reconstruction studies.

Table 2

Entheses Sites Chosen for Analysis and Their Associated Actions

Muscle/Ligament	Attachment	Action
Supraspinatus	Humerus - lesser tubercle	Initiation of the abduction of the arm at the glenohumeral joint. Rotator cuff muscle
Infraspinatus	Humerus – greater tubercle	Lateral rotation of arm at glenohumeral joint. Rotator cuff muscle
Lattismus Dorsi	Humerus – floor of intertubercular sulcus	Extends, adducts, and medially rotates humerus
Pectoralis Major	Humerus – lateral lip of intertubercular sulcus	Adduction, medial rotation and flexion of the humerus at the glenohumeral joint
Deltoideus	Humerus – deltoid tuberosity	Major abductor of arm. Assists in flexion and extension of the arm
Teres Major	Humerus – medial lip of intertubercular sulcus	Medial rotation and extension of the arm at the glenohumeral joint

Common Extensor Tendon	Humerus – lateral epicondyle	Provides attachment for the superficial muscles of the posterior forearm.
Brachioradialis & Extensor Carpi Radialis Longus	Humerus – lateral supracondylar ridge	Accessory flexor of elbow joint. Extends and abducts the wrist
Teres Minor	Humerus – greater tubercle	Lateral rotation of the arm at the glenohumeral joint. Rotator cuff muscle
Brachialis	Ulna – Ulnar tuberosity	Powerful flexor of the forearm at the elbow joint
Pronator Quadratus	Ulna – medial anterior surface	Pronates the forearm
Anconeus	Ulna – lateral surface of the olecranon process and superior proximal part of ulna	Abduction of the ulna in pronation and extensor of the elbow joint.
Triceps Brachii	Ulna – olecranon process	Extension of the forearm at the elbow joint
Supinator	Ulna – supinator crest and Radius – lateral proximal shaft	Supinates the forearm
Biceps Brachii	Radius – radial tuberosity	Flexor of the forearm at the elbow joint and supinator of forearm, accessory flexor of the arm at the glenohumeral joint
Pronator Teres	Radius –lateral surface of the shaft of radius	Pronation of forearm

Methods of Analysis

Two different types of scoring methods were used in this study, macroscopic and fractal analysis. The first macroscopic method utilized was developed by Hawkey and Merbs (1995), and assessed MSM for three features: Robusticity, Stress Lesions and Ossification. Each of these categories is scored separately on a scale of 1 to 3 with 1 being weak expression of the trait and 3 being strong expression. Robusticity looks at the normal reaction of the bone to daily activities that produce rugged markings on the bone at and around the attachment site; in their most extreme state they appear as “sharp ridges or crests of bone” (Hawkey & Merbs, 1995, p. 328). Stress Lesions are defined as “a pitting or 'furrow' into the cortex to the degree that it superficially resembles a lytic lesion” (Hawkey & Merbs, 1995, p. 392). The third category, Ossification, appears as a bony projection and is believed to be caused by acute trauma rather than everyday use of the muscle. Robusticity and Ossification are seen as a continuum with Ossification being the extreme expression of Robusticity.

The macroscopic method developed by Mariotti and colleagues gives a detailed outline of the development of both enthesospathies (Mariotti et al., 2004) and robusticity (Mariotti et al., 2007). Mariotti’s method differs from that of Hawkey and Merbs (1995) in the way in which Robusticity is scored. Instead of having a single set of criteria to be applied to all attachment sites, each of the twenty-three sites described in their study has its own criteria for the stages of development identified by the authors. Similar to Hawkey and Merbs (1995), each marker has three stages of development with 1 being a weak expression of the trait and 3 being the most pronounced expression of the trail. Stage one is further divided into a, b and c stages that are differentiated based on traits specific to the attachment site. Due to a recording error during data collection, the different categories of stage 1 was not recorded, and were rescored based on the 3D scanned images as well as the 2D images captured by the NextEngine scanner.

The third method used in this study was modeled after the technique developed by Zumwalt (2005). The three-dimensional images of the attachment site were captured using a NextEngine 3-D scanner. The proximal and distal borders of the enthesis were marked with string, which was tied around the bone at or slightly above the enthesis; only the enthesis and bone immediately surrounding the site was scanned. Once the borders of the enthesis were visually identified, the bone was mounted on the turntable. Both micro- and macroscans were taken, depending on the size of the enthesis. For example, the brachioradialis muscle and extensor carpi radialis longus were scanned and analyzed together because it is difficult to distinguish where one enthesis ends and another begins on the dry bone; however, this resulted in a long attachment site that could not be captured in its entirety on the micro setting.

The scans were edited using Scan Studio software (NextEngine, 2015) so that only the enthesis was present Figure 1. The edited scan was saved as an .XYZ file and then converted into a delimited tab file. This file was then uploaded to ArcGIS 10.1 (Esri, Inc., 2016) as a two-dimensional map. Profiles were taken starting at outer border of the enthesis, working inward at 1 to 1.2 mm intervals until the center was reached (Figure 3). This ensured that a large portion of the enthesis was included; however, this also meant that the number of profiles taken was dependent on the size of the entheses. These profiles, containing the x y z coordinates which contain the length, height, depth dimensions for every point, were next exported as Excel files and uploaded into the Beniot 1.3 fractal analysis software (TruSoft International, 2015). The x y z coordinates mark the location of the point taken from the enthesis including the height. The measurements taken using the Beniot 1.3 for each enthesis were then averaged, giving a total score for the entire enthesis. This method for analyzing the three-dimensional scans had fewer steps and did not use the exact same software (3D Systems, 2015) as

Zumwalt's (2005) method as the files could be more easily transferred from one program to another as compared to other programs. Due to the extensive amount of time involved in this method, only 12 individuals chosen at random for evaluation for this step of the analysis.

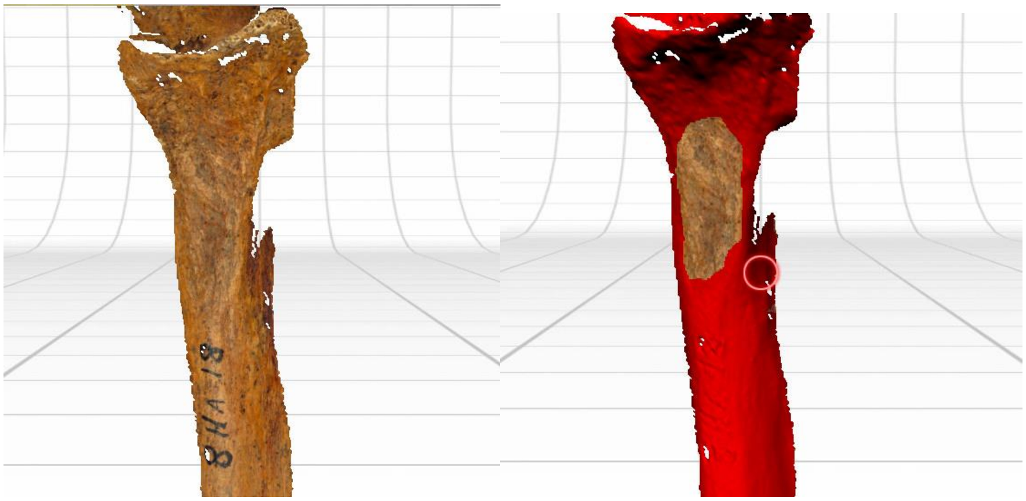

Figure 2. 180° scan of the left ulna before (left) and after (right) selection of bone to be removed for the Brachialis attachment site.

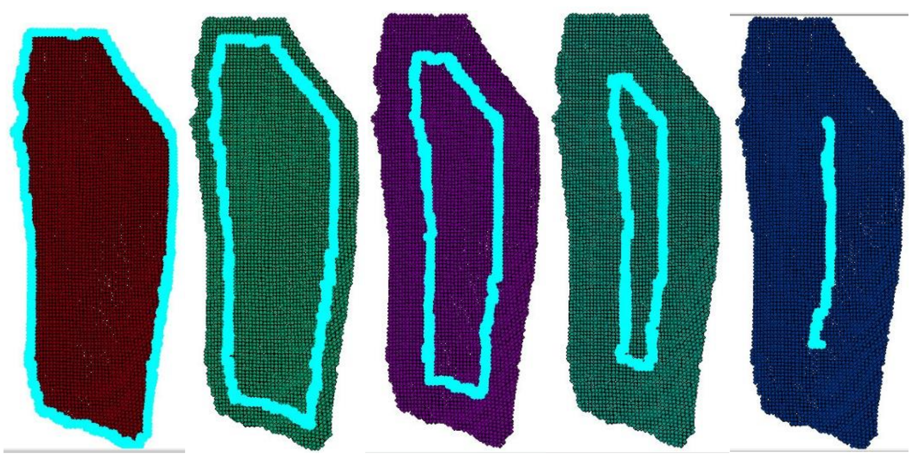

Figure 3. Example of four profiles taken from the insertion of Pronator Teres.

The muscles were grouped together based on function. The mean scores were calculated using SPSS (IBM, 2015) and each age group were compared for each method used as well as by time period. Statistical analysis was conducted using T-tests with $p \leq .05$.

CHAPTER IV – RESULTS

In this chapter, the results of the analysis of the three methods of enthesis development are presented. The means of the markers are then compared for each age set between the Archaic and Mississippian time periods. Major patterns for each of the activity groups are discussed after the data has been presented.

Attachment Sites Involved in Glenohumeral Flexion

Hawkey and Merbs Method (1995)

The attachment sites for the deltoid, pectoralis major, and biceps brachii were examined together for glenohumeral flexion. Overall virtually the same pattern of values for the various characteristics of attachment sites associated with flexion was seen in both samples. Robusticity scores (Table A1) ranged from 1-2 for all age groups, although late adolescents and young adults did show notably higher values (2.00) on the right side for the pectoralis major in the Archaic sample. In the Mississippian sample (Table A4), the late adolescent age set exhibited the lowest scores for almost all markers. In general, scores for osteophytic activity were noticeably lower (0-1), but no pattern was seen other than that older adults had the highest scores for both sides of the deltoid in both populations. Interestingly, the youngest age set appears to have had greater levels of osteophytic activity in the Mississippian group (Table A5) for all muscles, especially in the left deltoid, but the small sample sizes for the other age groups must be kept in mind. Osteolytic activity was absent in nearly all age groups in both time periods.

Mariotti et al. Method (2004, 2007)

Overall robusticity scores showed little variation between age sets in both samples. No obvious pattern in osteophytic activity was observed in the Archaic sample, although old adults did display some activity in all markers (Table A79). The majority of the osteophytic activity in the Mississippian sample (Table A82) was observed in the late adolescent age set, but little to no osteolytic activity was present in the Archaic sample. In the Mississippian sample (Table A83), the only osteolytic activity present was in the late adolescent age set for the left pectoralis major and the right biceps brachii.

Benoit Method (Trusoft International, 2015)

For extension at the glenohumeral joint, little variation of the scores was seen between the age sets in both the Archaic (Table A156) and Mississippian samples (Table A157). All scores fell between 1-2.

Attachment Sites Involved in Glenohumeral Extension

Hawkey and Merbs Method (1995)

The attachment sites for the deltoid, latissimus dorsi, and teres major were examined for extension at the glenohumeral joint. Virtually the same pattern of values for the various characteristics of attachment sites associated with flexion was seen in both samples. Robusticity scores ranged from 0-1 for all age groups, with the right and left deltoid having higher scores for all age groups. Late adolescents did express higher levels of robusticity for the right latissimus dorsi and teres major in the Mississippian sample (Table A7). For the remaining markers old or middle adults showed the highest scores. Little to no osteophytic activity was observed in either sample. However, the Archaic sample (Table A8) old adults had some osteophytic activity for all markers while in the Mississippian sample (Table A11) late adolescents appeared to have been the most active. Osteolytic activity was low to absent in nearly all age groups in both time periods.

Mariotti et al. Method (2004, 2007)

Overall robusticity scores showed little variation among age sets in both samples. No obvious pattern in osteophytic activity was observed in the Archaic sample, although old adults did display some activity in all markers (Table A85). The majority of the osteophytic activity in the Mississippian sample (Table A88) was observed in the late adolescent age set, but little to no osteolytic activity was present in the Archaic sample (Table A29.3). In the Mississippian sample (Table A89) the only osteolytic activity seen was in the late adolescent age set for the left pectoralis major and the right biceps brachii.

Benoit Method (Trusoft International, 2015)

For extension at the glenohumeral joint, little variation of the scores was seen between the age sets in both the Archaic (Table A158) and Mississippian samples (Table 159). All scores fell between 1-2.

Attachment Sites Involved in Glenohumeral Abduction

Hawkey and Merbs Method (1995)

The attachment sties for the deltoid and supraspinatus were examined for abduction of the glenohumeral joint. Similar patterns of robusticity were seen in both samples, with the both sides of the deltoid having markedly higher markers (1-2.556) than the supraspinatus (0-1). For the right and left deltoid, old adults had the higher scores in both samples. For the supraspinatus in the Archaic sample (Table A13), the late adolescent age set had the highest scores but this was not replicated in the Mississippian sample (Table A16)0. Little to no osteophytic activity was observed in the Archaic sample (Table A14). However, in the Mississippian sample (Table A17) osteophytic activity was highest among the late adolescent age set for the right and left deltoid, and for the right and left supraspinatus young adults and old adults show the highest osteophytic activity. Little to no osteolytic activity was displayed in either sample.

Mariotti et al. Method (2004; 2007)

The attachment sites for the deltoid and supraspinatus were examined for abduction at the glenohumeral joint. Robusticity scores could not be gathered for the supraspinatus as its development was not described in Mariotti (2007). Scores for the right and left deltoid showed little variation between age sets in both samples. In the Archaic sample, osteophytic activity (Table A91) was seen only in the right and left deltoid markers in the young and old adult age sets. In the Mississippian sample, all osteophytic scores (Table A94) fell between 0-1 with no obvious pattern discernable. Only sporadic osteolytic activity was found in either group.

Benoit Method (Trusoft International, 2015)

For abduction at the glenohumeral joint, little variation of the scores was observed between the age sets in both the Archaic (Table A160) and Mississippian samples (Table A161) with all scores ranging between 1-2.

Attachment Sites Involved in Glenohumeral Adduction

Hawkey and Merbs Method (1995)

The attachment sites for pectoralis major, latissimus dorsi, and teres major were examined for adduction at the glenohumeral joint. Little variation was observed in the robusticity scores for both samples other than scores for the pectoralis major were generally higher than those of the latissimus dorsi and teres major for all age sets in the Archaic sample (Table A19). More osteophytic activity was displayed in the Archaic sample (Table A20) compared to the Mississippian sample (Table A23), but the difference was small. However, the late adolescent age set in the Mississippian sample did seem to have the most osteophytic activity, as each marker has a score greater than zero. The highest scores were found in the old adult age set for the left pectoralis major (1.000) and the right latissimus dorsi and teres major (.2500). Little osteolytic activity was present in the Archaic sample (Table A21) while late adolescents in the Mississippian sample (Table A24) had activity in the left pectoralis major and left latissimus dorsi and teres major.

Mariotti et al. Method (2004; 2007)

Both samples showed little variation in robusticity scores for the adduction at the glenohumeral joint; scores ranged between 1.1-1.3. Osteophytic values in the Archaic sample (Table A97) for age sets also fell between 0-1. Interestingly in the Mississippian sample (Table A100), the late adolescent age set showed osteophytic activity for all markers. Some osteolytic activity was observed the late adolescent age set for multiple muscles in both samples.

Benoit Method (Trusoft International, 2015)

For adduction at the glenohumeral joint, little variation of the scores was seen between the age sets in both the Archaic (Table A162) and Mississippian samples (Table A163) with scores ranging between 1-2.

Attachment Sites Involved in Glenohumeral Lateral Rotation

Hawkey and Merbs Method (1995)

The attachments for the infraspinatus and teres minor were examined for lateral rotation of the glenohumeral joint. No obvious pattern was seen in the robusticity scores for the Archaic sample (Table A25) while the late adolescent age set in the Mississippian sample (Table A28) shows the most activity across all entheses. However, little variation between scores was present in both samples. Old adults had the most osteophytic expression in the Archaic sample (Table A26) with every marker showing some activity, while in the Mississippian sample (Table A29) little to no activity was observed. Osteolytic activity was seen only in one set of markers for both samples, and levels were minor.

Mariotti et al. Method (2004; 2007)

Robusticity scores for the lateral rotation at the glenohumeral joint was not able to be measured as Mariotti et al., (2007) did not describe development of robusticity for the infraspinatus and teres minor. In the Archaic sample (Table A103), the majority of the osteophytic activity appeared in the middle and old adult age set except for the left infraspinatus in the young age set. In the Mississippian sample (Table A106), the only osteophytic activity present was in the right and left infraspinatus for the young adult age set. No definable pattern was discernible in the Archaic sample (Table A104) for osteolytic activity, and in the Mississippian sample (Table A107), osteolytic activity was only present in the young adult age set for the teres minor.

Benoit Method (Trusoft International, 2015)

For lateral rotation at the glenohumeral joint in the Archaic sample (Table A164), only the left infraspinatus for the late adolescent age set was noticeably lower than the rest of the scores, which fell between 1-2. In the Mississippian sample (Table A165) all scores similarly ranged between 1-2.

Attachment Sites Involved in Glenohumeral Medial Rotation

Hawkey and Merbs Method (1995)

The attachment sites for the pectoralis major, latissimus dorsi, and teres major were examined for medial rotation of the glenohumeral joint. For both the Archaic (Table A31) and Mississippian (Table A34) samples, little variation among scores is seen for robusticity, and the only observable pattern was found in the scores for the right and left pectoralis major (1.3000 – 2.0000), which were generally higher than the scores for the right and left latissimus dorsi and teres major (.2500 – 1.08). Little to no osteophytic or osteolytic activity was seen in both samples with all scores falling between 0-1.

Mariotti et al. Method (2004; 2007)

The attachment sites for the pectoralis major, latissimus dorsi and teres major were examined for the medial rotation at the glenohumeral joint. Overall, little variation was observed between the scores for robusticity in both samples with all scores ranging from 1-2. Little variation was seen in the ostophytic activity for the Archaic sample (Table A109). In the Mississippian sample (Table A112), osteophytic activity was observed in the late adolescent age set for all markers examined (.1667 - .2000) and the middle adult age set in the left latissimus dorsi and teres major (.5000) for this trait. Interestingly, osteolytic activity present was displayed in the late adolescent age set for the left pectoralis major in the Archaic sample (Table A110) and in the left pectoralis major and left latissimus dorsi and teres major for the same age set.

Benoit Method (Trusoft International, 2015)

In the Archaic sample (Table A166), only values for the left infraspinatus for the late adolescent age set were noticeably lower than the rest of the scores, which fell between 1-2. In the Mississippian sample (Table A167) little variation between age sets was seen.

Attachment Sites Involved in Elbow Flexion

Hawkey and Merbs Method (1995)

The attachment sites for the biceps brachii, brachialis, and brachioradialis including extensor carpi radialis longus was examined for flexion at the elbow joint. Little variation in robusticity scores was seen in the Archaic sample (Table A37). However, in the Mississippian sample (Table A40), in general, young adults or old adults had the highest score for one set of markers with the exception of the brachialis, where middle adults exhibited the highest score (3.000) for the left side. In both samples little variation was seen for osteophytic activity, with all scores falling between 0-1. Little osteolytic activity was observed in the Archaic sample (Table 39). In the Mississippian sample (Table 42) the only osteolytic activity observed was in the late adolescent age set for the right biceps brachii and left brachialis.

Mariotti et al. Method (2004; 2007)

For flexion at the elbow, little variation was seen in the robusticity among age sets for both samples, with scores falling between 1.1 – 1.3. The only pattern that emerged concerning osteophytic activity was that late adolescent age set had some activity for every marker in the Mississippian group (Table 118). Osteolytic activity in the Archaic sample (Table A116) was present in the late adolescent age set for the right and left brachialis (.2500 and .3333, respectively), the young adult age set for the right brachioradialis (1.0000) and in the old adult age set for the right and left biceps brachii (.1250 and .1111, respectively). In the Mississippan sample (Table A119), low levels of activity in the late adolescent age set were present for several muscles whereas the middle adults show activity for the left brachioradialis (1.000).

Benoit Method (Trusoft International, 2015)

For flexion at the elbow joint, little variation of the scores was present between the age sets in both the Archaic (Table A168) and Mississippian samples (Table A169) with all scores falling between 1-2.

Attachment Sites Involved in Elbow Extension

Hawkey and Merbs Method (1995)

The attachment sites for the anconeus and triceps brachii were examined for extension at the elbow joint. Little variation was seen among the scores for robusticity in both samples. However, in the Mississippian sample (Table A46), late adolescents had the highest score for all markers except the left triceps brachii. Little osteophytic activity was observed in both samples. Osteolytic activity in the Archaic sample (Table A45) was limited to the triceps brachii in the old adult age set and in the Mississippian sample (Table 16.3) to the left anconeus and left triceps brachii in the late adolescent age set.

Mariotti et al. Method (2004; 2007)

For extension at the elbow joint robusticity could not be scored for the anconeus since development was not described in Mariotti (2007). Little variation was seen in the robusticity scores for the triceps brachii was seen in both samples. The only osteophytic activity present in both samples was in the right and left triceps brachii. In the Archaic sample (Table A121), young adults had the score of 1 for both sides and the old adults had a score of .1000 for the right triceps brachii. For the Mississippian sample (Table A124) the activity was limited to the late adolescent age set. Similarly, the only osteolytic activity for both samples was seen in the right and left triceps brachii, and levels were low.

Benoit Method (Trusoft International, 2015)

For extension at the elbow joint, little variation of the scores was seen among the age sets in both the Archaic (Table A170) and Mississippian samples (Table A171). All scores fell between 1-2.

Attachment Sites Involved in Elbow Pronation

Hawkey and Merbs Method (1995)

The attachment sites for the pronator teres and the pronator quadratus on the attachment sites for both the radius and ulna were examined for pronation at the elbow joint. Robusticity scores ranged from 0-1.5 for all age groups in both samples. In the Archaic sample (Table A49), the highest scores tended to belong to the middle and old adult age sets, but no obvious pattern was seen in the Mississippian sample (Table A51). In both samples the left pronator quadratus at both attachment sites had no osteophytic activity except for the right pronator quadratus on the radius for the Archaic (Table A50) and Mississippian samples (Table A52) where the old adult age set showed some activity. Osteophytic activity in the Archaic sample was found in the middle or old adult age sets and in the late adolescents and old adult age sets for the Mississippian sample. No osteolytic activity was present in any age set for either sample.

Mariotti et al. Method (2004; 2007)

For pronation at the elbow joint in the Archaic sample, development of robusticity could not be scored for the pronator quadratus (radius and ulna) as its development was not described in Mariotti (2007). Very little variation was seen in the robusticity scores for the pronator teres in both samples. The only osteophytic activity displayed in the Archaic sample (Table A127) was found in the old adult age set. In the Mississippian sample (Table A130) little osteophytic activity was seen; when present, it appeared in the late adolescent and/or old adult age sets with scores falling between .2-.5. No osteolytic activity was seen in the Archaic sample (Table A128), and in the Mississippian sample (Table A131) it was only observed in the old adult age set for the left pronator quadratus (Ra) (.5000).

Benoit Method (Trusoft International, 2015)

For pronation at the elbow joint in the Archaic sample (Table A172), the score for the right pronator quadratus (Ul) was noticeably lower than other scores for that marker. There was little variation between scores for the Mississippian sample (Table A173).

Attachment Sites Involved in Elbow Supination

Hawkey and Merbs Method (1995)

The attachment sites for the biceps brachii and supinator on both the radius and ulna were examined for supination at the elbow. For the Archaic (Table A54) and Mississippian samples (Table A57), there was little variation in scores for robusticity. The only noticeable pattern seen was that the right and left supinator (Ra) generally had lower scores (0-.8571) than other markers (1-2) in both groups. Osteophytic activity was consistently low. For the Archaic sample (Table 55), the only osteolytic activity present was found in the old adult age set for the right and left biceps brachii and the right supinator (Ul). In the Mississippian sample (Table A59), osteolytic activity was displayed in the late adolescent age set for the right biceps brachii and the right and left supinator (Ra).

Mariotti et al. Method (2004; 2007)

For supination at the elbow, the robusticity of the development of the supinator (Ra) could not be scored as its development was not described in Mariotti (2007). Little variation in robusticity scores between age sets was observed in both samples. In the Archaic sample (Table A133), the only pattern that emerged for osteophyte scores was that the old adult age set has some activity in all markers. In comparison, all osteophytic activity present in the Mississippian sample (Table A136) was found in the late adolescent and young adult age sets (0-.6667). The only osteolytic activity for the Archaic sample (Table 134) was present in the old adult age set for the right and left biceps brachii (.1250 and .1111, respectively) whereas the only osteolytic activity observed for the Mississippian sample (Table 137) was in the late adolescent age set (0 - .3333).

Benoit Method (Trusoft International, 2015)

For supination at the elbow joint, little variation of the scores was observed between the age sets in both the Archaic (Table A174) and Mississippian sample (Table A175) with all scores ranging between 1-2.

Attachment Sites Involved in Extension at the Wrist

Hawkey and Merbs Method (1995)

The attachment sites for the common extensor tendon and the bracioradialis including the extensor carpi radialis were examined for extension at the wrist joint. In the Archaic sample (Table A60), little variation between scores was seen for robusticity other than that the old adult age set had the highest robusticity scores for all markers (1-1.7778). In the Mississippian sample (Table A63), the robusticity scores for the right and left common extensors were generally lower than those for the brachioradialis. Little osteophytic activity was seen with no obvious pattern for both samples. The only osteolytic activity displayed was in the old adult age set for the left brachioradialis. Interestingly, it was the only marker in the Mississippian sample (Table A65) to have activity but occur in the middle adult age set.

Mariotti et al. Method (2004; 2007)

For the extension at the wrist joint, robusticity scores for the development of the common extensor could not be scored as its development was not described in Mariotti (2007). Little variation in the robusticity scores was observed with no obvious pattern present between the age sets for both samples. For osteophytic activity, the Archaic sample (Table A139) showed no discernable pattern except that the old adult age set had some activity in all markers (.2000-.5000) while in the Mississippian sample (Table A142), osteophytic activity present was only found in the late adolescent and young adult age sets. Little osteolytic activity was seen in either group.

Benoit Method (Trusoft International, 2015)

For extension at the joint, the range of the scores present between the age sets in both the Archaic (Table A176) and Mississippian sample (Table A177) fell between 1-2.

Attachment Sites Involved in Abduction at the Wrist

Hawkey and Merbs Method (1995)

The attachment site for the brachioradialis, including the extensor carpi radialis, was examined for abduction at the wrist joint. Little variation was present between the robusticity scores in both samples except for the tendency of the middle and old adult age sets in the Mississippian sample (Table A69) to have higher scores (2.0000). For osteophytic activity, no observable pattern of variation was observed the Archaic sample (Table 67), but the Mississippian sample (Table 70) did have low levels in late adolescents and old adults for the brachioradialis. The brachioradialis exhibited some osteolytic activity in the Archaic sample (Table A68), but no osteolytic activity was displayed in the Mississippian sample (Table A71).

Mariotti et al. Method (2004; 2007)

Little variation in robusticity scores was found in both samples. In the Mississippian sample, osteophytic activity was present in the late adolescent age set (.2000-1.000). No osteolytic activity was seen in the Archaic sample (Table A146), but some osteolytic activity was observed in the late adolescent age set for the Mississippian sample in the left brachioradialis (.2000) (Table A149).

Benoit Method (Trusoft International, 2015)

For abduction at the wrist joint, all scores fell between 1-2 for both the Archaic (Table A178) and Mississippian samples (Table A179).

Attachment Sites Relating to the Rotator Cuff Muscles

Hawkey and Merbs Method (1995)

The attachments for the supraspinatus, infraspinatus, latissimus dorsi, teres major, and teres minor were examined for the rotator cuff muscles. Overall the Archaic (Table A72) and Mississippian samples (Table A75) displayed little variation in the robusticity scores among the age sets. Little to no osteophytic or osteolytic activity was present in both samples.

Mariotti et al. Method (2004; 2007)

For the rotator cuff muscles, robusticity scores could not be measured for the supraspinatus, infraspinatus and teres minor as its development was not described in Mariotti (2007). Little variation among robusticity scores was present between age sets for both samples. In the Archaic (Table A151), sample little osteophytic activity was seen with no obvious pattern except the old adult age set exhibited some level of activity for every attachment site. Little variation was present in the Mississippian sample (Table A154). Neither sample displayed much osteolytic activity.

Benoit Method (Trusoft International, 2015)

For the rotator cuff entheses in the Archaic sample (Table A180), the scores for the right infraspinatus for the late adolescent age set were noticeably lower than those for the rest of the muscles, which fall between 1-2. In the Mississippian sample, little variation between age sets occurred with scores falling between 1-2 (Table A181).

Comparison of MSM Data by Method

What variation that was present was found in robusticity in the Hawkey and Merbs (1995) category. However, with the Mariotti et al. (2007) method, the variation in robusticity was not a pronounced as it was with the Hawkey and Merbs (1995) method. This may be due to the different ways each method describes the various stages of robusticity. In Mariotti's method, stage one has several different substages with detailed descriptions specific to each attachment site. In the study, it was very rare that any attachment site would be scored above a 1c, which was the most developed state of stage 1. With the Hawkey and Merbs (1995) method, the description of development of robusticity that is sufficiently broad to encourage the addition of half stages being introduced. With the use of the Benoit 1.3 fractal analysis software (Trusoft International, 2015), any variation that was seen with the previous methods, with the exception of the attachment sites for the rotator cuff of the late adolescent in the Archaic sample, was somewhat lower than observed the scores produced by Hawkey and Merbs (1995) and Mariotti et al. (2007). This is contrary to the initial hypothesis of the study which stated that the use of three-dimensional scans and fractal analysis software would detect subtler changes in the entheseal development not normally detected with traditional macroscopic methods. It is possible that the software used to take the scans was not sophisticated enough to capture the details necessary or there simply was not very much difference to detect. Another possibility is that during the editing process portions of the enthesis were inadvertently removed, but this seems highly unlikely given the care taken in preparing the scans for analysis.

This issue was not as pronounced with the osteophytic and osteolytic categories. This is likely because the standards for measuring their development do not differ as drastically as those for robusticity.

Summary

Overall the differences between the time periods and age sets was minimal, indicating that use of the individual methods did not produce distinct patterns of suggested behaviors in the populations analyzed   The results from the macroscopic methods did show a general pattern between the two time periods. In the Archaic period older age sets tended to have more activity, while in the Mississippian period the younger age sets had more activity. However, when looking at the results from the microscopic method no pattern between time periods is observed. The only difference among the age sets was found in the Archaic period among the late adolescent for the rotator cuff muscles. Interpretations for these findings are addressed in the following chapter.

CHAPTER V – DISCUSSION AND CONCLUSIONS

The purposes of this study were to compare the results of multiple scoring methods and to investigate the use of the late adolescent age set in MSM studies. The upper limb entheses of 29 males were analyzed using two macroscopic methods, Hawkey and Merbs (1995) and Mariotti et al. (2004, 2007), and a third method modeled after Zumwalt's (2005) study, which involved 3-D scanning, ArcGIS software (Esri, Inc., 2016), and Benoit 1.3 fractal analysis software (Trusoft International, 2015). Two samples representing the Archaic and Mississippian periods were comprised from multiple sites from the Tennessee River Valley. The individuals were divided into four age sets: late adolescent (15-20 years), young adult (20-25 years), middle adult (25-30) and older adult (30+ years). It was hypothesized that MSM scores obtained with the microscopic method would reveal more subtle differences between the age groups and time periods than those from the macroscopic methods, that scores would be greater in the Mississippian population, including late adolescents due to an increased workload, and that MSM in late adolescents would be highly comparable to those seen in young adults.

Discussion

Differences among Methods

For robusticity, it was expected that the younger adults would have generally lower scores. However, overall little variation was seen among the age sets. The variation that was present was usually recorded using the Hawkey and Merbs (1995) method. When the same markers were analyzed using the method outlined by Mariotti et al.

(2007), the great majority of the range of variation disappears. This may be because very few of the markers scored higher than the first stage of development.

Like robusticity, osteophytic activity was expected occur least frequently among the youngest adults as the etiology of osteophytes is associated with overuse/trauma. Overall, scores for osteophytic activity were much lower than those for robusticity using both the Mariotti et al. (2004) and Hawkey and Merbs (1995) methods with scores usually ranging between 0-1; no consistent pattern of difference between them was seen. Unlike robusticity, osteophytic activity was typically present in one age set while the other age sets had little to no activity all.

When data was analyzed with the Benoit program (Trusoft International, 2015), almost all variation among age sets disappeared as well with the exception of left infraspinatus for lateral rotation of the glenohumeral joint and the rotator cuff muscles in the Archaic sample, for which the score for late adolescents was noticeably lower than those for the other age sets. This is interesting as a similar pattern was not observed with the Hawkey and Merbs (1995) or Mariotti et al. (2007) methods for either action. The lower score with Benoit (Trusoft International, 2015) suggests that the infraspinatus muscle for those late adolescent selected for this part of the analysis was somewhat smoother than those for the other individuals scored but unfortunately the sample size is only a single individual. The rotator cuff muscles are responsible for stabilizing the glenohumeral joint, and they also aid in the external and internal rotation of the humerus, and abduction of the humerus. The rotator cuff muscles are fibrocartilaginous attachment sites and are typically smoother than fibrous entheses. It is possible that any surface changes that would have been found on the outside of the enthesis may have been removed during the editing process in ScanStudio (NextEngine, 2015). However, because the low scores are consistently in the rotator cuff muscles for only the late adolescent age set, it is believed that these scores are an accurate measure of the entheseal surface as opposed to error in editing. These results are contrary to what was expected as it appears that the slight variability observed with the macroscopic methods was greatly reduced with this method. Previous studies using three-dimensional scans have given mixed results (Nolder, 2013; Zumwalt, 2006). Most recently Noldner (2013) and Noldner and Edgar (2011) examined the surface area of fibrous enthesis using multiple methods including the use of three-dimensional scans. Both studies found that the data collected from the scans agreed with the data taken from macroscopic scoring. However, in Zumwalt's (2006) experiment where the surface morphology of the attachment sites of exercised and non-exercised sheep were examined the three-dimensional scanner was not able to pick up any differences between the two groups. The macroscopic method used in this study is more similar to Zumwalt's study and the results more are similar as well; no discernable pattern was seen between two groups who participated in different activities. It is possible that general measurements, such as surface area, are better suited to the type of three-dimensional scanners that are widely available on the market today.

It is concerning that none of the methods seemed to show any significant differences among age sets or between time periods. Instead, the amount of variation found among the samples appears to be most dependent on the methods used. The variation in results between the macroscopic approaches was unexpected, and may be due to the drastic difference in how robusticity is scored between the two. With the Hawkey and Merbs (1995) method, general descriptions are given for each stage of development and used for every marker, while with the Mariotti et al. (2007) method, each marker has detailed descriptions of its development accompanied with very clear pictures of the marker at each stage. In applying Mariotti et al. (2007), very few markers were scored beyond ‘1c’, the highest development of the first stage. Variation among entheses and age sets became almost non-existent when analyzed using the Benoit 1.3 fractal analysis software (Trusoft International, 2015). This was unexpected as it was believed that the use of the three-dimensional scanning and fractal analysis software would provide a more detailed evaluation of the attachment site.

Differences between Time Periods

It was anticipated that differences in the robusticity scores between the Archaic and Mississippian time periods would be dramatic based on previous reconstructions of their activity levels (Goodman et al., 1984; Lallo, 1973), but surprisingly this was not seen. The data did show a slight trend for some muscle groups in the Archaic sample to have most of their robusticity activity present in all markers for a particular action, or highest scores in either the middle adult or old adult age set. This could be seen for pronation at the elbow joint and extension at the wrist joint. In the Mississippian sample, the pattern was not as consistent, but most activity present was seen in the late adolescent and young adult age sets, especially in the lateral rotation at the glenohumeral joint and flexion at the elbow joint. However, the muscles associated with abduction at the wrist the Mississippian sample showed higher scores in the middle and old adult age sets. It is problematic to make any inferences about the different types of activity performed in either time period as the trends mentioned above are not very strong, but it appears possible that in the Mississippian sample younger individuals may have been participating in activities which required the motions described above at an earlier age than those of the same age in the Archaic sample. Some possible activities could be fishing or lithic production.

A general pattern was seen in osteophytic activity that was similar to the one observed for robusticity, namely that in Archaic samples older age sets tended to show some osteophytic activity in most or all of the markers in the activity groups. However, osteophytic activity in the Mississippian samples tended to fall within the younger age sets. This may indicate that different age sets participated in activities that were more prone to trauma leading to the formation of osteophytes. In the older age sets this may also be associated with degenerative process especially around the joints as the formation of osteophytes tends to increase with age (Mariotti et al., 2004; Robb, 1994). However it should be kept in mind that those in this study who fall under the age set of old adult were typically only 30+ years old, so degenerative process may not be the etiology of all osteophytic activity present. The small sample size must be taken into consideration, but unlike with robusticity, there is no real difference was seen between the methods used. This may be because the scoring method for ostophytic activity did not vary as dramatically between methods in the same way as robusticity did. A similar pattern of osteophytic activity was seen in the Mariotti et al. (2004) study in which osteophytic activity was more developed in the older adults. The development of osteophytes, especially when occurring bilaterally, was attributed by the authors to be the result of greater work load.

The pattern seen for osteolytic activity was similar to that seen in the osteophytic activity. Scores for the Archaic samples tended to be higher in the older age sets, but the

Mississippian samples showed more osteolytic activity in the younger age sets. Interestingly, the middle adult age set showed very little activity. This, however, may be due to the fact that the sample sizes for the middle adults were fairly small. This patterning of osteolytic activity is consistent with the given etiology of appearing in developing enthesis and as a degenerative process in old age (Mariotti et al., 2004).

The general pattern found in this study showed that most in the Archaic sample the older age sets (middle adults and old) tended to have the most activity for the categories scored, while for the Mississippian sample the younger age sets tended to have the most activity. However, studies analyzing patterns of degenerative joint disease (DJD) and cross sectional geometry to compare the activity levels between Archaic and Mississippian populations have found conflicting results. Bridges (1991) examined patterns of DJD in Archaic and Mississippian samples in the Southeast, and observed that the patterning of arthritis was not strongly linked to subsistence practices. However, the Archaic sample did display slightly more DJD than the Mississippian sample. Larsen (1982) also found that both males and females from the Mississippian time period from the Georgia Cost had significantly less arthritis than did their Archaic counterparts.

This might suggest that individuals in the Mississippian period were participating in activities that elicited bony remodeling at a younger age than those in the Archaic period. One possible explanation for this patterning is that the behavior required for subsistence in the Mississippian period required sudden bursts of activity that placed large amounts of mechanical strain on the bones. One possible interpretation is that children and/or adolescents were participating in farming activities. In contrast, individuals in the Archaic period performed activities that placed a steady amount of mechanical strain on the bone that rarely warranted a bony response. It can also be argued that activities conducted by males did not change substantially between the Archaic and Mississippian time period. Ethnographic evidence suggests that women took on much of the agricultural duties during the Mississippian time period, while men continued hunting with bow and arrow, fishing, and creating lithics (Shuler et al., 2012; Swanton, 1942). If true, then finding similar patterning or little variation between the time periods would be expected. However, Swanton (1942) suggests that men participated in the planting phase and some cultivation. Accounts from Adair (1775) state that hoes and small hatchets were utilized in clearing and planting the fields and bows and arrows were used to hunt deer, bear, fowl, and small animals. Unfortunately, ethnographic literature offers no possibility for detailing the hunting of the peoples of the Archaic time period. Although no ethnographic account was given for the age in which men began these activities, the patterns of entheseal development among the late adolescent age set suggests that there is a strong possibility that they were participating in these activities.

Use of Adolescents in MSM Studies

The inclusion of the late adolescent age set seemed to aid in interpretation, providing information that would have otherwise been lost. The differences between the late adolescents did not differ significantly from the other age sets and fit within the pattern created by the other age sets. In the Archaic time period the late adolescents tended to have the lower mean scores compared to the other age sets, while in the Mississippian period the late adolescents tended to have higher scores for most markers. This suggests that late adolescents may have been participating in activates which put an increased mechanical strain on the upper limb, given the time period these activates would most likely be linked to agriculture.

The late adolescents in this study fit into the pattern created by the other age sets which would suggest that mechanical strain is affecting the skeleton of individuals in the 15 to 20-year age range in the same manner as older individuals. This indicates that late adolescents, or individuals approaching skeletal maturity, would be good subjects for MSM research as they have likely begun to participate in adult activities. However, further studies using the same age sets with a larger sample will need to be done in order to confirm these findings. This study shows that the hesitation to exclude individuals who are approaching skeletal maturity is unfounded.

Challenges with MSM Research

Three-dimensional scanning and fractal analysis software were used in this study to attempt to eliminate some of the inherent subjectivity that is inherent with macroscopic methods in which the researcher must categorize the attachment site morphology based on written descriptions. Under these conditions, interobserver error is likely to be high (Davis et al., 2013). Even when all evaluation is accomplished by a single researcher, the inclusion of intermediate stages not present in the original method frequently occurs. While the data produced by the 3D scanning eliminates this issue, the method does present unique set of challenges. The first challenge is cost; the hardware and software needed to carry out this type of analysis can be quite expensive. The next and perhaps the most daunting challenges is time; the scans can take between 15 and 60 minutes depending on the quality and type of scan needed. Editing the scans and processing the data in the various software programs is also laborious. Depending on the amount of time available, this could significantly limit on the number of individuals included in the study. It is also concerning that the results obtained from the 3D fractal analysis was so drastically different than those from the macroscopic methods. Because of this, it is necessary to determine if the differences between the two methods is the result of not having software sensitive enough to measure the enthesis or that there were no differences to be detected before this method is used for further MSM research. However, despite these issues the 3D scanning provides an arguably more accurate and somewhat less subjective means to measuring MSM. The use of the 3D scanning also makes data more widely available to researches without the danger of damaging the remains.

Issues of overinterpretation of data associated with MSM analysis are also a concern (Jurmain, 1999; Jurmain & Roberts, 2008). In their review of an article claiming to have identified an acrobat in ancient Israel (Oats et al., 2008), Jurmain and Roberts (2008) noted that previous researchers have had difficulty pinning down the musculoskeletal stress marker development of one or more entheses even with historical documents relating to what the individual was doing. They argue that there is just too much variation in order to accurately pinpoint a specific activity.

Areas for Future Research

Before any MSM data is given any detailed interpretation, the manner in which robusticity is scored must be addressed. The accuracy of the most popular macroscopic methods does not seem to accurately reflect the mechanical stress placed on the bone. The potential for this type of study to provide data meant to help complete the archeological record and aid in the construction of past lifeways is great. However, a nondestructive, cost and time effective method that accurately reflects the mechanical stress placed on the skeletal system *in vivo;* any interpretation made with currently available methods must be looked at closely. Further research with a larger sample size of late adolescents from other regions is also necessary to confirm the general patterns found in this study and reach a more concrete interpretation of activities.

Conclusions

This study showed that the method used to analyze MSM is important to the outcome. The results from the two macroscopic methods did vary from each other but the same patterns in both time periods were observed. However, with the microscopic method no pattern was seen in either time period, and the only difference between age sets for either time period was seen in the Archaic late adolescents for the rotator cuff muscles. It is also clear that the hesitation of including late adolescent in the analysis of MSM seems to be unfounded. The late adolescents in this study followed the general pattern set by the other age sets. Differences in robusticity scores did not markedly vary between age sets or time periods. However, a general pattern was observed. In the Archaic sample, older age sets had the most robusticity activity in most action group. In the Mississippian sample, the younger ages sets tended to have the most robusticity activity. However, this was not true of all marker groups. Osteolytic and osteophytic scores were much lower than those seen for robusticity, but the general pattern observed for the robusticity was still seen.

Although these patterns were present, it is difficult to attribute them to activities relating to subsistence strategies, especially those that might be associated with late adolescents, as none of the differences were statistically significant. Also previous studies looking at other markers of activity, namely DJD and cross sectional bone geometry, have shown some contradictory evidence when comparing Archaic and Mississippian time periods. Even if MSM cannot be linked to specific activities, it may be possible to determine behaviors involving large bursts of activity that would elicit bony response versus those involving steady activity that would not, particularly as they might differ by age sets and time periods.

In this study, it was found that the type of method used to collect the data greatly affected the analysis, but that the inclusion of the late adolescent age set would be beneficial to the study of MSM. The variation that was seen when these populations were analyzed with the Hawkey and Merbs (1995) method drops off slightly when using the Mariotti et al. (2004, 2007), especially with robusticity, and becomes almost nonexistent when analyzed with the Benoit 1.3 fractal analysis software (Trusoft International, 2015). This gives some validity to the criticisms of Jurmain (1999) and Weiss (2004) that MSM, or more accurately the current methods used to score the markers, are insufficient for activity reconstruction. Further research investigating how bone responds to stress, specifically as reflected in the enthesis area, and how that can be effectivity scored is needed. Until then any interpretation of past life ways based on MSM must be examined in a somewhat skeptical light as MSM is an imperfect mirror or past activities.

APPENDIX A – TABLES

Table A1.

Mean Scores and Standard Deviations for Robusticity by Age for Glenohumeral Flexion Attachment sites – Archaic Sample

		R Deltoid	L Deltoid	R Pectorals Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	2	3	3	2	2	1
	Mean	1.5000	1.3333	2.0000	1.5000	1.2500	1.5000
	Std. Dev	.00000	.28868	.86603	.00000	.35355	.
Young Adults	N	2	2	1	1	2	2
	Mean	1.2500	1.7500	2.0000	1.0000	1.0000	1.0000
	Std. Dev	1.06066	.35355	.	.	.00000	.00000
Middle Adults	N	2	2	2	2	2	2
	Mean	1.5000	1.5000	1.7500	2.0000	1.0000	1.0000
	Std. Dev	.00000	.00000	.35355	.70711	.00000	.00000
Old Adults	N	11	9	10	8	8	9
	Mean	2.0000	2.0556	1.8000	1.8125	1.0000	1.1667
	Std. Dev	.59161	.39087	.25820	.37201	.26726	.43301

Table A2.

Mean Scores and Standard Deviations for Osteophytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	2	3	3	2	2	1
	Mean	.0000	.0000	.6667	.5000	.5000	.0000
	Std. Dev	.00000	.00000	.57735	.70711	.70711	.
Young Adults	N	2	2	1	1	2	2
	Mean	.0000	.5000	1.0000	.0000	.5000	.5000
	Std. Dev	.00000	.70711	.	.	.70711	.70711
Middle Adults	N	2	2	2	2	2	2
	Mean	.0000	.0000	.5000	.5000	.0000	.5000
	Std. Dev	.00000	.00000	.70711	.70711	.00000	.70711
Old Adults	N	11	9	10	8	8	9
	Mean	.6364	.5556	.4000	.3750	.1250	.1111
	Std. Dev	.50452	.52705	.51640	.51755	.35355	.33333

Table A3.

Mean Scores and Standard Deviations for Osteolytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	2	3	3	2	2	1
	Mean	.0000	.0000	.0000	.7500	.0000	.0000
	Std. Dev	.00000	.00000	.00000	1.06066	.00000	.
Young Adults	N	2	2	1	1	2	2
	Mean	.0000	.5000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.70711	.00000	.00000	.00000	.00000
Middle Adults	N	2	2	2	2	2	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000	.00000	.00000
Old Adults	N	11	9	10	8	8	9
	Mean	.0000	.0000	.0000	.0000	.0000	.1111
	Std. Dev	.00000	.00000	.00000	.00000	.00000	.33333

Table A4.

Mean Scores and Standard Deviations for Robusticity by Age for Glenohumeral Flexion Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	4	6	5	6	3	6
	Mean	1.2500	1.2500	1.3000	1.5833	1.0000	1.1667
	Std. Dev	.28868	.27386	.44721	.37639	.00000	.25820
Young Adults	N	1	2	2	2	1	2
	Mean	1.0000	1.5000	2.0000	2.0000	1.5000	1.2500
	Std. Dev	.	1.70711	.70711	.00000	.	.35355
Middle Adults	N	NA	1	NA	1	NA	NA
	Mean		2.0000		2.0000		
	Std. Dev		.		.		
Old Adults	N	2	1	2	1	1	2
	Mean	2.0000	2.0000	2.0000	2.0000	1.0000	1.0000
	Std. Dev	.00000	.	.00000	.	.	.00000

Table A5.

Mean Scores and Standard Deviations for Osteophytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	4	6	5	6	3	6
	Mean	.2500	1.667	.2000	.3333	.3333	.1667
	Std. Dev	.50000	.40825	.44721	.51640	.57735	.40825
Young Adults	N	1	2	2	2	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.00000	.	.00000
Middle Adults	N	NA	1	NA	1	NA	NA
	Mean		1.0000		.0000		
	Std. Dev		.		.		
Old Adults	N	2	1	2	1	1	2
	Mean	.0000	.0000	.0000	1.0000	.0000	.5000
	Std. Dev	.00000	.	.00000	.	.	.70711

Table A6.

Mean Scores and Standard Deviations for Osteolytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	4	6	5	6	3	6
	Mean	.0000	.0000	.0000	.1667	.3333	.0000
	Std. Dev	.00000	.00000	.00000	.40825	.57735	.00000
Young Adults	N	1	2	2	2	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.00000	.	.00000
Middle Adults	N	NA	1	NA	1	NA	NA
	Mean		.0000		.0000		
	Std. Dev		.		.		
Old Adults	N	2	1	2	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.	.	.00000

Table A7.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Extension Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	2	3	2	2
	Mean	1.5000	1.3333	.8750	.8750
	Std. Dev	.00000	.28868	.17678	.17678
Young Adults	N	2	2	1	1
	Mean	1.2500	1.7500	.7500	.7500
	Std. Dev	1.06066	.35355	.	.
Middle Adults	N	2	2	2	2
	Mean	1.5000	1.5000	.8750	.8750
	Std. Dev	.00000	.00000	.17678	.17678
Old Adults	N	11	9	10	9
	Mean	2.0000	2.0556	1.0250	.9444
	Std. Dev	.59161	.39087	.24861	.37034

Table A8.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Extension Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	3 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .5000 .70711	1 .5000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .2500 .35355	2 .2500 .35355
Old Adults	N Mean Std. Dev	11 .6364 .50452	9 .5556 .52705	10 .3000 .34960	9 .1667 .25000

Table A9.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Extension Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	2	3	2	2
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000
Young Adults	N	2	2	1	1
	Mean	.0000	.5000	.0000	.0000
	Std. Dev	.00000	.70711	.	.
Middle Adults	N	2	2	2	2
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000
Old Adults	N	11	9	10	9
	Mean	.0000	.0000	.0000	.0556
	Std. Dev	.00000	.00000	.00000	.16667

Table A10.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Extension Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	4 1.2500 .28868	6 1.2500 .27386	3 1.0833 .52042	6 .7500 .22361
Young Adults	N Mean Std. Dev	1 1.0000 .	2 1.5000 1.70711	1 .5000 .	1 .2500 .
Middle Adults	N Mean Std. Dev	NA	1 2.0000 .	NA	1 1.2500 .
Old Adults	N Mean Std. Dev	2 2.0000 .00000	1 2.0000 .	2 .7500 .35355	1 1.0000 .

Table A11.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Extension Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	4	6	3	6
	Mean	.2500	1.667	1.667	.1667
	Std. Dev	.50000	.40825	.28868	.25820
Young Adults	N	1	2	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.	.
Middle Adults	N	NA	1	NA	1
	Mean		1.0000		.5000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.

Table A12.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Extension Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	4 .0000 .00000	6 .0000 .00000	3 .0000 .00000	6 .0833 .20412
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .2500 .35355	1 .5000 .

Table A13.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Abduction Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N	2	3	1	1
	Mean	1.5000	1.3333	1.0000	1.0000
	Std. Dev	.00000	.28868	.	.
Young Adults	N	2	2	2	1
	Mean	1.2500	1.7500	.2500	.5000
	Std. Dev	1.06066	.35355	.35355	.
Middle Adults	N	2	2	2	2
	Mean	1.5000	1.5000	.7500	.7500
	Std. Dev	.00000	.00000	1.06066	1.06066
Old Adults	N	11	9	8	6
	Mean	2.0000	2.0556	.6875	.7500
	Std. Dev	.59161	.39087	.45806	.41833

Table A14.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Abduction Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	3 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .5000 .70711	2 .0000 .00000	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	11 .6364 .50452	9 .5556 .52705	8 .0000 .00000	6 .1667 .40825

Table A15.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Abduction Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N	2	3	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.	.
Young Adults	N	2	2	2	1
	Mean	.0000	.5000	.0000	.0000
	Std. Dev	.00000	.70711	.00000	.
Middle Adults	N	2	2	2	2
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000
Old Adults	N	11	9	8	6
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.0000	.00000

Table A16.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Abduction Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	4 1.2500 .28868	6 1.2500 .27386	1 1.0000 .	2 .5000 .70711
Young Adults	N Mean Std. Dev	1 1.0000 .	2 1.5000 1.70711	2 .0000 .00000	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 2.0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 2.0000 .00000	1 2.0000 .	2 .0000 .00000	1 1.0000 .

Table A17.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Abduction Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	4 .2500 .50000	6 1.667 .40825	1 .0000 .	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .5000 .70711	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 1.0000 .

Table A18.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Abduction Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N	4	6	1	2
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.	.00000
Young Adults	N	1	2	2	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.00000
Middle Adults	N	NA	1	NA	1
	Mean		.0000		.0000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	.0000	.0000	.0000	1.0000
	Std. Dev	.00000	.	.00000	.

Table A19.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Adduction Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	3	2	2	2
	Mean	2.0000	1.5000	.8750	.8750
	Std. Dev	.86603	.00000	.17678	.17678
Young Adults	N	1	1	1	1
	Mean	2.0000	1.0000	.7500	.7500
	Std. Dev	.	.	.	.
Middle Adults	N	2	2	2	2
	Mean	1.7500	2.0000	.8750	.8750
	Std. Dev	.35355	.70711	.17678	.17678
Old Adults	N	10	8	10	9
	Mean	1.8000	1.8125	1.0250	.9444
	Std. Dev	.25820	.37201	.24861	.37034

Table A20.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Adduction Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	3 .6667 .57735	2 .5000 .70711	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 1.0000 .	1 .0000 .	1 .5000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .5000 .70711	2 .5000 .70711	2 .2500 .35355	2 .2500 .35355
Old Adults	N Mean Std. Dev	10 .4000 .51640	8 .3750 .51755	10 .3000 .34960	9 .1667 .25000

Table A21.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Adduction Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .7500 1.06066	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	10 .0000 .00000	8 .0000 .00000	10 .0000 .00000	9 .0556 .16667

Table A22.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Adduction Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 1.3000 .44721	6 1.5833 .37639	3 1.0833 5.2042	6 .7500 .22361
Young Adults	N Mean Std. Dev	2 2.0000 .70711	2 2.0000 .00000	1 .5000 .	1 .2500 .
Middle Adults	N Mean Std. Dev	NA	1 2.0000 .	NA	1 1.2500 .
Old Adults	N Mean Std. Dev	2 2.0000 .00000	1 2.0000 .	2 .7500 .35355	1 1.0000 .

Table A23.

Mean Scores and Standard Deviation for Osetophytic Activity by age for Glenohumeral Adduction Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 .2000 .44721	6 .3333 .51640	3 .1667 .28868	6 .1667 .25820
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .5000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 1.0000 .	2 .2500 .35355	1 .5000 .

Table A24.

Mean Scores and Standard Deviation for Osetolytic Activity by age for Glenohumeral Adduction Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	5	6	3	6
	Mean	.0000	.1667	.0000	.0833
	Std. Dev	.00000	.40825	.00000	.20412
Young Adults	N	2	2	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.	.
Middle Adults	N	NA	1	NA	1
	Mean		.0000		.0000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.

Table A25.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Lateral Rotation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N	2	1	1	1
	Mean	.7500	1.0000	.0000	.0000
	Std. Dev	.35355	.	.	.
Young Adults	N	1	2	1	1
	Mean	.0000	.2500	.5000	1.5000
	Std. Dev	.00000		.	.
Middle Adults	N	2	2	2	2
	Mean	.5000	.5000	.7500	.7500
	Std. Dev	.70711	.70711	.35355	.35355
Old Adults	N	5	6	6	7
	Mean	.8000	.6667	.8333	.7857
	Std. Dev	.75829	.51640	.40825	.26726

Table A26.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Lateral Rotation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N	2	1	1	1
	Mean	.0000	1.0000	.0000	.0000
	Std. Dev	.00000	.	.	.
Young Adults	N	1	2	1	1
	Mean	.0000	.5000	.0000	.0000
	Std. Dev	.	.70711	.	.
Middle Adults	N	2	2	2	2
	Mean	.5000	.5000	.0000	.0000
	Std. Dev	.70711	.70711	.00000	.00000
Old Adults	N	5	6	6	7
	Mean	.4000	.1667	.1667	.1429
	Std. Dev	.54772	.40825	.40825	.37796

Table A27.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Lateral Rotation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	1 1.0000 .	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .5000 .70711	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	5 .2000 .44721	6 .1667 .40825	6 .0000 .00000	7 .0000 .00000

Table A28.

Mean Scores and Standard Deviation for Robusticity by age for Glenohumeral Lateral Rotation Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 1.5000 .70711	2 1.0000 1.41421	1 1.0000 .	1 1.0000 .
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	1 1.0000	1 1.0000 .	NA

Table A29.

Mean Scores and Standard Deviation for Osteophytic Activity by age for Glenohumeral Lateral Rotation Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .5000 .70711	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	NA

Table A30.

Mean Scores and Standard Deviation for Osteolytic Activity by age for Glenohumeral Lateral Rotation Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 1.0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	NA

Table A31.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Medial Rotation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	3	2	2	2
	Mean	2.0000	1.5000	.8750	.8750
	Std. Dev	.86603	.00000	.17678	.17678
Young Adults	N	1	1	1	1
	Mean	2.0000	1.0000	.7500	.7500
	Std. Dev	.	.	.	.
Middle Adults	N	2	2	2	2
	Mean	1.7500	2.0000	.8750	.8750
	Std. Dev	.35355	.70711	.17678	.17678
Old Adults	N	10	8	10	9
	Mean	1.8000	1.8125	1.0250	.9444
	Std. Dev	.25820	.37201	.24861	.37034

Table A32.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	3	2	2	2
	Mean	.6667	.5000	.0000	.0000
	Std. Dev	.57735	.70711	.00000	.00000
Young Adults	N	1	1	1	1
	Mean	1.0000	.0000	.5000	.0000
	Std. Dev	.	.	.	.
Middle Adults	N	2	2	2	2
	Mean	.5000	.5000	.2500	.2500
	Std. Dev	.70711	.70711	.35355	.35355
Old Adults	N	10	8	10	9
	Mean	.4000	.3750	.3000	.1667
	Std. Dev	.51640	.51755	.34960	.2500

Table A33.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pectoralis Major	L Pectorals Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .7500 1.06066	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .00000	1 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	10 .0000 .00000	8 .0000 .00000	10 .0000 .00000	9 .0556 .16667

Table A34.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Medial Rotation Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 1.3000 .44721	6 1.5833 .37639	3 1.0833 .52042	6 .7500 .22361
Young Adults	N Mean Std. Dev	2 2.0000 .70711	2 2.0000 .00000	1 .5000 .	1 .2500 .
Middle Adults	N Mean Std. Dev	NA	1 2.0000 .	NA	1 1.2500 .
Old Adults	N Mean Std. Dev	2 2.0000 .00000	1 2.0000 .	2 .7500 .35355	1 1.0000 .

Table A35.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 .2000 .44721	6 .3333 .51640	3 .1667 .28868	6 .1667 .25820
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .5000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 1.0000 .	2 .2500 .35355	1 .5000 .

Table A36.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	5	6	3	6
	Mean	.0000	.1667	.0000	.0833
	Std. Dev	.00000	.40825	.00000	.20412
Young Adults	N	2	2	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.	.
Middle Adults	N	NA	1	NA	1
	Mean		.0000		.0000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	.0000	.0000	.2500	.5000
	Std. Dev	.00000	.	.35355	.

Table A37.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Flexion Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N	2	1	4	3	3	2
	Mean	1.2500	1.5000	1.6250	1.5000	1.0000	1.5000
	Std.Dev	.35355	.	.47871	.50000	.50000	.00000
Young Adults	N	2	2	2	2	1	2
	Mean	1.0000	1.0000	2.2500	1.5000	1.5000	1.5000
	Std. Dev	.00000	.00000	.35355	.70711	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	1.0000	1.0000	1.5000	1.0000	1.5000	1.2500
	Std. Dev	.00000	.00000	.70711	.	.70711	.35355
Old Adults	N	8	9	11	9	9	9
	Mean	1.0000	1.1667	1.9545	1.6667	1.7778	1.7222
	Std. Dev	.26726	.43301	.52223	.43301	.26352	.36324

Table A38.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Flexion Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Brachi alis	L Brachi alis	R Brachio radialis	L Brachio radialis
Late Adolescents	N	2	1	4	3	3	2
	Mean	.5000	.0000	.7500	.3333	.0000	.0000
	Std. Dev	.70711	.	.50000	.57735	.00000	.00000
Young Adults	N	2	2	2	2	1	2
	Mean	.5000	.5000	.5000	1.0000	1.0000	.0000
	Std. Dev	.70711	.70711	.70711	.00000	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	.0000	.5000	.5000	.0000	.5000	.5000
	Std. Dev	.00000	.70711	.70711	.00000	.70711	.70711
Old Adults	N	8	9	11	9	9	9
	Mean	.1250	.1111	.1818	.2222	.4444	.4444
	Std. Dev	.35355	.33333	.40452	.44096	.52705	.52705

Table A39.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Flexion Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	1 .0000 .00000	3 .2500 .50000	3 .3333 .57735	3 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 1.0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	8 .1250 .35355	9 .1111 .33333	11 .0000 .00000	9 .0000 .00000	9 .0000 .00000	9 .1111 .33333

Table A40.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Flexion Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Brachi alis	L Brachi alis	R Brachio radialis	L Brachio radialis
Late Adolescents	N Mean Std. Dev	3 1.0000 .00000	6 1.1667 .25820	3 1.6667 .57735	6 1.2500 .61237	1 1.5000 .	5 1.4000 .22361
Young Adults	N Mean Std. Dev	1 1.5000 .	2 1.2500 .35355	2 1.7500 .35355	1 1.0000 .	1 .5000 .	2 1.0000 .70711
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 3.0000 .	NA	1 2.0000 .
Old Adults	N Mean Std. Dev	1 1.0000 .	2 1.0000 .00000	2 2.0000 .00000	1 2.0000 .	1 2.0000 .	1 2.0000 .

Table A41.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Flexion Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Brachi alis	L Brachi alis	R Brachio radialis	L Brachio radialis
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .1667 .40825	3 .6667 .57735	6 .8333 .40825	1 1.0000 .	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 1.0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 1.0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	2 .5000 .70711	2 .5000 .70711	1 1.0000 .	1 1.0000 .	1 1.0000 .

Table A42.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Flexion Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .0000 .00000	3 .0000 .00000	6 .1667 .40825	1 .0000 .	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 .0000 .	NA	1 1.0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	1 .0000 .

Table A43.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Extension Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 1.0000 .00000	2 1.0000 .00000
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .7500 .35355	1 1.0000 .	2 1.0000 .00000
Middle Adults	N Mean Std. Dev	2 .7500 .35355	1 .5000 .	2 1.0000 .00000	NA
Old Adults	N Mean Std. Dev	11 .9545 .41560	9 .7222 .36324	10 1.0000 .47140	5 .6000 .54772

Table A44.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Extension Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .5000 .70711
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 1.0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	NA
Old Adults	N Mean Std. Dev	11 .0000 .00000	9 .0000 .00000	10 .20000 .42164	5 .0000 .00000

Table A45.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Extension Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	NA
Old Adults	N Mean Std. Dev	11 .0000 .00000	9 .0000 .00000	10 .1000 .31623	5 .2000 .44721

Table A46.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Extension Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	3 1.0000 .00000	4 1.0000 .00000	1 1.5000 .	4 .5000 .57735
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .5000 .
Old Adults	N Mean Std. Dev	2 .2500 .35355	1 .0000 .	2 1.0000 .00000	1 1.0000 .

Table A47.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Extension Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N	3	4	1	4
	Mean	.0000	.0000	1.0000	.5000
	Std. Dev	.00000	.00000	.	.57735
Young Adults	N	1	2	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.	.
Middle Adults	N	NA	1	NA	1
	Mean		.0000		.0000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.

Table A48.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Extension Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	4 1.0000 .00000	1 .0000 .	4 .2500 .50000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	1 1.0000 .
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .	NA	1 .0000 0
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A49.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Pronation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N	2	1	2	1	1	1
	Mean	.7500	.5000	1.0000	1.0000	.5000	.5000
	Std. Dev	.35355	.	.00000	.	.	.
Young Adults	N	1	2	2	1	1	2
	Mean	1.0000	.7500	1.0000	.5000	.5000	.5000
	Std. Dev	.	.35355	.70711	.	.	.00000
Middle Adults	N	1	2	1	1	1	2
	Mean	.5000	1.0000	1.5000	1.5000	.5000	.5000
	Std. Dev	.	.70711	.	.	.	.00000
Old Adults	N	7	7	7	6	6	7
	Mean	1.0714	.9286	1.3571	1.5833	.7500	.8571
	Std. Dev	.44987	.53452	.47559	.49160	.27386	.37796

Table A50.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Pronation Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N	2	1	2	1	1	1
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.	.	.
Young Adults	N	1	2	2	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.	.	.00000
Middle Adults	N	1	2	1	1	1	2
	Mean	.0000	.5000	.0000	.0000	.0000	.0000
	Std. Dev	.	.70711	.	.	.	.00000
Old Adults	N	7	7	7	6	6	7
	Mean	.2857	.2857	.1429	.0000	.0000	.0000
	Std. Dev	.48795	.48795	.37796	.00000	.00000	.00000

Table A51.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Pronation Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	4 .9250 .67515	5 1.5400 1.99575	5 .9000 .54772	4 1.0000 .00000	4 .5000 .40825	5 .4000 .41833
Young Adults	N Mean Std. Dev	1 1.0000 .	1 1.0000 .	1 .0000 .	2 .5000 .70711	2 .5000 .00000	1 .5000 .
Middle Adults	N Mean Std. Dev	NA	1 1.500 .	NA	1 1.0000 .	NA	1 .5000 .
Old Adults	N Mean Std. Dev	2 .7500 .35355	2 .5000 .00000	2 1.2500 .35355	2 1.2500 .35355	1 .5000 .	2 1.0000 .70711

Table A52.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Pronation Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N	4	5	5	4	4	5
	Mean	.2500	.4000	.0000	.0000	.0000	.0000
	Std. Dev	.50000	.54772	.00000	.00000	.00000	.00000
Young Adults	N	1	1	1	2	2	1
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.	.00000	.00000	0
Middle Adults	N	NA	1	NA	1	NA	1
	Mean		.0000		.0000		.0000
	Std. Dev		.		.		.
Old Adults	N	2	2	2	2	1	2
	Mean	.5000	.5000	.5000	.0000	.0000	.0000
	Std. Dev	.70711	.70711	.70711	.00000	.	.00000

Table A53.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Pronation Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	4 .0000 .00000	5 .0000 .00000	5 .0000 .00000	4 .0000 .00000	4 .0000 .00000	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	2 .0000 000000	2 .0000 .00000	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .0000 .00000

Table A54.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Supination Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N	2	1	3	2	2	3
	Mean	1.2500	1.5000	1.6667	1.5000	.0000	.1667
	Std. Dev	.35355	.	.28868	.00000	.00000	.28868
Young Adults	N	2	2	2	2	1	2
	Mean	1.0000	1.0000	1.0000	1.5000	.5000	.5000
	Std. Dev	.00000	.00000	.00000	.70711	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	1.0000	1.0000	2.0000	2.0000	.7500	.7500
	Std. Dev	.00000	.00000	.00000	.	.35355	.35355
Old Adults	N	8	9	10	10	7	9
	Mean	1.0000	1.1667	1.8500	1.4500	.8571	.5000
	Std. Dev	.26726	.433301	.33747	.64334	.98802	.25000

Table A55.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Supination Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N	2	1	3	2	2	3
	Mean	.5000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.70711	.	.00000	.00000	.00000	.00000
Young Adults	N	2	2	2	2	1	2
	Mean	.5000	.5000	.5000	.0000	.0000	.0000
	Std. Dev	.70711	.70711	.70711	.00000	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	.0000	.5000	.5000	.0000	.0000	.5000
	Std. Dev	.00000	.70711	.70711	.	.00000	.70711
Old Adults	N	8	9	10	10	7	9
	Mean	.1250	.1111	.2000	.1000	.0000	.0000
	Std. Dev	.35355	.33333	.42164	.31623	.00000	.00000

Table A56.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Supination Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N	2	1	3	2	2	3
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.00000	.00000	.00000
Young Adults	N	2	2	2	2	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.	.00000	.00000
Old Adults	N	8	9	10	10	7	9
	Mean	.1250	.1111	.1000	.0000	.0000	.0000
	Std. Dev	.35355	.33333	.31623	.00000	.00000	.00000

Table A57.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Supination Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	3 1.0000 .00000	6 1.1667 .25820	4 1.1250 .25000	5 1.3000 .44721	3 .3333 .28868	4 .3750 .25000
Young Adults	N Mean Std. Dev	1 1.5000 .	2 1.2500 .35355	1 1.500 .	2 1.2500 .35355	1 .5000 .	1 .5000 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 1.0000 .	2 1.0000 .00000	2 1.2500 .35355	1 1.5000 .	1 .5000	2 .5000 .4286

Table A58.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Supination Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .1667 .40825	4 .5000 .57735	5 .2000 .44721	3 .0000 .00000	4 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .5000 .70711	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	2 .5000 .70711	2 .5000 .70711	1 .0000 .	1 .0000 .	2 .0000 .00000

Table A59.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Supination Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .0000 .00000	4 .0000 .00000	5 .0000 .00000	3 .3333 .57735	4 .2500 .50000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000

Table A60.

Mean Scores and Standard Deviation for Robusticity by Age for Extension at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Brachio radialis	L Brachio radialis	R Common. Extensor	L Common. Extensor
Late Adolescents	N	3	2	3	3
	Mean	1.0000	1.5000	.6667	.6667
	Std. Dev	.50000	.00000	.57735	.57735
Young Adults	N	1	2	1	2
	Mean	1.5000	1.5000	.0000	1.0000
	Std. Dev	.	.00000	.	.00000
Middle Adults	N	2	2	2	1
	Mean	1.5000	1.2500	1.0000	1.0000
	Std. Dev	.70711	.35355	.00000	.
Old Adults	N	9	9	9	10
	Mean	1.7778	1.7222	1.1111	1.0000
	Std. Dev	.26352	.36324	.33333	.00000

Table A61.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Extension at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Brachio radialis	L Brachio radialis	R Common. Extensor	L Common. Extensor
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .0000 .00000	3 .0000 .00000	3 .3333 .57735
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .0000 .00000	1 .0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	2 .5000 .70711	2 .5000 .70711	2 .0000 .00000	1 .0000 .
Old Adults	N Mean Std. Dev	9 .4444 .52705	9 .4444 .52705	9 .2222 .44096	10 .2000 .42164

Table A62.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Extension at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Brachio radialis	L Brachio radialis	R Common. Extensor	L Common Extensor
Late Adolescents	N	3	2	3	3
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000
Young Adults	N	1	2	1	2
	Mean	1.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.	.00000
Middle Adults	N	2	2	2	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.
Old Adults	N	9	9	9	10
	Mean	.0000	.1111	.0000	.0000
	Std. Dev	.00000	.33333	.00000	.00000

Table A63.

Mean Scores and Standard Deviation for Robusticity by Age for Extension at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Brachio radialis	L Brachio radialis	R Common. Extensor	L Common. Extensor
Late Adolescents	N Mean Std. Dev	1 1.5000 .	5 1.4000 .22361	1 .0000 .	5 .2000 .44721
Young Adults	N Mean Std. Dev	1 .5000 .	2 1.0000 .70711	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 2.0000 .	NA	1 1.0000 .
Old Adults	N Mean Std. Dev	1 2.0000 .	1 2.0000 .	1 .0000 .	1 1.0000 .

Table A64.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Extension at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Brachio radialis	L Brachio radialis	R Common. Extensor	L Common. Extensor
Late Adolescents	N	1	5	1	5
	Mean	1.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.	.00000
Young Adults	N	1	2	1	2
	Mean	.0000	.0000	.0000	.5000
	Std. Dev	.	.00000	.	.70711
Middle Adults	N	NA	1	NA	1
	Mean		.0000		.0000
	Std. Dev		.		.
Old Adults	N	1	1	1	1
	Mean	1.0000	1.0000	.0000	.0000
	Std. Dev	.	.	.	.

Table A65.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Extension at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Brachio radialis	L Brachio radialis	R Common. Extensor	L Common. Extensor
Late Adolescents	N Mean Std. Dev	1 .0000 .	5 .0000 .00000	1 .0000 .	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	1 .0000 .

Table A66.

Mean Scores and Standard Deviation for Robusticity by Age for Abduction at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	3	2
	Mean	1.0000	1.5000
	Std. Dev	.50000	.00000
Young Adults	N	1	2
	Mean	1.5000	1.5000
	Std. Dev	.	.00000
Middle Adults	N	2	2
	Mean	1.5000	1.2500
	Std. Dev	.70711	.35355
Old Adults	N	9	9
	Mean	1.7778	1.7222
	Std. Dev	.26352	.36324

Table A67.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Abduction at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	3	2
	Mean	.0000	.0000
	Std. Dev	.00000	.00000
Young Adults	N	1	2
	Mean	1.0000	.0000
	Std. Dev	.	.00000
Middle Adults	N	2	2
	Mean	.5000	.5000
	Std. Dev	.70711	.70711
Old Adults	N	9	9
	Mean	.4444	.4444
	Std. Dev	.52705	.52705

Table A68.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Abduction at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	3	2
	Mean	.0000	.0000
	Std. Dev	.00000	.00000
Young Adults	N	1	2
	Mean	1.0000	.0000
	Std. Dev	.	.00000
Middle Adults	N	2	2
	Mean	.0000	.0000
	Std. Dev	.00000	.00000
Old Adults	N	9	9
	Mean	.0000	.1111
	Std. Dev	.00000	.33333

Table A69.

Mean Scores and Standard Deviation for Robusticity by Age for Abduction at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	1 1.5000 .	5 1.4000 .22361
Young Adults	N Mean Std. Dev	1 .5000 .	2 1.0000 .70711
Middle Adults	N Mean Std. Dev	NA	1 2.0000 .
Old Adults	N Mean Std. Dev	1 2.0000 .	1 2.0000 .

Table A70.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Abduction at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	1	5
	Mean	1.0000	.0000
	Std. Dev	.	.00000
Young Adults	N	1	2
	Mean	.0000	.0000
	Std. Dev	.	.00000
Middle Adults	N	NA	1
	Mean		.0000
	Std. Dev		.
Old Adults	N	1	1
	Mean	1.0000	1.0000
	Std. Dev	.	.

Table A71.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Abduction at the Wrist Attachment Sites Using Hawkey and Merbs (1995) – Mississippian Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	1 .0000 .	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .

Table A72.

Mean Scores and Standard Deviation for Robusticity by Age for Rotator Cuff Muscle Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N	1	1	2	1	1	1	1	1
	Mean	1.0000	1.0000	.7500	1.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.35355	.	.	.	.	.
Young Adults	N	2	1	1	2	1	1	1	1
	Mean	.2500	.5000	.0000	.2500	.5000	1.500	.5000	1.500
	Std. Dev	.35355	.	.	.35355	.	.	.	.
Middle Adults	N	2	2	2	2	2	2	2	2
	Mean	.7500	.7500	.5000	.5000	.7500	.7500	.7500	.7500
	Std. Dev	1.06066	1.06066	.70711	.70711	.35355	.35355	.35355	.35355
Old Adults	N	8	6	5	6	6	7	6	7
	Mean	.6875	.7500	.8000	.6667	.8333	.7857	.8333	.7857
	Std. Dev	.45806	.41833	.75829	.51640	.40825	.26726	.40825	.26726

Table A73.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N	1	1	2	1	2	2	1	1
	Mean	.0000	.0000	.0000	1.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.00000	.	.00000	.00000	.	.
Young Adults	N	2	1	1	2	1	1	1	1
	Mean	.0000	.0000	.0000	.5000	.5000	.0000	.0000	.0000
	Std. Dev	.00000	.	.	.70711	.	.	.	.
Middle Adults	N	2	2	2	2	2	2	2	2
	Mean	.0000	.0000	.5000	.5000	.2500	.2500	.0000	.0000
	Std. Dev	.00000	.00000	.70711	.70711	.35355	.35355	.00000	.00000
Old Adults	N	8	6	5	6	10	9	6	7
	Mean	.0000	.1667	.4000	.1667	.3000	.1667	.1667	.1429
	Std. Dev	.00000	.40825	.54772	.40825	.34960	.25000	.40825	.37796

Table A74.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Hawkey and Merbs (1995) – Archaic Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	1 .0000 .	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	1 1.0000 .	2 .5000 .70711	1 .0000 .	1 .0000 .	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	8 .0000 .00000	6 .0000 .00000	5 .2000 .44721	6 1.667 .40825	10 .0000 .00000	9 .0556 .16667	6 .0000 .00000	7 .0000 .00000

Table A75.

Mean Scores and Standard Deviation for Robusticity by Age for Rotator Cuff Muscle Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	1 1.0000 .	2 1.5000 .70711	2 1.5000 .70711	2 1.0000 1.41421	3 1.0833 .52042	6 .7500 .22361	1 1.0000 .	1 1.0000 .
Young Adults	N Mean Std. Dev	2 .2500 .35355	1 .0000 .	1 .0000 .	2 .0000 .00000	1 .5000 .	1 .2500 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 1.2500 .	NA	NA
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	1 1.0000 .	1 1.0000 .	2 .7500 .35355	1 1.0000 .	1 1.0000 .	NA

Table A76.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	3 .1667 .28868	6 .1667 .25820	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	2 .5000 .70711	1 .0000 .	1 1.0000 .	2 .5000 .70711	1 .0000 .	1 .0000 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 .5000 .	NA	NA
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 1.0000 .	1 .0000 .	1 .0000 .	2 .2500 .35355	1 .5000 .	1 .0000 .	NA

Table A77.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Hawkey and Merbs (1995) – Mississippi Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	3 .0000 .00000	6 .0833 .20412	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .	1 1.0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 1.0000 .	1 .0000 .	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .	NA

Table A78.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Flexion Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachi i
Late Adolescents	N	2	3	3	2	1	1
	Mean	1.1000	1.1000	1.2000	1.1500	1.1000	1.1000
	Std. Dev	.00000	.00000	.10000	.07071	.	.
Young Adults	N	2	2	1	1	2	2
	Mean	1.1000	1.1500	1.1000	1.2000	1.2000	1.1500
	Std. Dev	.00000	.07071	.	.	.00000	.07071
Middle Adults	N	2	2	2	2	2	2
	Mean	1.2000	1.1000	1.2000	1.1500	1.1000	1.1000
	Std. Dev	.00000	.00000	.00000	.07071	.00000	.00000
Old Adults	N	11	9	10	8	8	9
	Mean	1.2182	1.2111	1.2200	1.2182	1.1500	1.2333
	Std. Dev	.06030	.07817	.04216	.06409	.07559	.29155

Table A79.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	2	3	3	2	1	1
	Mean	.0000	.0000	.6667	.5000	1.0000	.0000
	Std. Dev	.00000	.00000	.57735	.70711	.	.
Young Adults	N	2	2	1	1	2	2
	Mean	.0000	.5000	1.0000	.0000	.5000	.5000
	Std. Dev	.00000	.70711	.	.	.70711	.70711
Middle Adults	N	2	2	2	2	2	2
	Mean	.0000	.0000	.5000	.5000	.0000	.5000
	Std. Dev	.00000	.00000	.70711	070711	.00000	.70711
Old Adults	N	11	9	10	8	8	9
	Mean	.6364	.5556	.4000	.5000	.1250	.1111
	Std. Dev	.50452	.52705	.51640	.53452	.35355	.33333

Table A80.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	2	3	3	2	1	1
	Mean	.0000	.0000	.0000	.5000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.70711	.	.
Young Adults	N	2	2	1	1	2	2
	Mean	.5000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.70711	.00000	.	.	.00000	.00000
Middle Adults	N	2	2	2	2	2	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000	.00000	.00000
Old Adults	N	11	9	10	8	8	9
	Mean	.0909	.0000	.0000	.0000	.1250	.1111
	Std. Dev	.30151	.00000	.00000	.00000	.35355	.33333

Table A81.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Flexion Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N Mean Std. Dev	4 1.1750 .09574	6 1.2000 .06325	5 1.1400 .05477	6 1.2000 .06325	3 1.1000 .00000	6 1.1833 .07528
Young Adults	N Mean Std. Dev	1 1.2000 .	2 1.1500 .07071	2 1.2500 .07071	2 1.2000 .0000	1 1.1000 .	2 1.0500 .07071
Middle Adults	N Mean Std. Dev	NA	1 1.3000 .	NA	1 1.3000 .	NA	NA
Old Adults	N Mean Std. Dev	2 1.2500	1 1.3000 .	2 1.2500 .7071	1 1.2000 .	1 1.3000 .	2 1.2000 .00000

Table A82.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N	4	6	5	6	3	6
	Mean	.2500	.1667	.2000	.1667	.3333	.1667
	Std. Dev	.50000	.40825	.44721	.40825	.57735	.40825
Young Adults	N	1	2	2	2	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.00000	.	.00000
Middle Adults	N	NA	1	NA	1	NA	NA
	Mean		1.0000		.0000		
	Std. Dev		.		.		
Old Adults	N	2	1	2	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.	.	.00000

Table A83.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Flexion Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N Mean Std. Dev	4 .0000 .00000	6 .0000 .00000	5 .0000 .00000	6 .3333 .51640	3 .3333 .57735	6 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000

Table A84.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Extension Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 1.1000 .00000	3 1.1000 .00000	2 1.1000 .0000	2 1.1500 .07071
Young Adults	N Mean Std. Dev	2 1.1000 .00000	2 1.1500 .07071	1 1.1000 .	1 1.1000 .
Middle Adults	N Mean Std. Dev	2 1.2000 .00000	2 1.1000 .00000	2 1.2000 .14142	2 1.2000 .00000
Old Adults	N Mean Std. Dev	11 .12182 .06030	9 1.2111 .07817	10 1.1900 .07379	9 1.1667 .07071

Table A85.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Extension Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	3 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .5000 .70711	1 .5000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	11 .6364 .50452	9 .5556 .52705	10 .3000 .34960	9 .1111 .22048

Table A86.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Extension Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	3 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	2 .5000 .70711	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	11 .0909 .30151	9 .0000 .00000	10 .0500 .15811	9 .0556 .16667

Table A87.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Extension Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	4	6	3	6
	Mean	1.1750	1.2000	1.1333	1.1667
	Std. Dev	.09574	.06325	.05774	.08165
Young Adults	N	1	2	1	1
	Mean	1.2000	1.1500	1.1000	1.1000
	Std. Dev	.	.07071	.	.
Middle Adults	N	NA	1	NA	1
	Mean		1.3000		1.2000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	1.2500	1.3000	1.1500	1.2000
	Std. Dev	.07071	.	.07071	.

Table A88.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Extension Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	4 .2500 .50000	6 .1667 .40825	3 .1667 .28868	6 .1667 .25820
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .	NA	1 .5000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A89.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Extension Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	4 .0000 .00000	6 .0000 .00000	3 .0000 .00000	6 .0833 .20412
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A90.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Abduction Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	2 1.1000 .00000	3 1.1000 .00000	NA	NA
Young Adults	N Mean Std. Dev	2 1.1000 .00000	2 1.1500 .07071	NA	NA
Middle Adults	N Mean Std. Dev	2 1.2000 .00000	2 1.1000 .00000	NA	NA
Old Adults	N Mean Std. Dev	11 1.2182 .06030	9 1.2111 .07817	NA	NA

Table A91.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Abduction Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	3 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .5000 .70711	2 .0000 .00000	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	11 .6364 .50452	9 .5556 .52705	8 .0000 .00000	6 .0000 .00000

Table A92.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Abduction Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N	2	3	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.	.
Young Adults	N	2	2	2	2
	Mean	.5000	.0000	.0000	.0000
	Std. Dev	.70711	.00000	.00000	.
Middle Adults	N	2	2	2	2
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000
Old Adults	N	11	9	8	6
	Mean	.0909	.0000	.0000	.0000
	Std. Dev	.30151	.00000	.00000	.00000

Table A93.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Abduction Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	4 1.1750 .09574	6 1.2000 .06325	NA	NA
Young Adults	N Mean Std. Dev	1 1.2000 .	2 1.500 .07071	NA	NA
Middle Adults	N Mean Std. Dev	NA	1 1.3000 .	NA	NA
Old Adults	N Mean Std. Dev	2 1.2500 .07071	1 1.3000 .	NA	NA

Table A94.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Abduction Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	4 .2500 .50000	6 .1667 .40825	1 .0000 .	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .5000 .70711	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 1.0000 .

Table A95.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Abduction Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	4 .0000 .00000	6 .0000 .00000	1 .0000 .	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 1.0000 .

Table A96.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Adduction Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	3 1.2000 .10000	2 1.1500 .07071	2 1.1000 .00000	2 1.1500 .07071
Young Adults	N Mean Std. Dev	1 1.1000 .	1 1.2000 .	1 1.1000 .	1 1.1000 .
Middle Adults	N Mean Std. Dev	2 1.2000 .00000	2 1.1500 .07071	2 1.2000 1.4142	2 1.2000 .00000
Old Adults	N Mean Std. Dev	10 1.2200 .04216	8 1.2125 .06409	10 1.1900 .7379	9 1.1667 .07071

Table A97.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Adduction Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	3	2	2	2
	Mean	.6667	.5000	.0000	.0000
	Std. Dev	.57735	.70711	.00000	.00000
Young Adults	N	1	1	1	1
	Mean	1.0000	.0000	.5000	.0000
	Std. Dev	.	.	.	.
Middle Adults	N	2	2	2	2
	Mean	.5000	.5000	.0000	.0000
	Std. Dev	.70711	70711	.00000	.00000
Old Adults	N	10	8	10	9
	Mean	.4000	.5000	.3000	.1111
	Std. Dev	.51640	.53452	.34960	.22048

Table A98.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Adduction Attachment Sites Using Mariotti et al. (2004;2007) – Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .5000 .70711	2 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	10 .0000 .00000	8 .0000 .00000	10 .0500 .15811	9 .0556 .16667

Table A99.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Adduction Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 1.1400 .05477	6 1.200 .06325	3 1.1333 .05774	6 1.1667 .08165
Young Adults	N Mean Std. Dev	2 1.2500 .07071	2 1.2000 .00000	1 1.1000 .	1 1.2000 .
Middle Adults	N Mean Std. Dev	NA	1 1.3000 .	NA	1 1.2000 .
Old Adults	N Mean Std. Dev	2 1.2500 .07071	1 1.2000 .	2 1.1500 .07071	1 1.2000 .

Table A100.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Adduction Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	5	6	3	6
	Mean	.2000	.1667	.1667	.1667
	Std. Dev	.44721	.40825	.28858	.25820
Young Adults	N	2	2	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.	.
Middle Adults	N	NA	1	NA	1
	Mean		.0000		.5000
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.	.00000	.

Table A101.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Adduction Attachment Sites Using Mariotti et al. (2004;2007) – Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 .0000 .00000	6 .3333 .51640	3 .0000 .00000	6 .0833 .20412
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A102.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Lateral Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	NA	NA	NA	NA
Young Adults	N Mean Std. Dev	NA	NA	NA	NA
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	NA	NA	NA	NA

Table A103.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Lateral Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N	2	1	1	1
	Mean	.0000	1.0000	.0000	.0000
	Std. Dev	.00000	.	.	.
Young Adults	N	1	2	1	1
	Mean	.0000	.5000	.0000	.0000
	Std. Dev	.	.70711	.	.
Middle Adults	N	2	2	2	2
	Mean	.5000	.5000	.0000	.0000
	Std. Dev	.70711	.70711	.00000	.00000
Old Adults	N	5	6	6	7
	Mean	.4000	.1667	.1667	.1429
	Std. Dev	.544772	.40825	.40825	.37796

Table A104.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Lateral Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .5000 .70711	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	5 .2000 .44721	6 .1667 .40825	6 .0000 .00000	7 .0000 .00000

Table A105.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Lateral Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	NA	NA	NA	NA
Young Adults	N Mean Std. Dev	NA	NA	NA	NA
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	NA	NA	NA	NA

Table A106.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Lateral Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .0000 00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .5000 .70711	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	NA

Table A107.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Lateral Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 1.0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	NA

Table A108.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Medial Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	3 1.2000 .10000	2 1.1500 .07071	2 1.100 .00000	2 1.1500 .07071
Young Adults	N Mean Std. Dev	1 1.1000 .	1 1.2000 .	1 1.1000 .	1 1.1000 .
Middle Adults	N Mean Std. Dev	2 1.2000 .00000	2 1.1500 .07071	2 1.2000 .14142	2 1.2000 .00000
Old Adults	N Mean Std. Dev	10 1.2200 .04214	8 1.2125 .06409	10 1.1900 .07379	9 1.1667 .07071

Table A109.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	3	2	2	2
	Mean	.6667	.5000	.0000	.0000
	Std. Dev	.57735	.70711	.00000	.00000
Young Adults	N	1	1	1	1
	Mean	1.0000	.0000	.5000	.0000
	Std. Dev	.	.	.	.
Middle Adults	N	2	2	2	2
	Mean	.5000	.5000	.0000	.0000
	Std. Dev	.70711	.70711	.00000	.00000
Old Adults	N	10	8	10	9
	Mean	.4000	.5000	.3000	.1111
	Std. Dev	.51640	.53452	.34960	.22048

Table A110.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N	3	2	2	2
	Mean	.0000	.5000	.0000	.0000
	Std. Dev	.00000	.70711	.00000	.00000
Young Adults	N	1	1	1	1
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.	.
Middle Adults	N	2	2	2	2
	Mean	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000
Old Adults	N	10	8	10	9
	Mean	.0000	.0000	.0500	.0556
	Std. Dev	.00000	.00000	.15811	.16667

Table A111.

Mean Scores and Standard Deviation for Robusticity by Age for Glenohumeral Medial Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 1.1400 .05477	6 1.2000 .06325	3 1.1333 .05774	6 1.1667 .08165
Young Adults	N Mean Std. Dev	2 1.2500 .07071	2 1.2000 .00000	1 1.1000 .	1 1.2000 .
Middle Adults	N Mean Std. Dev	NA	1 1.3000 .	NA	1 1.2000 .
Old Adults	N Mean Std. Dev	2 1.2500 .07071	1 1.2000 .	2 1.1500 .07071	1 1.2000 .

Table A112.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 .2000 .44721	6 .1667 .40825	3 .1667 .28868	6 .1667 .25820
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .5000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A113.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Glenohumeral Medial Rotation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	5 .0000 .00000	6 .3333 .51640	3 .0000 .00000	6 .0833 .20412
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A114.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Flexion Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N	1	1	4	3	3	2
	Mean	1.1000	1.1000	1.1500	1.1333	1.1333	1.1000
	Std. Dev	.	.	.05774	.05774	.05774	.00000
Young Adults	N	2	2	2	2	1	2
	Mean	1.2000	1.1500	1.2000	1.2000	1.3000	1.2000
	Std. Dev	.00000	.07071	.00000	.14142	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	1.1000	1.1000	1.6000	1.2000	1.1500	1.2000
	Std. Dev	.00000	.00000	.56569	.	.07071	.00000
Old Adults	N	8	9	11	9	8	8
	Mean	1.1500	1.2333	1.3091	1.3000	1.1250	1.1625
	Std. Dev	.07559	.29155	.23856	.27839	.04629	.07440

Table A115.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Flexion Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Brachi alis	L Brachi alis	R Brachio radialis	L Brachio radialis
Late Adolescents	N Mean Std. Dev	1 1.0000 .	1 .0000 .	4 .7500 .50000	3 .3333 .57735	3 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	2 .5000 .70711	2 .5000 .70711	2 .5000 .70711	2 1.0000 .00000	1 .0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .5000 .70711	2 .5000 .70711	1 .0000 .	2 .5000 .70711	2 .0000 .00000
Old Adults	N Mean Std. Dev	8 .1250 .35355	9 .1111 .33333	11 .1818 .40452	9 .2222 .44096	8 .5000 .53452	8 .5000 .53452

Table A116.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Flexion Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N	1	1	4	3	3	2
	Mean	.0000	.0000	.2500	.3333	.0000	.0000
	Std. Dev	.	.	.50000	.57735	.00000	.00000
Young Adults	N	2	2	2	2	1	2
	Mean	.0000	.0000	.0000	.0000	1.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000	.	.00000
Middle Adults	N	2	2	2	1	2	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.	.00000	.00000
Old Adults	N	8	9	11	9	8	8
	Mean	.1250	.1111	.0000	.0000	.0000	.0000
	Std. Dev	.35355	.33333	.00000	.00000	.00000	.00000

Table A117.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Flexion Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	3 1.1000 .00000	6 1.1833 .07528	3 1.1667 .05774	6 1.1667 .10328	1 1.2000 .	5 1.1800 .08367
Young Adults	N Mean Std. Dev	1 1.1000 .	2 1.05000 .07071	2 1.1500 0 .07071	1 1.1000 .	1 1.2000 .	2 1.1500 .07071
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 1.3000 .	NA	1 1.2000 .
Old Adults	N Mean Std. Dev	1 1.3000 .	2 1.2000 .00000	2 1.2500 .07071	1 1.2000 .	1 1.1000 .	1 1.1000 .

Table A118.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Flexion Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Brachi alis	L Brachi alis	R Brachio radialis	L Brachio radialis
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .1667 .40825	3 .6667 .57735	6 .8333 .40825	1 1.0000 .	5 .2000 .44721
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 1.0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .00000	1 .0000 .	1 .0000 .

Table A119.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Flexion Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .0000 .00000	3 .0000 .00000	6 .1667 .40825	1 .0000 .	5 .2000 .44721
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 .0000 .	NA	1 1.0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	1 .0000 .

Table A120.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Extension Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	NA	NA	1 1.1000 .	2 1.1000 .00000
Young Adults	N Mean Std. Dev	NA	NA	1 1.1000 .	2 1.1000 .00000
Middle Adults	N Mean Std. Dev	NA	NA	2 1.1000 .00000	NA
Old Adults	N Mean Std. Dev	NA	NA	10 1.1200 .04216	5 1.1000 .00000

Table A121.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Extension Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .5000 .70711
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1.0000 .	2 1.0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	NA
Old Adults	N Mean Std. Dev	11 .0000 .00000	9 .0000 .00000	10 .1000 .31623	5 .0000 .00000

Table A122.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Extension Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	NA
Old Adults	N Mean Std. Dev	11 .0000 .00000	9 .0000 .00000	10 .2000 .42164	5 .0000 .00000

Table A123.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Extension Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	NA	NA	1 1.1000 .	4 1.1250 .05000
Young Adults	N Mean Std. Dev	NA	NA	1 1.1000 .	2 1.1000 .00000
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 1.1000 .
Old Adults	N Mean Std. Dev	NA	NA	2 1.1000 .00000	1 1.1000 .

Table A124.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Extension Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	4 .0000 .00000	1 1.0000 .	4 .5000 .57735
Young Adults	N Mean Std. Dev	1 .0000 0	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A125.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Extension Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	4 .0000 .00000	1 .0000 .	4 .2500 .50000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .

Table A126.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Pronation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	2 1.1000 .00000	2 1.1000 .00000	NA	NA	NA	NA
Young Adults	N Mean Std. Dev	1 1.1000 .	2 1.1500 .07071	NA	NA	NA	NA
Middle Adults	N Mean Std. Dev	1 1.2000 .	2 1.1000 .00000	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	8 1.1875 .06409	7 1.1857 .10690	NA	NA	NA	NA

Table A127.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Pronation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N	2	2	2	1	1	1
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.	.	.
Young Adults	N	1	2	2	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.	.	.00000
Middle Adults	N	1	2	1	1	1	2
	Mean	.0000	.5000	.0000	.0000	.0000	.0000
	Std. Dev	.	.70711	.	.	.	.00000
Old Adults	N	8	7	7	6	6	7
	Mean	.2500	.2857	.1429	.0000	.0000	.0000
	Std. Dev	.46291	.48795	.37796	.00000	.00000	.00000

Table A128.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Pronation Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N	2	2	2	1	1	1
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.	.	.
Young Adults	N	1	2	2	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.00000	.	.	.00000
Middle Adults	N	1	2	1	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.00000	.	.	.	.00000
Old Adults	N	8	7	7	6	6	7
	Mean	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000	.00000	.00000

Table A129.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Pronation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	4 1.1750 .05000	5 1.1600 .05477	NA	NA	NA	NA
Young Adults	N Mean Std. Dev	1 1.2000 .	1 1.2000 .	NA	NA	NA	NA
Middle Adults	N Mean Std. Dev	NA	1 1.2000 .	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	2 1.2500 .07071	2 1.2500 .07071	NA	NA	NA	NA

Table A130.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Pronation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	4 .2500 .50000	5 .4000 .54772	4 .0000 .00000	4 .0000 .00000	4 .0000 .00000	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .5000 .70711	2 .5000 .70711	2 .5000 .70711	2 .0000 .00000	1 .0000 .	2 .5000 .70711

Table A131.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Pronation Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	4 .0000 .00000	5 .0000 .00000	4 .0000 .00000	4 .0000 .00000	4 .0000 .00000	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	2 .0000 .00000	2 .0000 .0000	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .5000 .70711

Table A132.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Supination Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	1 1.1000 .	1 1.1000 .	3 1.1333 .05774	2 1.1500 .07071	NA	NA
Young Adults	N Mean Std. Dev	2 1.2000 00000	2 1.1500 .07071	2 1.1000 .00000	2 1.1000 .00000	NA	NA
Middle Adults	N Mean Std. Dev	2 1.1000 .00000	2 1.1000 .00000	2 1.1000 .00000	2 1.1000 .00000	NA	NA
Old Adults	N Mean Std. Dev	8 1.1500 .07559	9 1.2333 .29155	11 1.1545 .06876	10 1.1300 .04830	NA	NA

Table A133.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Supination Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	1 1.0000 .	1 .0000 .	3 .0000 .00000	2 .0000 .00000	2 .0000 .00000	3 .0000 .00000
Young Adults	N Mean Std. Dev	2 .5000 .70711	2 .5000 .70711	2 .0000 .00000	2 .2500 .35355	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .5000 .70711	2 .5000 .70711	2 .0000 .00000	2 .0000 .00000	2 .5000 .70711
Old Adults	N Mean Std. Dev	8 .1250 .35355	9 .1111 .33333	11 .2727 .46710	10 .1000 .31623	7 1429 .37796	9 .1111 .33333

Table A134.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Supination Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	1 .0000 .	1 .0000 .	3 .0000 .00000	2 .0000 .00000	2 .0000 .00000	3 .0000 .00000
Young Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000
Old Adults	N Mean Std. Dev	8 .1250 .35355	9 .1111 .33333	11 .0000 .00000	10 .0000 .00000	7 .0000 .00000	9 .0000 .00000

Table A135.

Mean Scores and Standard Deviation for Robusticity by Age for Elbow Supination Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	3 1.1000 .00000	6 1.1833 .07528	3 1.2000 .10000	5 1.600 .08944	NA	NA
Young Adults	N Mean Std. Dev	1 1.1000 .	2 1.0500 .07071	1 1.1000 .	2 1.1000 .00000	NA	NA
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 1.3000 .	2 1.2000 .00000	2 1.2000 .14142	1 1.1000 .	NA	NA

Table A136.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Elbow Supination Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .1667 .40825	3 .6667 .57735	5 .2000 .44721	3 .0000 .00000	4 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .2500 .35355	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000

Table A137.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Elbow Supination Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	3 .3333 .57735	6 .0000 .00000	3 .0000 .00000	5 .0000 .00000	3 .3333 .57735	4 .2500 .50000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	1 .0000 .	1 .0000 .	2 .0000 .00000

Table A138.

Mean Scores and Standard Deviation for Robusticity by Age for Wrist Extension Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Brachio radialis	L Brachio radialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	3 1.1333 .05774	2 1.1000 .00000	NA	NA
Young Adults	N Mean Std. Dev	1 1.3000 .	2 1.2000 .00000	NA	NA
Middle Adults	N Mean Std. Dev	2 1.1500 .07071	1 1.2000 .00000	NA	NA
Old Adults	N Mean Std. Dev	8 1.1250 .04629	8 1.1625 .07440	NA	NA

Table A139.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Wrist Extension Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Brachio radialis	L Brachio radialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .0000 .00000	3 .0000 .00000	3 .3333 .57735
Young Adults	N Mean Std. Dev	1 .0000 .	2 .5000 .70711	1 .0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	2 .5000 .70711	2 .0000 .00000	2 .0000 .00000	1 .0000 .
Old Adults	N Mean Std. Dev	8 .5000 .53452	8 .5000 .53452	9 .2222 .44096	10 .2000 .42164

Table A140.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Wrist Extension Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Brachioradialis	L Brachioradialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .0000 .00000	3 .0000 .00000	3 .0000 .00000
Young Adults	N Mean Std. Dev	1 1.0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	1 .0000 .
Old Adults	N Mean Std. Dev	8 .0000 .00000	8 .0000 .00000	9 .0000 .00000	10 .0000 .00000

Table A141.

Mean Scores and Standard Deviation for Robusticity by Age for Wrist Extension Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Brachioradialis	L Brachioradialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	1 1.2000 .	5 1.1800 .08367	NA	NA
Young Adults	N Mean Std. Dev	1 1.2000 .	2 1.1500 .07071	NA	NA
Middle Adults	N Mean Std. Dev	NA	1 1.2000 .	NA	NA
Old Adults	N Mean Std. Dev	1 1.1000 .	1 1.1000 .	NA	NA

Table A142.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Wrist Extension Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Brachioradialis	L Brachioradialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	1 1.0000 .	5 .2000 .44721	1 .0000 .	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	1 .0000 .

Table A143.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Wrist Extension Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Brachioradialis	L Brachioradialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	1 .0000 .	5 .2000 .44721	1 .0000 .	5 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 1.0000 .	NA	1 .0000 .00000
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .	1 .0000 .	1 .0000 .

Table A144.

Mean Scores and Standard Deviation for Robusticity by Age for Wrist Abduction Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	3	2
	Mean	1.1333	1.1000
	Std. Dev	.05774	.00000
Young Adults	N	1	2
	Mean	1.3000	1.2000
	Std. Dev	.	.00000
Middle Adults	N	2	1
	Mean	1.1500	1.2000
	Std. Dev	.07071	.00000
Old Adults	N	8	8
	Mean	1.1250	1.1625
	Std. Dev	.04629	.07440

Table A145.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Wrist Abduction Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	3 .0000 .00000	2 .0000 .00000
Young Adults	N Mean Std. Dev	1 .0000 .	2 .5000 .70711
Middle Adults	N Mean Std. Dev	2 .5000 .70711	2 .0000 .00000
Old Adults	N Mean Std. Dev	8 .5000 .53452	8 .5000 .53452

Table A146.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Wrist Abduction Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	3	2
	Mean	.0000	.0000
	Std. Dev	.00000	.00000
Young Adults	N	1	2
	Mean	1.0000	.0000
	Std. Dev	.	.00000
Middle Adults	N	2	2
	Mean	.0000	.0000
	Std. Dev	.00000	.00000
Old Adults	N	8	8
	Mean	.0000	.0000
	Std. Dev	.00000	.00000

Table A147.

Mean Scores and Standard Deviation for Robusticity by Age for Wrist Abduction Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	1 1.2000 .	5 1.1800 .08367
Young Adults	N Mean Std. Dev	1 1.2000 .	2 1.1500 .07071
Middle Adults	N Mean Std. Dev	NA	1 1.2000 .
Old Adults	N Mean Std. Dev	1 1.1000 .	1 1.1000 .

Table A148.

Mean Scores and Standard Deviation for Osteophytic Activity by Age for Wrist Abduction Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	1 1.0000 .	5 .2000 .44721
Young Adults	N Mean Std. Dev	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .
Old Adults	N Mean Std. Dev	1 .0000 .	1 .0000 .

Table A149.

Mean Scores and Standard Deviation for Osteolytic Activity by Age for Wrist Abduction Attachment Sites Using Mariotti et al. (2004;2007) –Mississippian Sample

		R Brachioradialis	L Brachioradialis
Late Adolescents	N	1	5
	Mean	.0000	.2000
	Std. Dev	.	.44721
Young Adults	N	1	2
	Mean	.0000	.0000
	Std. Dev	.	.00000
Middle Adults	N	NA	1
	Mean		1.0000
	Std. Dev		.
Old Adults	N	1	1
	Mean	.0000	.0000
	Std. Dev	.	.

Table A150.

Mean Scores and Standard Deviation for Robusticity by Age for Rotator Cuff Muscle Attachment Sites Using Mariotti et al. (2004;2007) –Archaic Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	NA	NA	NA	NA	2 1.1000 .00000	2 1.1500 .07071	NA	NA
Young Adults	N Mean Std. Dev	NA	NA	NA	NA	1 1.1000 .	1 1.1000 .	NA	NA
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	2 1.2000 .14142	2 1.2000 .00000	NA	NA
Old Adults	N Mean Std. Dev	NA	NA	NA	NA	10 1.1900 .07379	9 1.1667 .07071	NA	NA

Table A151.

Mean Scores and Standard Deviations for Osteophytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Mariotti et al. (2004; 2007) – Archaic Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N	1	1	2	1	2	2	1	1
	Mean	.0000	.0000	.0000	1.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.00000	.	.00000	.00000	.	.
Young Adults	N	2	1	1	2	1	1	1	1
	Mean	.0000	.0000	.0000	.5000	.5000	.0000	.0000	.0000
	Std. Dev	.00000	.	.	.70711	.	.	.	.
Middle Adults	N	2	2	2	2	2	2	2	2
	Mean	.0000	.0000	.5000	.5000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.70711	.70711	.00000	.00000	.00000	.00000
Old Adults	N	8	6	5	6	10	9	6	7
	Mean	.0000	.0000	.4000	.1667	.3000	.1111	.1667	.1429
	Std. Dev	.00000	.00000	.54772	.40825	.34960	.22048	.40825	.37796

Table A152.

Mean Scores and Standard Deviations for Osteolytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Mariotti et al. (2004; 2007) – Archaic Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N	1	1	2	1	1	1	1	1
	Mean	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.00000	.	.	.	.	.
Young Adults	N	2	1	1	2	1	1	1	1
	Mean	.0000	.0000	1.0000	.5000	.0000	.0000	.0000	.0000
	Std. Dev	.	.	.	.70711	.	.	.	.
Middle Adults	N	2	2	2	2	2	2	2	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
Old Adults	N	8	6	5	6	6	7	6	7
	Mean	.0000	.0000	.2000	.1667	.0000	.0000	.0000	.0000
	Std. Dev	.00000	.00000	.44721	.40825	.00000	.00000	.00000	.00000

Table A153.

Mean Scores and Standard Deviations for Robusticity by Age for Rotator Cuff Muscle Attachment Sites Using Mariotti et al. (2004; 2007) – Mississippian Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	NA	NA	NA	NA	3 1.1333 .05774	6 1.1667 .08165	NA	NA
Young Adults	N Mean Std. Dev	NA	NA	NA	NA	1 1.1000 .	1 1.2000 .	NA	NA
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	1 1.2000 .	NA	NA
Old Adults	N Mean Std. Dev	NA	NA	NA	NA	2 1.1500 .07071	1 1.2000 .	NA	NA

Table A154.

Mean Scores and Standard Deviations for Osteophytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Mariotti et al. (2004; 2007) – Mississippian Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	1 .0000 .	2 .0000 .00000	2 .0000 .00000	2 .0000 .00000	3 .1667 .28868	6 1.667 .25820	1 .0000 .	1 .0000 .
Young Adults	N Mean Std. Dev	2 .50000 .70711	1 .0000 .	1 1.0000 .	2 .5000 .70711	1 .0000 .	1 .0000 .	1 .0000 .	2 .0000 .00000
Middle Adults	N Mean Std. Dev	NA	1 .0000 .	NA	1 .0000 .	NA	1 .5000 .	NA	NA
Old Adults	N Mean Std. Dev	2 .0000 .	1 1.0000 .	1 .0000 .	1 .0000 .	2 .0000 .00000	1 .0000 .	1 .0000 .	NA

Table A155.

Mean Scores and Standard Deviations for Osteolytic Activity by Age for Rotator Cuff Muscle Attachment Sites Using Mariotti et al. (2004; 2007) – Mississippian Sample

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N	1	2	2	2	3	6	1	1
	Mean	.0000	.0000	.0000	.0000	.0000	.0833	.0000	.0000
	Std. Dev	.	.00000	.00000	.00000	.00000	.20412	.	.
Young Adults	N	2	1	1	2	1	1	1	2
	Mean	.0000	.0000	.0000	.0000	.0000	.0000	1.0000	.5000
	Std. Dev	.00000	.	.	.00000	.	.	.	.70711
Middle Adults	N	NA	1	NA	1	NA	1	NA	NA
	Mean		.0000		.0000		.0000		
	Std. Dev		.		.		.		
Old Adults	N	2	1	1	1	2	1	1	NA
	Mean	.0000	1.0000	.0000	.0000	.0000	.0000	.0000	
	Std. Dev	.00000	.	.	.	.00000	.	.	

Table A156.

Mean Scores and Standard Deviations for Glenohumeral Flexion Attachment Sites Using

Benoit (Trusoft International, 2015*) – Archaic Sample*

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N Mean Std. Dev	2 1.5900 .26870	1 1.6300 .	2 1.7150 .04950	2 1.6950 .06364	1 1.6700 .	1 1.7100 .
Young Adults	N Mean Std. Dev	NA	1 1.8000 .	1 1.8800 .	NA	1 1.7800 .	1 1.7400 .
Middle Adults	N Mean Std. Dev	1 1.4500 .	1 1.4000 .	1 1.4200 .	1 1.4500 .	1 1.5000 .	NA
Old Adults	N Mean Std. Dev	2 1.6350 .23335	2 1.8300 .01414	1 1.7200 .	2 1.6100 .07071	3 1.7800 .0606	2 1.7300 .04243

Table A157.

Mean Scores and Standard Deviations by Age for Glenohumeral Flexion Attachment Sites Using Benoit (Trusoft International, 2015*) – Mississippian Sample*

		R Deltoid	L Deltoid	R Pectoralis Major	L Pectoralis Major	R Biceps Brachii	L Biceps Brachii
Late Adolescents	N Mean Std. Dev	1 1.4900 .	2 1.6850 .26163	1 1.4900 .	2 1.5700 .15556	1 1.5000 .	2 1.5050 .12021
Young Adults	N Mean Std. Dev	1 1.6700 .	1 1.7800 .	1 1.7300 .	1 1.5200 .	1 1.4700 .	1 1.4800 .
Middle Adults	N Mean Std. Dev	NA	1 1.5400	NA	1 1.5400 .	NA	NA
Old Adults	N Mean Std. Dev	1 1.7600 .	1 1.8900 .	2 1.6850 .07778	1 1.8400 .	1 1.4100 .	2 1.6450 .09192

Table A158.

Mean Scores and Standard Deviations by Age for Glenohumeral Extension Attachment Sites Using Benoit (Trusoft International, 2015*) – Archaic Sample*

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 1.5900 .26870	1 1.6300 .	2 1.6150 .04950	2 1.7650 .00707
Young Adults	N Mean Std. Dev	NA	1 1.8000 .	1 1.6200 .	NA
Middle Adults	N Mean Std. Dev	1 1.4500 .	1 1.4000 .	1 1.3700 .	1 1.5200 .
Old Adults	N Mean Std. Dev	2 1.6350 .23335	2 1.8300 .01414	1 1.6608 .	2 1.6900 .11314

Table A159.

Mean Scores and Standard Deviations by Age for Glenohumeral Extension Attachment Sites Using Benoit (Trusoft International, 2015*) – Mississippian Sample*

		R Deltoid	L Deltoid	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi& Teres Major
Late Adolescents	N Mean Std. Dev	1 1.4900 .	2 1.6850 .26163	1 1.4500 .	2 1.5650 .23335
Young Adults	N Mean Std. Dev	1 1.6700 .	1 1.7800 .	1 1.6900 .	1 1.8200 .
Middle Adults	N Mean Std. Dev	NA	1 1.5400	NA	1 1.5600 .
Old Adults	N Mean Std. Dev	1 1.7600 .	1 1.8900 .	2 1.5900 .01414	1 1.6300 .

Table A160.

Mean Scores and Standard Deviations by Age for Glenohumeral Abduction Attachment Sites Using Benoit (Trusoft International, 2015*) – Archaic Sample*

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N	2	1	1	1
	Mean	1.5900	1.6300	1.7200	1.5700
	Std. Dev	.26870	.	.	.
Young Adults	N	NA	1	NA	NA
	Mean		1.8000		
	Std. Dev		.		
Middle Adults	N	1	1	1	1
	Mean	1.4500	1.4000	1.5900	1.4200
	Std. Dev	.	.	.	.
Old Adults	N	2	2	1	2
	Mean	1.6350	1.8300	1.5600	1.6050
	Std. Dev	.23335	.01414	.	.24749

Table A161.

Mean Scores and Standard Deviations by Age for Glenohumeral Abduction Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Deltoid	L Deltoid	R Supraspinatus	L Supraspinatus
Late Adolescents	N Mean Std. Dev	1 1.4900 .	2 1.6850 .26163	NA	NA
Young Adults	N Mean Std. Dev	1 1.6700 .	1 1.7800 .	1 1.6300 .	1 1.4400 .
Middle Adults	N Mean Std. Dev	NA	1 1.5400	NA	NA
Old Adults	N Mean Std. Dev	1 1.7600 .	1 1.8900 .	2 1.5050 .33234	NA

Table A162.

Mean Scores and Standard Deviations by Age for Glenohumeral Adduction Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 1.7150 .04950	2 1.6950 .06364	2 1.6150 .04950	2 1.7650 .00707
Young Adults	N Mean Std. Dev	1 1.8800 .	NA	1 1.6200 .	NA
Middle Adults	N Mean Std. Dev	1 1.4200 .	1 1.4500 .	1 1.3700 .	1 1.5200 .
Old Adults	N Mean Std. Dev	1 1.7200 .	2 1.6100 .07071	1 1.6608	2 1.6900 .11314

Table A163.

Mean Scores and Standard Deviations by Age for Glenohumeral Adduction Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	1 1.4900 .	2 1.5700 .15556	1 1.4500 .	2 1.5650 .23335
Young Adults	N Mean Std. Dev	1 1.7300 .	1 1.5200 .	1 1.6900 .	1 1.8200 .
Middle Adults	N Mean Std. Dev	NA	1 1.5400 .	NA	1 1.5600 .
Old Adults	N Mean Std. Dev	2 1.6850 .07778	1 1.8400 .	2 1.5900 .01414	1 1.6300 .

Table A164.

Mean Scores and Standard Deviations by Age for Glenohumeral Lateral Rotation Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	2 .7000 .90510	1 1.6100 .	NA	NA
Young Adults	N Mean Std. Dev	1 1.5900 .	NA	1 1.6500 .	NA
Middle Adults	N Mean Std. Dev	1 1.4300 .	1 1.6300 .	NA	1 1.4900 .
Old Adults	N Mean Std. Dev	NA	2 1.5900 .12728	NA	1 1.7600 .

Table A165.

Mean Scores and Standard Deviations by Age for Glenohumeral Lateral Rotation Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Infraspinatus	L Infraspinatus	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	NA	NA	NA	NA
Young Adults	N Mean Std. Dev	1 1.6300 .	1 1.4800 .	1 1.7200 .	NA
Middle Adults	N Mean Std. Dev	NA	1 1.4900 .	NA	NA
Old Adults	N Mean Std. Dev	1 1.5500 .	1 1.8200 .	NA	NA

Table A166.

Mean Scores and Standard Deviations by Age for Glenohumeral Medial Rotation Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	2 1.7150 .04950	2 1.6950 .06364	2 1.6150 .04950	2 1.7650 .00707
Young Adults	N Mean Std. Dev	1 1.8800 .	NA	1 1.6200 .	NA
Middle Adults	N Mean Std. Dev	1 1.4200 .	1 1.4500 .	1 1.3700 .	1 1.5200 .
Old Adults	N Mean Std. Dev	1 1.7200 .	2 1.6100 .07071	1 1.6608 .	2 1.6900 .11314

Table A167.

Mean Scores and Standard Deviations by Age for Glenohumeral Medial Rotation Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Pectoralis Major	L Pectoralis Major	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major
Late Adolescents	N Mean Std. Dev	1 1.4900 .	2 1.5700 .15556	1 1.4500 .	2 1.5650 .23335
Young Adults	N Mean Std. Dev	1 1.7300 .	1 1.5200 .	1 1.6900 .	1 1.8200 .
Middle Adults	N Mean Std. Dev	NA	1 1.5400 .	NA	1 1.5600 .
Old Adults	N Mean Std. Dev	2 1.6850 .07778	1 1.8400 .	2 1.5900 .01414	1 1.6300 .

Table A168.

Mean Scores and Standard Deviations by Age for Elbow Flexion Attachment Sites Using

Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N	1	1	2	2	1	2
	Mean	1.6700	1.7100	1.6750	1.6700	1.8700	1.6200
	Std. Dev	.	.	.19092	.11314	.02828	.35355
Young Adults	N	1	1	1	1	NA	NA
	Mean	1.7800	1.7400	1.3000	1.3500		
	Std. Dev	.	.	.	.		
Middle Adults	N	1	NA	1	NA	1	1
	Mean	1.5000		1.5900		1.6600	1.4600
	Std. Dev	.		.		.	.
Old Adults	N	3	2	3	1	1	2
	Mean	1.7800	1.7300	1.8033	1.5700	1.8500	1.6350
	Std. Dev	.03606	.04243	.04163	.	.	.38891

Table A169.

Mean Scores and Standard Deviations by Age for Elbow Flexion Attachment Sites Using

Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Biceps Brachii	L Biceps Brachii	R Brachialis	L Brachialis	R Brachioradialis	L Brachioradialis
Late Adolescents	N	1	2	2	2	1	2
	Mean	1.5000	1.5050	1.5050	1.5300	1.4600	1.6700
	Std. Dev	.	.12021	.10607	.07071	.	.31113
Young Adult	N	1	1	1	1	1	1
	Mean	1.4700	1.4800	1.7000	1.7600	1.8800	1.8100
	Std. Dev	.	.	.	.	.	
Middle Adults	N	NA	NA	NA	1	NA	1
	Mean				1.3300		1.3200
	Std. Dev				.		.
Old Adults	N	1	2	2	1	1	1
	Mean	1.4100	1.6450	1.3050	1.7000	1.8700	1.8900
	Std. Dev	.	.09192	.17678	.	.	

Table A170.

Mean Scores and Standard Deviations by Age for Elbow Extension Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N Mean Std. Dev	2 1.4950 .26163	1 1.4600 .	NA	1.8000 .
Young Adults	N Mean Std. Dev	NA	NA	NA	1 1.6100 .
Middle Adults	N Mean Std. Dev	1 1.4700 .	NA	NA	NA
Old Adults	N Mean Std. Dev	3 1.6833 .14012	1 1.7700 .	1 1.8000 .	NA

Table A171.

Mean Scores and Standard Deviations by Age for Elbow Extension Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Anconeus	L Anconeus	R Triceps Brachii	L Triceps Brachii
Late Adolescents	N	NA	2	NA	2
	Mean		1.4450		1.4700
	Std. Dev		.20506		.24042
Young Adults	N	1	1	1	NA
	Mean	1.7600	1.7100	2.0000	
	Std. Dev	.	.	.	
Middle Adults	N	NA	1	NA	1
	Mean		1.3400		1.6400
	Std. Dev		.		.
Old Adults	N	2	1	2	1
	Mean	1.4800	1.5300	1.8050	1.8700
	Std. Dev	.02828	.	.04950	.

Table A172.

Mean Scores and Standard Deviations by Age for Elbow Pronation Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	1 1.6800 .	1 1.7400 .	1 1.7000 .	1 1.7300 .	1 1.4100 .	NA
Young Adults	N Mean Std. Dev	NA	1 1.4500 .	1 .0600 .	NA	NA	1 1.4100 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	1 1.3700 .
Old Adults	N Mean Std. Dev	2 1.6200 .16971	1 1.6900 .	1 1.7000 .	2 1.7150 .19092	2 1.7850 .03536	1 1.7300 .

Table A173.

Mean Scores and Standard Deviations by Age for Elbow Pronation Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Pronator Teres	L Pronator Teres	R Pronator Quadratus (Ul)	L Pronator Quadratus (Ul)	R Pronator Quadratus (Ra)	L Pronator Quadratus (Ra)
Late Adolescents	N Mean Std. Dev	2 1.3700 .09899	2 1.5550 .19092	2 1.6700 .28284	1 1.4300 .	NA	1 1.7400 .
Young Adult	N Mean Std. Dev	1 1.6000 .	1 1.7100 .	1 1.8400 .	1 1.7000 .	NA	NA
Middle Adults	N Mean Std. Dev	NA	1 1.4400 .	NA	1 1.4500 .	NA	NA
Old Adults	N Mean Std. Dev	1 1.5400 .	2 1.3650 .03536	2 1.7050 .12021	2 1.7900 .02828	1 1.4600 .	NA

Table A174.

Mean Scores and Standard Deviations by Age for Elbow Supination Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	1 1.6700 .	1 1.7100 .	2 1.7350 .09192	1 1.8100 .	2 1.6350 .00707	1 1.7500 .
Young Adults	N Mean Std. Dev	1 1.7800 .	1 1.7400 .	NA	NA	NA	NA
Middle Adults	N Mean Std. Dev	1 1.5000 .	NA	NA	NA	1 1.5100 .	NA
Old Adults	N Mean Std. Dev	3 1.7800 .03606	2 1.7300 .04243	2 1.6500 .15556	NA	NA	2 1.5150 .14849

Table A175.

Mean Scores and Standard Deviations by Age for Elbow Supination Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Biceps Brachii	L Biceps Brachii	R Supinator (Ul)	L Supinator (Ul)	R Supinator (Ra)	L Supinator (Ra)
Late Adolescents	N Mean Std. Dev	1 1.5000 .	2 1.5050 .12021	1 1.4600 .	2 1.7050 .24749	1 1.4800 .	1 1.5400 .
Young Adults	N Mean Std. Dev	1 1.4700 .	1 1.4800 .	1 1.7800 .	1 1.7500 .	1 1.6100 .	1 1.7700 .
Middle Adults	N Mean Std. Dev	NA	NA	NA	NA	NA	NA
Old Adults	N Mean Std. Dev	1 1.4100 .	2 1.6450 .09192	2 1.8250.0 .00707	1 1.7200 .	1 1.7000 .	2 1.7550 .00707

Table A176.

Mean Scores and Standard Deviations by Age for Wrist Extension Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Brachio radialis	L Brachio radialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	2 1.8700 .02828	2 1.6200 .35355	2 1.5800 .31113	2 1.6400 .12728
Young Adults	N Mean Std. Dev	NA	NA	1 1.8800 .	1 1.8200 .
Middle Adults	N Mean Std. Dev	1 1.6600 .	1 1.4600 .	1 1.3700 .	NA
Old Adults	N Mean Std. Dev	1 1.8500 .	2 1.6350 .38891	2 1.7300 .11314	2 1.6950 .17678

Table A177.

Mean Scores and Standard Deviations by Age for Wrist Extension Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Brachioradialis	L Brachioradialis	R Common Extensor	L Common Extensor
Late Adolescents	N Mean Std. Dev	1 1.4600 .	2 1.6700 .31113	1 1.8100 .	2 1.6650 .04950
Young Adults	N Mean Std. Dev	1 1.8800 .	1 1.8100 .	1 1.8700 .	1 1.7200 .
Middle Adults	N Mean Std. Dev	NA	1 1.3200 .	NA	1 1.3900 .
Old Adults	N Mean Std. Dev	1 1.8700 .	1 1.8900 .	1 1.7100 .	1 1.5100 .

Table A178.

Mean Scores and Standard Deviations by Age for Wrist Abduction Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	2 1.8700 .02828	2 1.6200 .35355
Young Adults	N Mean Std. Dev	NA	NA
Middle Adults	N Mean Std. Dev	1 1.6600 .	1 1.4600 .
Old Adults	N Mean Std. Dev	1 1.8500 .	2 1.6350 .38891

Table A179.

Mean Scores and Standard Deviations by Age for Wrist Abduction Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Brachioradialis	L Brachioradialis
Late Adolescents	N Mean Std. Dev	1 1.4600 .	2 1.6700 .31113
Young Adults	N Mean Std. Dev	1 1.8800 .	1 1.8100 .
Middle Adults	N Mean Std. Dev	NA	1 1.3200 .
Old Adults	N Mean Std. Dev	1 1.8700 .	1 1.8900 .

Table A180.

Mean Scores and Standard Deviations by Age for Rotator Cuff Muscle Attachment Sites Using Benoit (Trusoft International, 2015*) –Archaic Sample*

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	1 1.7200 .	1 1.5700 .	2 .7000 .90510	1 1.6100 .	2 1.6150 .04950	2 1.7650 .00707	NA	NA
Young Adults	N Mean Std. Dev	NA	NA	1 1.5900 .	NA	1 1.6200 .	NA	1 1.6500 .	NA
Middle Adults	N Mean Std. Dev	1 1.5900 .	1 1.4200 .	1 1.4300 .	1 1.6300 .	1 1.3700 .	1 1.5200 .	NA	1 1.4900 .
Old Adults	N Mean Std. Dev	1 1.5600 .	2 1.6050 .24749	NA	2 1.5900 .12728	1 1.6608 .	2 1.6900 .11314	NA	1 1.7600 .

Table A181.

Mean Scores and Standard Deviations by Age for Rotator Cuff Muscle Attachment Sites Using Benoit (Trusoft International, 2015*) –Mississippian Sample*

		R Supraspinatus	L Supraspinatus	R Infraspinatus	L Infraspinatus	R Latissimus Dorsi & Teres Major	L Latissimus Dorsi & Teres Major	R Teres Minor	L Teres Minor
Late Adolescents	N Mean Std. Dev	NA	NA	NA	NA	1 1.4500 .	2 1.5650 .23335	NA	NA
Young Adult	N Mean Std. Dev	1 1.6300 .	1 1.4400 .	1 1.6300 .	1 1.4800 .	1 1.6900 .	1 1.8200 .	1 1.7200 .	NA
Middle Adults	N Mean Std. Dev	NA	NA	NA	1 1.4900 .	NA	1 1.5600 .	NA	NA
Old Adults	N Mean Std. Dev	2 1.5050 .33234	NA	1 1.5500 .	1 1.8200 .	2 1.5900 .01414	1 1.6300 .	NA	NA

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