ACTIVITY-RELATED VARIATION IN PATHOLOGIES OF THE PATELLA AMONG NATIVE AMERICAN GROUPS

THESIS

Presented to the Graduate Council of
Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree

Master of ARTS

by

Maggie L. McClain, B.A.

San Marcos, Texas
May 2013

ACTIVITY-RELATED VARIATION IN PATHOLOGIES OF THE PATELLA

AMONG NATIVE AMERICAN GROUPS

Committee Members Approved:

Michelle D. Hamilton, Chair

C. Britt Bousman

M. Katherine Spradley

Jon C. Lohse

Jennifer Mathews

Approved:

J. Michael Willoughby
Dean of the Graduate College

DEDICATION

To Shawn,

whose love, support, and encouragement made this possible;

and Conner,

who brings joy to my life every day;

and Mom,

who showed me all that a mother could do.

.

ACKNOWLEDGEMENTS

I would like to extend my gratitude to Dr. Michelle Hamilton, my thesis advisor, for her guidance, encouragement, and tolerance for my endless late-night e-mails. My committee members, Dr. C. Britt Bousman, Dr. Jon Lohse, and Dr. Kate Spradley provided valuable assistance, insights, and suggestions. I would also like to thank Dr. Mathews, my final committee member, friend, and mentor, for allowing me access to the Hitzfelder Cave collection, and helping me explore that rabbit hole.

This research would not have been possible without the generous support of Dr. Grady Early. The faculty and staff of the Department of Anthropology and the Forensic Anthropology Center at Texas State University-San Marcos have also been extremely supportive of my studies. My thanks also go to Dr. Benjamin Auerbach of The University of Tennessee at Knoxville, for granting access to the Averbuch and Larson collections. I am also grateful to Dr. Lynne Sullivan and the Frank H. McClung Museum of The University of Tennessee at Knoxville, for assisting in the selection of suitable comparison groups, facilitating access to the Thompson Village and Eva collections, and for providing me with additional data from the museum archives. I am extremely grateful to Dan Rose for creating the site location maps.

Thanks also to Carole Leezer, my friend and unofficial life coach, who has always been an inspiration to me; to my dear friend Haley Rush, for helping to keep me sane and optimistic through late-night study sessions and thesis writing; and to Lauren Springs, Cristina Figueroa-Soto, Caryn Tegtmeyer, and the rest of my cohort. We made a great team.

Finally, I would like to thank my family. Without all your help, encouragement, and sheer tolerance I could not have succeeded. Shawn, you are the love of my life, and I am truly blessed to have a partner who supports me in my aspirations. To my dear son Conner, you brighten up my life, and just thinking of your smile always cheers me up. You've been so patient; yes, we can go play now. Mom and Denny, I can't thank you enough for all your help, and for teaching me the value of hard work. My dear mother trekked across the country with me to take care of my son while I collected data, and it was an adventure I'll never forget. Dad, thanks for encouraging me to follow my dreams. To Virginia, my mommy-at-arms, and to my brothers Gene and Keith, thank you for cheering me on.

This manuscript was submitted on March 7, 2013.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

ABSTRACT

ACTIVITY-RELATED VARIATION IN PATHOLOGIES OF THE

PATELLA AMONG NATIVE AMERICAN GROUPS

by

Maggie L. McClain, B.A.

Texas State University-San Marcos

May 2013

SUPERVISING PROFESSOR: MICHELLE D. HAMILTON

This study explores pathologies affecting the patella among skeletal collections from six North American archaeological groups. Given the location of the patella in the knee joint and attachment sites of the quadriceps femoralis tendon (QFT) and the patellar ligament (PL), changes in this bone may reflect muscle development and joint degeneration from activities involving the lower extremities.

The archaeological groups examined were Archaic through Historic hunter-gatherers, Middle and Late Mississippian agriculturalists, and Historic horticulturalists. The groups spanned the Eastern Woodlands, Great Plains, and Texas regions. For each patella examined, the frequency of moderate to severe expressions of QFT and PL entheses on the anterior surface of the patella and of lipping on the margins of the articular surface was recorded, as was the presence of coalesced porosity, surface osteophytes, and eburnation on the articular surface.

The following five research questions were explored:

1) Do individuals within an archaeological group exhibit variation in patellar pathologies?

2) Do patellar pathologies exhibit variation within a group by factors such as sex, age, or temporal component?

3) Do patellar pathologies vary between groups?

4) If individual, within-group, or between-group variation exists, what causes it?

5) Can examination of this variation be used to identify subsistence practices or division of labor in prehistoric groups?

Significant variation in patellar pathologies was found within all six archaeological groups. Furthermore, patterning of these pathologies was found to vary by sex, age, and temporal component. Division of labor was implicated as an underlying factor of significant sex differences. While geographical region could not account for the differences between groups, subsistence regime did correspond to the patterning in coalesced porosity between groups. Coalesced porosity was extremely high in agricultural groups. This degenerative condition, is caused by a prolonged, habitual kneeling posture, which is commonly adopted by agriculturalists while processing maize. While not accounted for in this study, variation among horticulturalists and hunter-gatherers may be more reflective of mobility than of subsistence regime.

The ability to identify activity patterns via a single skeletal element may prove useful in archaeological cases of commingled, unprovenienced, or poorly preserved/highly fragmented remains. The results of this analysis indicate that unique signatures of entheses and articular surface and margin changes are found both within and between groups. Differences in activity can account for some of this variation, and analysis of this type can provide valuable information on prehistoric lifeways.

CHAPTER I

INTRODUCTION

This research began with a puzzle. In 1998, while cleaning out a storage closet in the Anthropology Department at Trinity University in San Antonio, I uncovered boxes of human remains. The remains were unlabeled, and there were no associated artifact tags or paperwork. The only clue to their provenience was a site trinomial on the boxes: 41BX26. The department had been unaware of the existence of these bones, and was unable to provide any further information.

It was determined that the remains were most likely from Hitzfelder Cave, an Archaic site in Central Texas that had been excavated by a Trinity University archaeologist in the 1960s. Examination of the remains indicated that the collection was incomplete; it seemed that one-half of each individual was missing. The longbones in the collection represented a minimum number of individuals (MNI) of only eight, far fewer than the 30–40 estimated in the preliminary site report (Givens 1968a). After nearly a decade of archival research, I discovered that the collection had been split up in the 1970s among several institutions, and that the skeletal collection housed at Trinity University was only a portion of the remains recovered from the site.

The remains from the site were intriguing, and showed evidence of healed fractures, arthritis, osteoporosis, and other unidentified pathologies. I was determined to try to figure out something about the people buried at Hitzfelder Cave, especially since little could be located about the site excavations, or the archaeological context from which the remains came. With an MNI of only eight, such a small sample was unlikely to yield enough data for a Master's thesis. However, there were 49 patellae in the collection, which would yield an MNI of at least 25, much closer to the 30–40 individuals previously reported.

While at first I was unsure of the potential of deriving useful information only from patellae, a preliminary review of the literature suggested the research might have promise after all. Studies had been conducted on estimating sex from the patella (Bidmos et al. 2005; Dayal and Bidmos 2005; Introna et al. 1998; Kemkes-Grottenhaler 2005). Furthermore, I uncovered a large amount of research on using musculoskeletal markers and osteoarthritis to reconstruct prehistoric activity patterns. While none of these focused on the patella, a few of them included that element in their analysis (al-Oumaoui et al. 2004; Milella et al. 2012). Many of the patellae in the Hitzfelder Cave collection had signs of arthritis, such as extreme lipping, surface osteophytes, and eburnation, and the anterior surfaces of many of them had ossified ligament attachments. The patellae were the only well-represented element in the collection; was it possible that the pathologies on this single element could provide useful information about the people interred at the site?

While designing this research, it was determined that an appropriate way to investigate patellar pathologies would be to examine them through a framework of variation. The frequency of pathologies on the patella would be recorded and compared for several archaeological skeletal collections from different periods and geographic areas, and that employed different subsistence practices. The archaeological groups compared included Archaic through Historic hunter-gatherers, Middle and Late Mississippian agriculturalists, and Historic horticulturalists. The groups spanned the Eastern Woodlands, Great Plains, and Texas regions. While not accounted for in this study, it should be noted that the horticulturalists and hunter-gatherers ranged in mobility from sedentary to highly mobile.

Research Questions

While designing this research, it was determined that an appropriate way to investigate patellar pathologies would be to examine them through a framework of variation. By comparing the nature and occurrence of pathologies in the Hitzfelder Cave collection to patterns among well-documented, analyzed collections, I addressed the following questions:

1. Do individuals within an archaeological group exhibit variation in patellar pathologies?
2. Do patellar pathologies exhibit variation within an archaeological group, by factors such as sex, age, or temporal component?
3. Do patellar pathologies vary between archaeological groups?
4. If individual, within-group, or between-group variation exists, what causes it?
5. Can examination of this variation be used to identify subsistence practices or division of labor in prehistoric groups?

If such variation exists, and patterns in patellar pathologies can be compared both within and between groups, it will elevate the analytical usefulness of the overlooked and underanalyzed patella. For example, archaeological skeletal collections are frequently commingled, fragmentary, and incomplete, but may nevertheless contain patellae. Patterns in patellar pathology could be used to corroborate other skeletal and artifactual analyses.

Morphology of the Patella

The patella, commonly referred to as the kneecap, is the largest sesamoid bone in the body. Sesamoid bones are variable, accessory bones that develop within tendons near joints (Steele and Bramblett 1988; White and Folkens 2005). Individuals display great variation in the number, size, and placement of these bones. The patella is dense and compact, which usually allows for its survival and preservation in archaeological contexts (Kemkes-Grottenhaler 2005). It has been shown to be sexually dimorphic in most populations (Mahfouz et al. 2007), and limited recent efforts in forensic anthropology have successfully used patellar measurements to estimate sex (Mahfouz et al. 2007).

The patella (Figure 1) is a roughly triangular-shaped bone that develops in the quadriceps femoris muscle tendon in the knee joint; ossification begins from a single center sometime between the ages of 2 and 6, and completes by the end of late childhood (Steele and Bramblett 1988). Anatomically, it articulates with the patellar notch of the distal femur (Figure 2); the posterior surface of the patella is covered by hyaline cartilage (White and Folkens 2005; Woods 1995). A thick pad of adipose tissue separates the patella from the tibia. The base, or proximal border of the anterior surface, serves as an attachment site for the quadriceps femoralis tendon, consisting of the vastus intermedius and rectus femoris. Furthermore, the vastus medialis attaches at the medial margin (Toumi et al. 2006). The distal end tapers at the apex and is the attachment site for the patellar ligament, which attaches to the tibial tuberosity. The purpose of the patella is to stabilize and provide leverage for the quadriceps femoralis tendon during knee flexion.

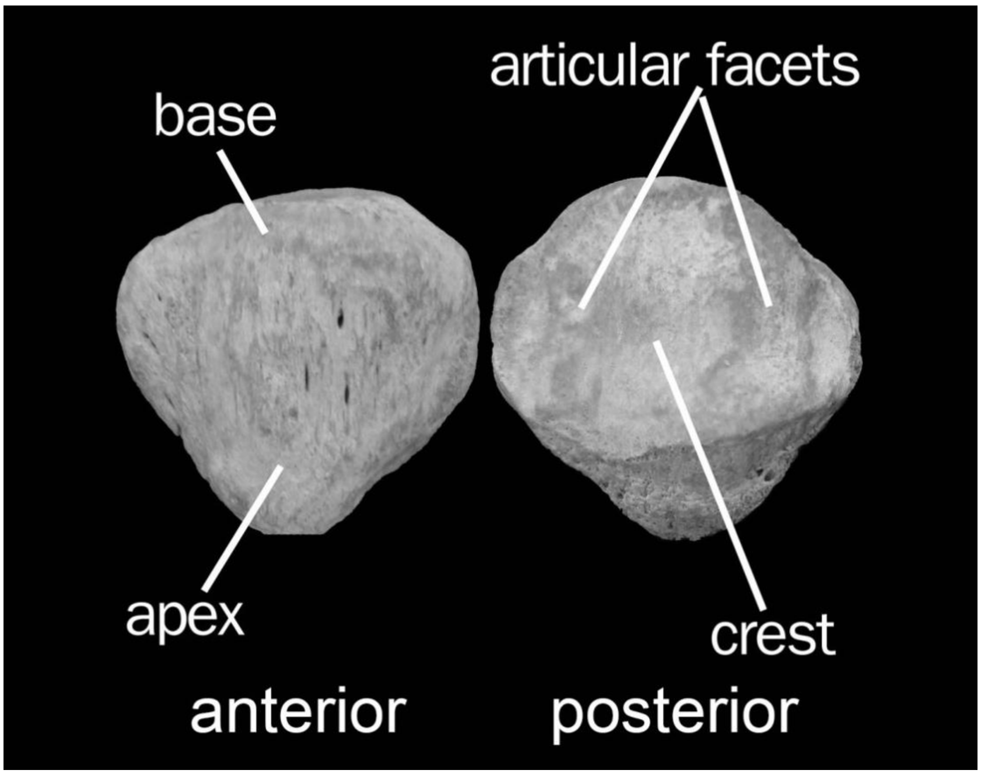

Figure 1. Diagram of a left patella (figure by Shawn McClain).

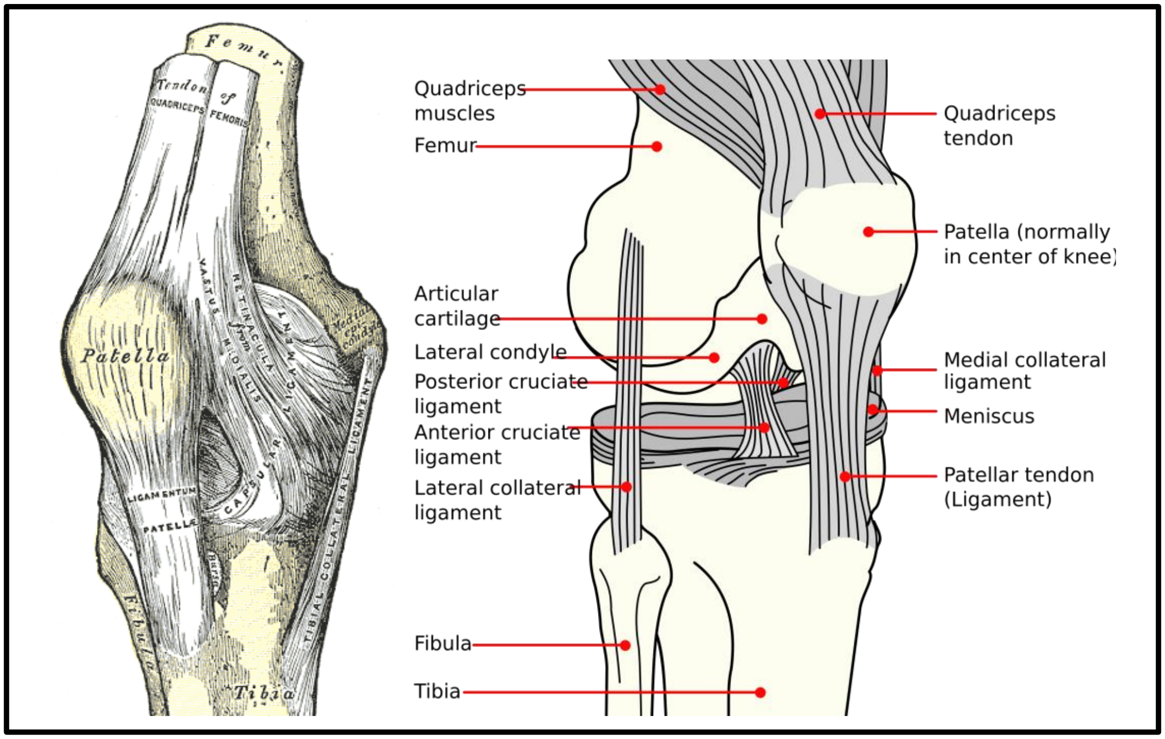

Figure 2. Diagrams of a right knee showing tendon and ligament attachments (left from *Gray's Anatomy*, right License PD-USGo by Mysid; both are public domain, obtained from Wikimedia Commons).

Pathologies of the Patella

The Hitzfelder Cave patellae exhibited five pathological symptoms: entheses (at both the quadriceps femoralis tendon and patellar ligament insertion sites), lipping, surface osteophytes, eburnation, and porosity. This by no means an exhaustive list of possible pathological changes to the patella. Nevertheless, I limited my focus to the five discussed below, which I observed in the Hitzfelder Cave collection at the beginning of my investigations.

A Question of Terms

Among the difficulties in studying pathologies to joints are ambiguity, misuse, and lack of definition of terms. For example, while some authors have referred to

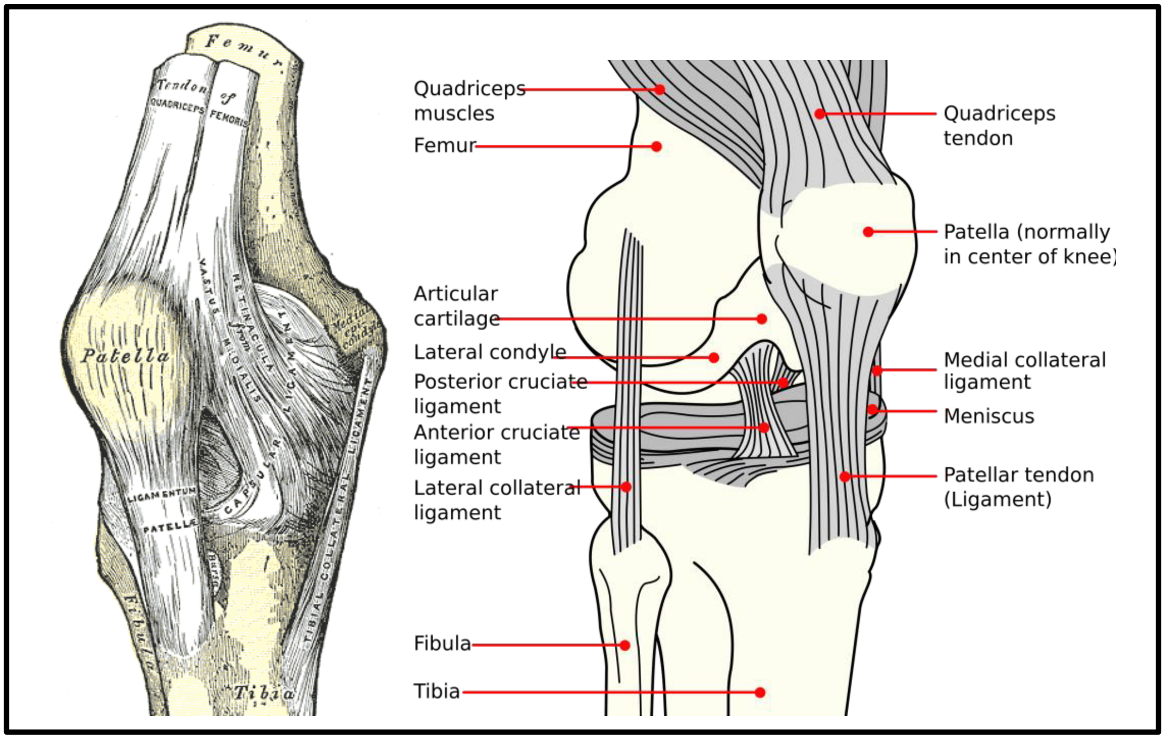

Figure 2. Diagrams of a right knee showing tendon and ligament attachments (left from *Gray's Anatomy*, right License PD-USGo by Mysid; both are public domain, obtained from Wikimedia Commons).

Pathologies of the Patella

The Hitzfelder Cave patellae exhibited five pathological symptoms: entheses (at both the quadriceps femoralis tendon and patellar ligament insertion sites), lipping, surface osteophytes, eburnation, and porosity. This by no means an exhaustive list of possible pathological changes to the patella. Nevertheless, I limited my focus to the five discussed below, which I observed in the Hitzfelder Cave collection at the beginning of my investigations.

A Question of Terms

Among the difficulties in studying pathologies to joints are ambiguity, misuse, and lack of definition of terms. For example, while some authors have referred to entheses as enthesophytes (Buikstra and Ubelaker 1994; Roberts and Manchester 2005), others use exostoses (Ortner 2003; White and Folkens 2005). To avoid confusion, I will use the term *entheses* to refer to bone deposition at muscle insertion sites.

Osteophytes are defined by some authors as small, abnormal bone protuberances on bone surfaces (Buikstra and Ubelaker 1994), while others define them as bony growths from joints (Roberts and Manchester 2005); still others limit use of the term *osteophyte* to bone growth at joint margins and do not mention bone growth on the articular surface (Jurmain and Kilgore 1995; Weiss and Jurmain 2007; White and Folkens 2005). This thesis will use the term *lipping* to refer to overgrowth of bone at joint margins and the term *surface osteophytes* to refer to (usually round) abnormal bone projections from articular surfaces following the practice of Buikstra and Ubelaker (1994).

Entheses

Entheses are new bone formations at the site of muscle attachment (see Chapter III: Methods for examples). The muscles attach via tendons and ligaments into the periosteum and cortex underneath. According to Wolff's law (Wolff 1892), stress at these insertion sites results in increased blood flow, increased number of capillaries, and osteoblast stimulation. This in turn results in deposition of new bone, or ossification of the ligament and tendon insertions (Chapman 1997; Weiss 2004).

Because this remodeling is known to occur in response to mechanical stress, these rugose, bony muscle attachments are often referred to as musculoskeletal stress markers (MSMs). However, studies have shown that entheseal remodeling is also affected by age, sex, genetics, and body size (Churchill and Morris 1998; Molnar et al. 2009; Weiss 2004;

Weiss et al. 2010). Entheses increase with age, although whether this is due to age-specific changes or simply a longer time for exposure to mechanic stress is unclear (Milella et al. 2012; Weiss 2004). And although males have been shown to have greater entheseal development, it is equally unclear whether this is due to body size, joint morphology differences, or hormonal factors (al-Oumaoui et al. 2004; Molnar 2006; Stevens and Vidarsdóttir 2008). Furthermore, some studies have shown a reverse trend of females exhibiting higher entheseal scores, which many have attributed to differences in activity rather than biology (Chapman 1997; Eshed et al. 2004; Weiss et al. 2010; Weiss 2004).

MSMs have been studied to compare activity levels, mobility patterns, and subsistence strategies among archaeological groups (al-Oumaoui et al. 2004; Chapman 1997; Churchill and Morris 1998; Eshed et al. 2004; Molnar 2006; Molnar et al. 2009; Schrader 2012; Steen and Lane 1998; Stefanović and Porčić 2011; Weiss 2004). Confounding variables such as sex, age, osteoarthritis, and body size must be taken into account when using MSMs for comparison (Stefanović and Porčić 2011; Weiss and Jurmain 2007). Nevertheless they have been successfully used to corroborate archaeological data on economy and subsistence (al-Oumaoui et al. 2004; Chapman 1997; Eshed et al. 2004).

While some studies have employed MSMs on the patella in combination with other MSMs (e.g., al-Oumaoui et al. 2004; Milella et al. 2012), most ignored scoring the patella in favor of focusing on the femur and tibia (e.g, Churchill and Morris 1998), and none have focused solely on the patella. This study is the first to focus on MSMs on this single element. There are two areas of muscle attachment on the patella: the insertion of the quadriceps femoralis tendon at the base, and the origin of the patellar ligament at the apex (see Figures 1 and 2). Examination of these two attachment sites may shed light on the relative mechanical stress from upper leg versus lower leg use, which may in turn reflect different types of activity and levels of mobility.

Lipping, Surface Osteophytes, and Eburnation

Osteophytes are bony nodules that grow to diffuse the mechanical stress load on a joint (Aufderheide and Rodríguez-Martín 1998; Roberts and Manchester 2005). As mentioned above, lipping (osteophyte development around the joint margins) is here differentiated from surface osteophytes (small projections from the articular surface of the joint; see examples in Chapter III: Methods). Eburnation is polishing and/or grooving of a joint surface as a result of bone-on-bone contact, which happens with loss of cartilage in the joint (Aufderheide and Rodríguez-Martín 1998; Buikstra and Ubelaker 1994; Roberts and Manchester 2005; Steele and Bramblett 1988; White and Folkens 2005).

Osteoarthritis is the most common joint pathology observed in archaeological skeletal collections (Jurmain and Kilgore 1995). As with MSMs, numerous studies have attempted to use osteoarthritis prevalence and patterning to ascertain activity patterns and subsistence practices (e.g., Eshed et al. 2010; Klaus et al. 2009; Molnar et al. 2009). These studies have focused on the effect of mechanical stress loading on the development of osteoarthritis, particularly when the stress is initiated early in life. While agricultural groups have shown a clear increase in osteoarthritis, studies of other groups have met with mixed results (i.e., Coggon et al. 1998; Rossignol 2004). Similar to MSM studies, reconstruction of activity patterns via osteoarthritis have been scrutinized due to confounding biological variables such as age, sex, genetics, and body size (Weiss and Jurmain 2007).

Osteoarthritis increases with age (Jurmain and Kilgore 1995; Weiss and Jurmain 2007; Woods 1995). It is particularly common in the knee joint, especially among females (Aufderheide and Rodríguez-Martín 1998; Weiss and Jurmain 2007; Woods 1995), possibly as a result of sex-based hormonal differences and anatomical differences (Stevens and Vidarsdóttir 2008; Weiss and Jurmain 2007; Woods 1995). Body mass index has also been shown in some studies to be negatively correlated with osteoarthritis, with smaller individuals displaying higher rates of osteoarthritis (Weiss and Jurmain 2007). In addition, nine genetic loci have been linked with osteoarthritis; each locus seems to influence different aspects of osteoarthritis progression (e.g., osteophyte development or cartilage loss) (Weiss and Jurmain 2007). Studies of twins have reported heritability estimates of 0.40 for the knee joint, and as high as 0.60–0.70 in other joints; however, it must be noted that twin studies may overestimate heritability, and extreme mechanical loading was not common in the urban populations upon which these studies were based (Weiss and Jurmain 2007). Furthermore, these heritability estimates reflect the heritability of osteoarthritis severity, rather than its absence or presence (Weiss and Jurmain 2007).

Lipping, surface osteophytes, and eburnation have been used as diagnostic criteria for osteoarthritis in both archaeological and modern populations (Weiss and Jurmain 2007). Many studies count the occurrence of any of these features (as well as porosity, discussed separately below) as an instance of osteoarthritis. However, there is wide disagreement about which criteria are appropriate for diagnosing osteoarthritis. As osteophyte development is correlated with age, Weiss and Jurmain (2007) caution against using osteophytes in identification of osteoarthritis, and advocate using eburnation as a diagnostic feature. Furthermore, they note that defects in the margins of joints (i.e., lipping) may not correlate with defects on the articular surfaces (i.e., surface osteophyte development and eburnation). Conversely, Rothschild (1997) argues that eburnation is the result of severe arthritis (and not specific to osteoarthritis), and argues for the use of osteophytes in osteoarthritis diagnosis. Nevertheless, researchers continue to use both eburnation (Molnar et al. 2009) and osteophytes (Klaus et al. 2009) as indicators of osteoarthritis. To avoid the confusion surrounding osteoarthritis diagnosis, this research employed the methods of Buikstra and Ubelaker (1994) to score lipping, surface osteophytes, and eburnation separately (see Chapter III: Methods), as suggested by Weiss and Jurmain (2007).

Porosity

Although porosity, or surface pitting (see Chapter III: Methods for example), has been previously used as a diagnostic characteristic of osteoarthritis (Weiss and Jurmain 2007), it has been demonstrated to in fact be unassociated with the disease. Rothschild (1997) showed that in a sample of 400 individuals from the Hamman-Todd Collection, 29.5 percent of individuals exhibited osteoarthritis, and 17.5 percent exhibited porosity, but only 5 percent of individuals exhibited both. Thus, 70 percent of individuals with porosity lacked signs of osteoarthritis, and 82 percent of individuals with osteoarthritis did not exhibit porosity. Therefore, Rothschild (1997) has suggested that porosity be removed as a diagnostic indicator of osteoarthritis.

Woods (1995) demonstrated that porosity occurred in areas of the knee that did not come into contact during normal flexion, such as occurs while walking. However, these areas are in direct contact with one another during extreme flexion, as occurs during activities such as squatting or rising from a kneel. He also demonstrated that the biomechanical processes leading to porosity are distinct from those resulting in eburnation, and that different groups showed varying susceptibilities to porosity. In his study, black females showed the highest susceptibility to porosity, followed by black males, then white males, and then white females (Woods 1995).

Porosity is difficult to detect clinically, as it does not show up on radiographs (Woods 1995). Furthermore, during this study, it was noticed that much of the pinpoint porosity defined by Buikstra and Ubelaker (1994) could be easily confused with taphonomic damage. Therefore, this study focused on cases of coalesced porosity, which is much more clearly differentiated from taphonomic damage, and occurs as a result of more extreme joint loading (Woods 1995).

Outline of the Thesis

This introductory chapter will be followed by Chapter II: Materials, which has several objectives: to outline the rationale for the selection of the six comparative groups examined; to discuss the types of data available for the six comparative groups; to provide background information on each of the sites including site location and excavation, previous skeletal analyses, and information on the subsistence practices of the site inhabitants; and to enumerate the sample sizes drawn from the comparative groups. The Methods chapter (Chapter III) will define the observations made from each patella and present the statistical methods used to analyze the data. Next are the Results (Chapter IV), arranged by site, followed by between-group comparisons of patellar pathology. The Discussion chapter (Chapter V) considers how the data relate to the research questions asked and what contribution this research may make to the fields of biological anthropology and archaeology. The Conclusions (Chapter VI) are followed by Appendix A, which contains the data collected from each site, and Appendix B, which presents the results of chi-square analyses.

CHAPTER II

MATERIALS

Comparative Groups

Samples were drawn from the following archaeological skeletal collections: Archaic hunter-gatherers from the Eva site, Middle Mississippian agriculturalists from Thompson Village, and Late Mississippian agriculturalists from the Averbuch site, all in Tennessee; Historic Arikara horticulturalists from the Larson site in South Dakota; Archaic–Late Prehistoric hunter-gatherers from Hitzfelder Cave in Central Texas, and Late Prehistoric–Historic hunter-gatherers from Mitchell Ridge on the Upper Texas Coast. These six groups were chosen because they occur in three regional areas (Eastern Woodlands, Great Plains, and Texas (Figure 3), span 8,000 years of prehistory and history, and because the groups practiced three major subsistence regimes (hunting-gathering, horticulture, and agriculture). These skeletal collections are accessible, large, and fairly well preserved, and contain enough patellae to comprise a sufficiently large sample for statistical analysis. Moreover, some sites have been analyzed to various degrees, which allows the data collected for this project to be further analyzed in regards to age, sex, and temporal component. Table 1 presents a summary of the sites, including their dates, subsistence types, and collection sizes.

Figure 3. Site locations in the United States (map by Daniel Rose).

The Eva and Thompson Village materials are housed at the Frank McClung Museum at The University of Tennessee at Knoxville (UTK), while the Averbuch and Larson materials are held by the Department of Anthropology at UTK. The portion of the Hitzfelder Cave collection containing the patellae is currently housed in the Archaeology and Biological Anthropology Laboratory of the Department of Sociology and Anthropology at Trinity University (Trinity) in San Antonio, Texas, and the Mitchell Ridge collection is held at the Texas Archeological Research Laboratory (TARL) at the University of Texas at Austin. Background information for each of these sites is presented later in this chapter.

Table 1. Overview of Comparative Groups Used in this Study.

SITE	REGION	PERIOD	COMPONENTS/ DATES	SUBSISTENCE	SKELETAL COLLECTION SIZE (MNI)	SOURCES(S)	SAMPLE SIZE
Eva (6BN12/ 40BN12)	Eastern Woodlands (Western Tennessee)	Middle Archaic (6000–4000 BC) to Late Archaic (4000 BC–1000 BC) [a]	Eva (6000–4000 BC) Three Mile (4000–2000 BC) Big Sandy (2000–1000/500 BC)	sedentary hunter-gatherers	180	Lewis and Lewis (1961)	40
Thompson Village (40HY5)	Eastern Woodlands (Western Tennessee)	Middle Mississippian (AD 1000–1300)[b]	unknown	agriculture	203	Moore (2002); Sullivan (2007); Lynne Sullivan (personal communication 2012)	41
Averbuch (40DV60)	Eastern Woodlands (Central Tennessee)	Late Mississippian (AD 1300–1600)[b]	14th century AD (length of occupation 15–25 years)	agriculture	887	Klippel and Bass (1984)	41
Larson (41WW2)	Great Plains (South Dakota)	Historic Arikara Postcontact Coalescent (AD 1600–1862)[c]	AD 1750–1785	horticulture/ bison hunting	699 (628 from cemetery)	Blakeslee (1994); Owsley and Bass (1979); Owsley et al. (1977)	41
Hitzfelder Cave (41BX26)	Central Texas	Archaic (8800 BP–1300/1200 BP) to Late Prehistoric (Toyah) (800–260 BP) [d]	4000 ± 37 RCYBP– 400 ± 33 RCYBP[f]	mobile hunter-gatherers	30–40?	Benfer (1967); Benfer and Frank (n.d.); Collins (1970); Davis (1966); Givens (1968a, b)	48
Mitchell Ridge (41GV66)	Upper Texas Coast	Final Late Prehistoric (AD 1250–1500) Protohistoric (AD 1500–1700) Early Historic (AD 1700–1800)[e]	Late Prehistoric, Protohistoric, Historic	hunter-gatherers	54	Ricklis (1994)	17

[a]Fagan (2005); [b]Schroedl et al. (1990); [c]Johnson (1998); [d]Collins (2004); [e]Ricklis (1994); [f]Munoz et al. 2013

Available Data for Comparative Groups

Published site reports are available for Averbuch (Klippel and Bass 1984), Eva (Lewis and Lewis 1961), and Mitchell Ridge (Ricklis 1994), but the analyses conducted and data presented in each report varies. The burials from the Larson site have been analyzed and some studies have been published (Blakeslee 1994; Owsley and Bass 1979; Owsley et al. 1977), but no formal site report was produced. Only preliminary reports and partial analyses have appeared on Hitzfelder Cave (Benfer 1967; Benfer and Frank n.d.; Collins 1970; Davis 1966; Givens 1968a, b), which is a commingled collection. Thompson Village has never been analyzed or published. Thus, the amount and types of information available for each of these six sample sites varies widely, as summarized in Table 2. Age estimations for individuals were inconsistent between collections, as previous analysts employed different methods and provided different age categories. Furthermore, while the Averbuch and Larson sites were occupied for only a short time (and thus all skeletons are from a single component), Eva, Mitchell Ridge, and Hitzfelder Cave were occupied over multiple temporal components. Eva, Averbuch, Larson, and Mitchell Ridge all have various types of demographic information, such as mortality profiles and life expectancy, which are included here to assist in interpretation of the effects of age on the patellar pathologies (see Table 2).

Table 2. Available Data for Comparative Groups.

SITE	PREVI-OUSLY ANALYZED	SITE REPORT	SEX DATA	AGE DATA	TEMPORAL DATA	DEMOGRA-PHIC DATA
Eva	Yes	Yes	Available	5-year age categories for 24 of the 40 individuals	Available (3 components)	Limited mortality profile based on a sample of 69 adults
Thompson Village	No	No	Available	Imprecise, overlapping categories	Unavailable (unknown occupation length)	Unavailable
Averbuch	Yes	Yes	Available	5-year age ranges for all individuals	Unavailable (short occupation)	Available
Larson	Yes	No	Available	Unavailable	Unavailable (short occupation)	Available
Hitzfelder Cave	Limited	No	Unavailable (commingled)	Unavailable	Unavailable	Unavailable
Mitchell Ridge	Yes	No	Available	Overlapping, 5–30-year age estimations	Available (but uncertain in cases)	Available

Eastern Woodlands

Three sites were located in Tennessee, in the Eastern Woodlands archaeological region. In prehistoric times, the Eastern Woodlands region was mostly forested with a multitude of river systems, had a relatively mild climate, and received ample rainfall (Hudson 1976). The abundant forest and riverine resources allowed Archaic groups to exploit a large number of resources within a small territory, allowing for a more sedentary hunter-gatherer lifestyle compared to that of the highly mobile, megafauna-hunting Paleoindians (Fagan 2005; Hudson 1976). Sedentism increased through the Woodland and Mississippian periods, as pottery became more widespread, mortuary practices became more elaborate, agriculture was adopted, and large city-states arose (Fagan 2005; Hudson 1976). Eva, Thompson Village, and Averbuch were located in western and central Tennessee (Figure 4) (Fagan 2005). Excavations at the Eva site have revealed a pattern typical of Archaic lifeways. Thompson Village and the Averbuch site provide evidence of life in small, marginalized hamlets contemporaneous with (but likely unassociated with) major Mississippian centers such as Cahokia and Moundville.

Figure 4. Locations of the Eva, Thompson Village, and Averbuch sites in Tennessee (map by Daniel Rose).

Eva (40BN12)

Site Location and Excavation

Information about the Eva site was derived from the single available site report (Lewis and Lewis 1961). The site, now inundated by Kentucky Lake, was located in Benton County, Tennessee, 150 kilometers west of Nashville (see Figure 4). It was previously situated along the eastern edge of Cypress Creek Slough, which at the time of site occupation was the location of the Tennessee River. The University of Tennessee and the Works Progress Administration (WPA) excavated the Eva site for the Tennessee

River Valley Authority in 1940 (Lewis and Lewis 1961). In total, 3,200 square feet (approximately 300 square meters) were excavated. The components of the site date to the Eva (6000–4000 BC) and the Three Mile (4000–2000 BC) phases of the Middle Archaic, and to the Big Sandy phase (2000–1000/500 BC) of the Late Archaic. Antler from Stratum IV Bottom (Eva phase) produced a radiocarbon date of 5200 BC ± 500. During excavation, 180 human burials were exposed (Table 3), mostly in flexed position. Thirteen of the 133 adults were from the Eva phase, 67 were from the Three Mile phase, and 52 were from the Big Sandy phase (Lewis and Lewis 1961).

Table 3. Age and Sex Distribution of Burials by Component at the Eva Site (adapted from Lewis and Lewis 1961:Table 20).

AGE/SEX CATEGORY	EVA	THREE MILE	STRATUM III	BIG SANDY	TOTAL
Infants	3	20	0	6	29
Children	1	8	0	2	11
Juveniles	0	7	0	0	7
Adult Females	5	29	0	18	52
Adult Males	7	25	1*	16	49
Adult Indeterminate	1	13	0	18	32
Total	17	102	0	60	180

*The single burial in Stratum III was not assigned to a component; this individual was not included in the present analysis.

Previous Skeletal Analyses

Osteological and demographic analyses of the human remains in the site report by Lewis and Lewis (1961) were limited. Brief burial descriptions were provided for only 92 of the burials, and no paleopathological analysis was conducted. However, analysis of a sample of 69 of the 132 adults indicated that a high proportion, particularly among the males, lived to advanced age (60+ years) (Lewis and Lewis 1961). During the Eva phase, all females in the sample had died before the age of 30, although by the Big Sandy, fewer women of childbearing age died and more women lived past 50 (Figure 6). The trend was opposite in males, with the majority of Eva males dying past age 50, while more Big Sandy males died in their 30s (Figure 7). Life expectancy was not calculated for the population.

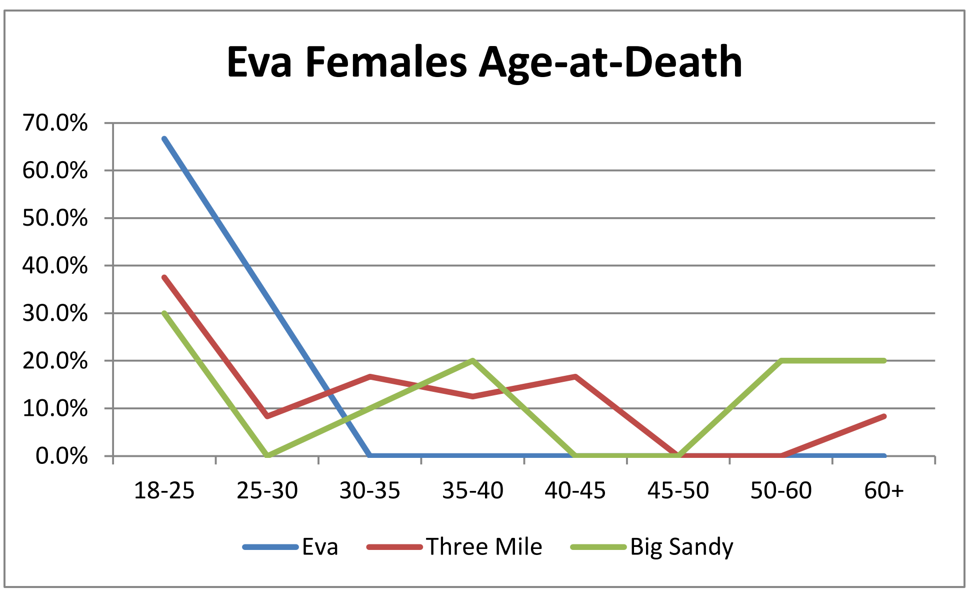

Figure 6. Age distribution of mortality in a sample of adult Eva females.

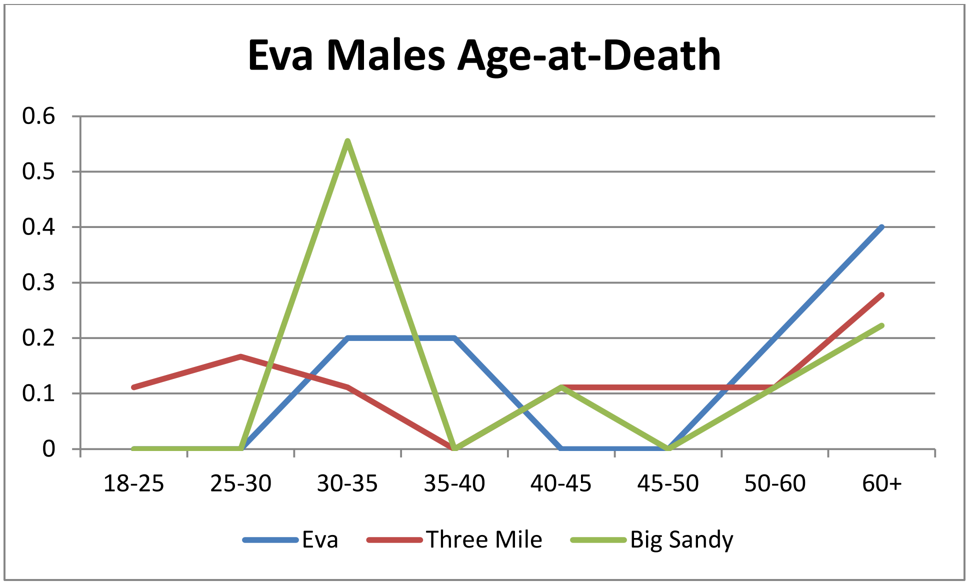

Figure 7. Age distribution of mortality in a sample of adult Eva males.

Subsistence

The occupants of the Eva site are described as sedentary hunter-gatherers (Lewis and Lewis 1961). It appears that during the earlier Eva component, the inhabitants relied primarily on deer, supplementing their diet with mussels, fish, birds, and turtles. Possibly as a result of environmental shifts and overhunting, the deer population seems to have declined during the Three Mile and Big Sandy components. Fish, shellfish, and birds appear to have played a more important role in the latter two phases, with individuals in the Three Mile component relying intensively on mussels (Lewis and Lewis 1961). Once again, however, environmental conditions seem to have altered the subsistence practices of the Eva occupants, as mussels disappear completely from the archaeological record during the Big Sandy component. Given the lack of preserved plant remains recovered at the site, the role of plants and nuts can only be speculated, although they surely must have played a crucial role in the diets of the Eva inhabitants (Lewis and Lewis 1961).

These shifts in resource utilization were likely accompanied by shifts in mobility. Deer hunting during the Eva component would have required high mobility, while gathering mussels during the Three Mile component would have resulted in a dramatic decrease in mobility. Although hunting appeared to once again play a more important role during the Big Sandy, the quantity of bone and increased reliance on birds, fish, and turtles suggests relatively low mobility in this component as well. This change in mobility is not directly addressed by the Eva site report authors, who refer to the site inhabitants as simply "sedentary" (Lewis and Lewis 1961); perhaps "semi-sedentary" would be a more appropriate label for this group.

Thompson Village (40HY5)

Site Location and Excavation

As the Thompson Village site has never been analyzed and no field report has been published, little information is available. The site was located in Henry County, Tennessee, approximately 150 kilometers west of Nashville, Tennessee, and 11 kilometers south of the Tennessee-Kentucky border (see Figure 4). Situated on the west bank of the Tennessee River, 3 kilometers south of the junction of the Big Sandy and Tennessee rivers, the palisaded village extended 305 meters (1,000 feet) along the bank and 183 meters (600 feet) inland. In 1939, the WPA excavated 15 structures for the Kentucky Lake reservoir project, led by George A. Lidberg under the supervision of Charles H. Nash (Moore 2002; Sullivan 2007). According to Lynne Sullivan (personal communication 2012), the site dates to the Middle Mississippian period. However, Moore (2002) reports that a few flexed burials and ceramics date to the Woodland period. No radiocarbon dates were obtained from the site (Lynne Sullivan, personal communication 2012). At least 208 burials were uncovered at the site, the majority of them fully extended burials without stone boxes (Moore 2002), although the inventory provided by the Frank H. McClung Museum lists 187 individuals (Table 4).

Table 4. Age and Sex Distribution of Burials at Thompson Village (source: Frank H. McClung Museum).

	FEMALE	FEMALE?	MALE	MALE?	INDETERMINATE	TOTAL
Fetus					6	6
Infant					19	19
Child					21	21
Adolescent					8	8
Subadult					1	1
Adult?					1	1
Adult	40	19	28	22	22	131
Total	40	19	28	22	78	187

Previous Skeletal Analyses

No analyses have been conducted on the Thompson Village skeletal collection. However, the inventory from the McClung Museum did contain sex estimations and broad age categories (i.e., fetus, infant, child, adolescent, adult). Analysis of this information indicates that adults comprise 71 percent of the skeletal collection.

Subsistence

Lidberg's notes indicate the site structures were from the Middle Mississippian period (Sullivan 2007). Site inhabitants likely followed a typical Mississippian subsistence regime of agriculture and hunting and gathering. The inhabitants of Thompson Village probably grew Eastern Flint maize, beans, gourds, and squashes. In addition, they probably supplemented their diets with gathered wild plants and by fishing and hunting animals such as deer and turkey (Hudson 1976).

Averbuch (40DV60)

Site Location and Excavation

As the subject of an extensive, two-volume report published by The University of Tennessee (Klippel and Bass 1984), Averbuch has been extensively studied and has the most information available of any site in this study. The Averbuch site was located in northwest Nashville in Davidson County, Tennessee (see Figure 4). The area is in the Nashville Basin, and the site itself was situated on a hill 450 meters east of Drakes Branch, 4 kilometers away from the Cumberland River Valley (Klippel and Bass 1984). The site was discovered in 1975 following water main installation for a subdivision development. Following the recommendations of a reconnaissance survey, The University of Tennessee undertook mitigation efforts in 1977 and 1978, under the direction of William M. Bass and Walter E. Klippel (Reed 1984). Three cemeteries and a village containing 22 structures and 97 features were exposed in the excavation blocks (Reed and Klippel 1984).

Occupation of this Late Mississippian village began sometime in fourteenth century AD (Klippel 1984), and length of occupation is estimated at 15–25 years (Berryman 1984), although some authors suggest it lasted as long as 100 years (Kelley and Eisenberg 1987; Konigsberg and Frankenberg 1995; Reed 1984). Little evidence for social stratification was found at Averbuch, and the site itself appears to have been an outlier village with low standing in the Mississippian settlement hierarchy (Klippel

1984). The site's location away from the fertile soils of the valley, along with the poor health status of its occupants, has been used as evidence for population pressure in the region (Klippel 1984).

In total, 887 individuals were recovered from 645 graves in the three cemeteries and from underneath 12 structures (Table 5). An estimated additional 409 individuals were present but either destroyed by the housing construction or unexcavated due to time constraints (Berryman 1984). Most of the individuals were buried in stone box graves, which aided in the preservation of the remains (Klippel 1984).

Table 5. Sex and Age Distribution of the Averbuch Skeletal Collection by Burial Area (adapted from Berryman 1984:Table 5.1).

AGE GROUP	**CEMETERY 1**			**CEMETERY 2**			**CEMETERY 3**			**STRUCTURES**			
	F	**M**	**I**	**F**	**M**	**I**	**F**	**M**	**I**	**F**	**M**	**I**	**Total**
0–1.5			40			9			11			21	81
1.5–5.5			119			16			36			5	176
5.5–10.5			35			5			13			1	54
10.5–15.5			18			2			5				25
15.5–20	37	24		4	2		5	6					79
20–25	36	56		8	14		23	13				1	152
25–30	27	35		2	4		15	10					93
30–35	18	18		1	9		8	10					64
35–40	17	16		2	6		3	6					49
40–45	10	11		3	1		1	5					30
45–50	10	11		3	1		1	5					30
50–55	7	7		1	2		1	4					21
55–60	7	7		1	2		1	4					21
Adult												1	1
Subtotal	168	183	212	24	40	32	59	63	66	0	0	29	876
Fetal			1			2			2			6	11
Total	168	183	213	24	40	34	59	63	68	0	0	35	887
Note: the numbers in the site report consist of fractions resulting from the sex estimation methodology; those numbers are rounded in this table to the nearest whole number, and therefore may differ slightly.													

Previous Skeletal Analyses

Total population during site occupation was estimated at 800 to 1,400 individuals (Berryman 1984). Berryman (1984) reports that the entire population, females in particular, was heavily stressed as indicated by dental enamel hypoplasias and Harris lines. Adults made up 61 percent of the total skeletal group. In all three cemeteries, females were subject to the highest mortality rates in the 20–25 year age range (Figure 8), probably as a result of complications from pregnancy and birth. Males were also subject to high mortality in the 20–25 age group, although males from Cemetery 2 and Cemetery 3 also exhibited small peaks in mortality in the 30–35 age range (Figure 9). Life expectancy at birth at this site was extremely low, only 14.6 for females and 17.4 for males (Berryman 1984).

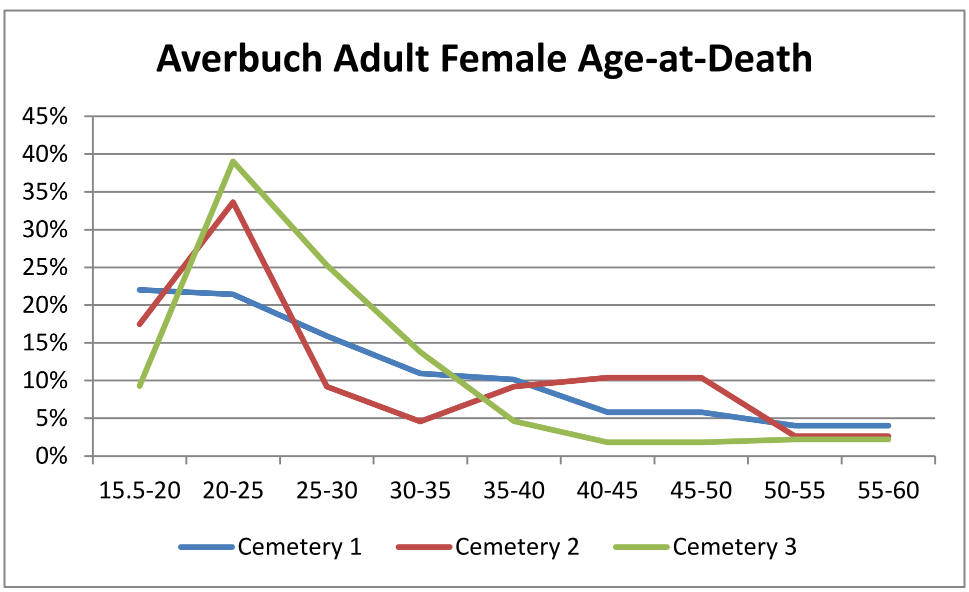

Figure 8. Age distribution of adult female mortality at the Averbuch site.

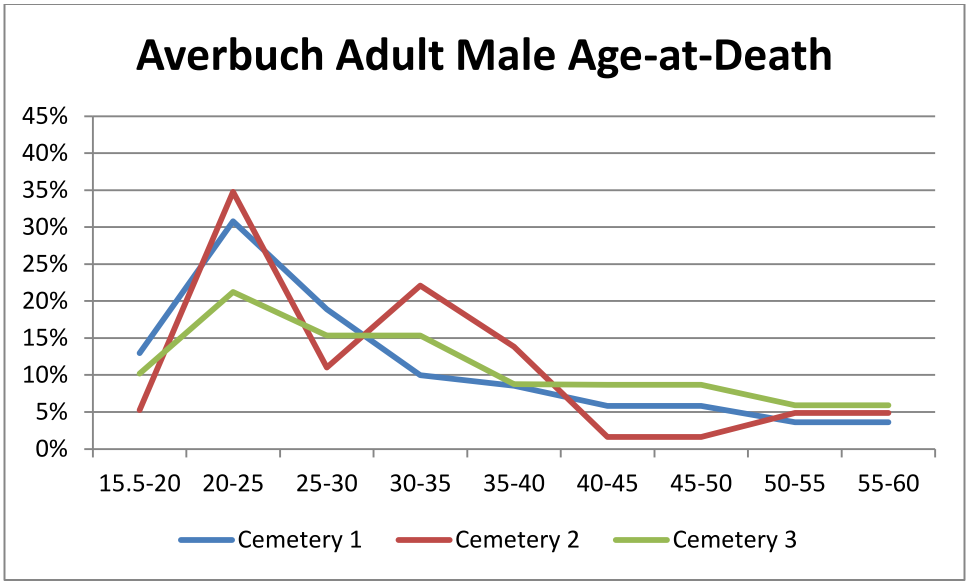

Figure 9. Age distribution of adult male mortality at the Averbuch site.

Subsistence

Although organic preservation at the site was poor, the faunal and botanical analyses revealed an assemblage similar to other Late Mississippian sites (Klippel 1984). The people of Averbuch were agriculturalists who relied on a narrow suite of botanical species, including Northern Flint maize, two types of beans, and a small amount of wild species. Notably, no squash was found at the site. The inhabitants exploited a wide variety of animals, especially deer and elk, with bear, turkey, raccoon, mountain lion, beaver, waterfowl, fox, rabbit, opossum, skunk, turtle, squirrels, and a small amount of fish and mussels also present (Klippel 1984).

Great Plains

The Great Plains cover much of the center of North America and stretch from Canada south into North Texas (Wood 1998). After the extinction of Ice Age megafauna, many inhabitants of this relatively flat, often arid grassland relied on bison when they were available. Even as some groups in the river valleys adopted farming, most continued to hunt bison as well, particularly during the harsh winters (Fagan 2005; Rogers 1990). The Larson site is located in the Middle Missouri Valley of Great Plains (Figure 10), and its inhabitants were a group of Historic Arikara who practiced horticulture, traded with the Europeans and nomadic bison hunters, and engaged in winter bison hunts and other supplemental hunting (Johnson 1998; Rogers 1990).

Figure 10. Location of the Larson site in South Dakota (map by Daniel Rose).

Larson (39WW2)

Site Location and Excavation

While the Larson site has been extensively studied, no formal site report has been published, although a number of articles have included analyses of this collection (e.g., Owsley and Bass 1979; Owsley et al. 1977; Owsley and Jantz 1994). The Larson site is located in Walworth County, South Dakota, two miles southeast of Mobridge on the east bank of the Missouri River. The site was excavated first in 1963–1964 by River Basin Survey crews working under Alfred W. Bowers, and then again in 1966 by J. J. Hoffman. The cemetery was also excavated in 1966–1968, by University of Kansas crews under William M. Bass. The fortified earthlodge village and associated cemetery was part of the Le Beau phase of the Postcontact Coalescent Tradition, and dates to AD 1750–1785, within the Protohistoric (Blakeslee 1994; Owsley et al. 1977). In the Arikara village, 71 individuals were scattered on earthlodge floors, and osteological and demographic analyses indicate warfare was involved in the violence that caused this massacre, which marked the termination of site occupation (Owsley et al. 1977). The cemetery excavations under Bass produced 628 skeletons interred over approximately 30 years (Table 6) (Owsley and Bass 1979). The Arikara, who were Caddoan speakers, organized their society into different ranks or classes (Rogers 1990), a practice which was reflected in the burials at the site (Johnson 1998).

Table 6. Age and Sex Distribution of Burials from the
Larson Cemetery (Owsley and Bass 1979).

AGE	FEMALE	MALE	IND.	TOTAL
0–1			254	254
1–4			94	94
5–9			48	48
10–14			14	14
15–19	21	10		31
20–24	15	10		25
25–29	10	12		22
30–34	10	25		35
35–39	18	21		39
40–49	14	20		34
50–59	15	10		25
Indeterminate			7	7
Total	103	108	417	628

Previous Skeletal Analyses

Previous research indicates that infant mortality was extremely high at Larson (41 percent of the cemetery skeletons were under the age of one), as was childhood mortality (56 percent were under the age of four), but adolescent mortality was relatively low (Owsley and Bass 1979; Owsley et al. 1977). Nearly two-thirds of the population died by the age of 19. Mortality peaks in adults occurred during the childbearing years and in the late 30s for females (Figure 11), and in the early 30s and during the 40s for males (Owsley and Bass 1979; Owsley et al. 1977). Male life expectancy at birth was only 13.7 years, while it was only 12.8 for females. However, if one survived to the age of five, a male could expect to live until 29.2 years of age and a female until the age of 27.5. Childbirth and complications from pregnancy seemed to heavily impact the mortality of infants and as well as females of childbearing age (Owsley and Bass 1979).

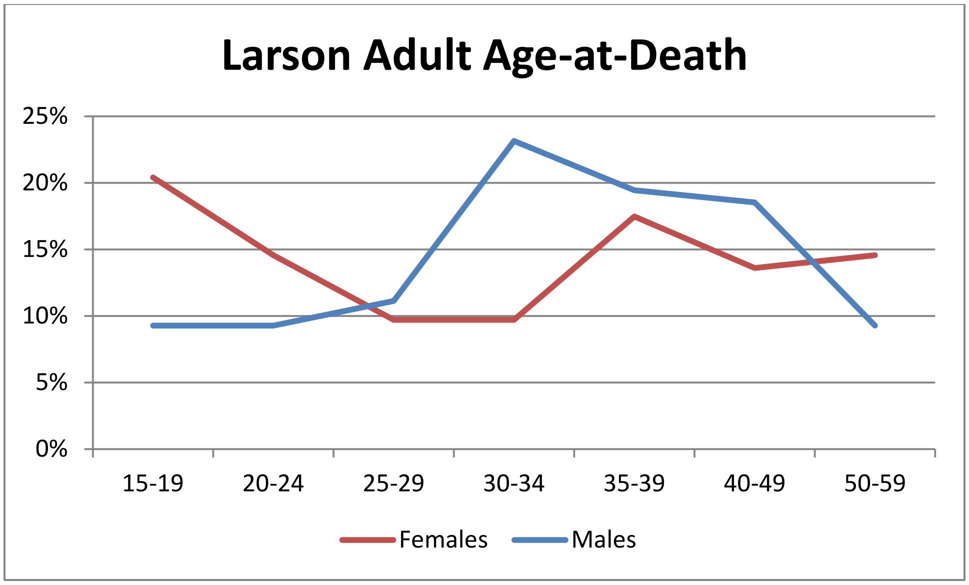

Figure 11. Age distribution of adult mortality at the Larson site.

Subsistence

Subsistence practices included seasonal bison hunting expeditions, particularly during the summer months of June and July, when everyone in the village moved out on to the Plains to hunt bison. Only the sick and feeble stayed behind (Owsley and Bass 1979). The Arikara also hunted antelope and deer, and caught fish in traps along the Missouri River (Rogers 1990). In addition to hunting and gathering wild food plants, the Arikara practiced horticulture, with a focus on maize, beans, squash, and sunflowers (Owsley and Bass 1979). According to historical sources, the females were entirely responsible for the gardening (Rogers 1990). Despite such a mixed economy, the Arikara at Larson appeared to have suffered periods of malnutrition and even starvation, in addition to bouts of epidemic disease and warfare (Owsley and Bass 1979).

Texas

Texas is unique in that it overlaps several archaeological regions, including the Eastern Woodlands in East Texas, the Southwest in far West Texas, and the Great Plains in the Panhandle and North Texas. The patterns of prehistoric lifeways in these areas of Texas are largely similar to those of the overlapping regions. However, much of the interior of Texas is divided into quite distinct archaeological regions, each with a unique pattern of development. Hitzfelder Cave and Mitchell Ridge (Figure 12) are located in the Central Texas and the Southeast Texas archaeological regions, respectively (Perttula 2004).

Figure 12. Locations of Hitzfelder Cave and Mitchell Ridge in Texas (map by Daniel Rose).

Hitzfelder Cave (41BX26)

Site Location and Excavation

No formal report of the excavations of Hitzfelder Cave has yet been published, although some preliminary findings have been reported (Bartholomew 1973; Benfer 1967; Givens 1968a, b), and site files at the Texas Archeological Research Laboratory in Austin, Texas, contain some notes and manuscripts (Benfer and Frank n.d.; Davis 1966). Hitzfelder Cave is a shaft cave overlooking Cibolo Creek northeast of San Antonio in Bexar County, Texas (see Figure 12). After its discovery by landowner Norman Hitzfelder in 1962, the site was investigated by various professional and avocational archaeologists and spelunkers in the 1960s, including Robert Benfer of the Witte Museum and R. Dale Givens of Trinity University (Givens 1968a). In 1967 and 1968, Givens and students from Trinity University partially excavated the cave and uncovered the commingled remains of 30–40 individuals (Givens 1968a).

Dating of the remains has been problematic. Frio, Pedernales, and "Marshall-like" (Collins 1970) or Ensor (Benfer and Frank n.d.) projectile points recovered from the fill above the remains (Collins 1970). A Clear Fork Gouge was collected from the "burial zone" (Benfer 1967). Benfer collected a single charcoal sample from Test Pit 1, 6–18 inches below the surface (Benfer 1967; Benfer and Frank n.d.). The uncalibrated radiocarbon date obtained from the sample was 1000 ±190 (Davis 1966), which would place it in the Austin phase of the Late Prehistoric (Collins 2004; Hester 2004). However, Givens postulates that the carbon sample used for the date was "washed in surface carbon," which seems plausible given his observation that water flowed into the cave whenever it rained, and that the cave was filled with mud (1968a).

Recent radiocarbon dating of 20 individuals was conducted by the Center for Archaeological Research at The University of Texas at San Antonio. The results indicate that the 20 burials tested date as early as 4000 ± 37 radiocarbon years before present (RCYBP), during the Terminal Middle Archaic, and as late as 400 ± 33 RCYBP, during the Toyah Phase of the Late Prehistoric (Munoz et al. 2013). Concurrent stable isotope analysis showed that during the Terminal Middle Archaic, the inhabitants buried at Hitzfelder Cave relied mostly on C_3 plants and fauna, such as trees, herbs, and deer. During the Initial Late Archaic, a subsistence shift was indicated by an increase in C_4 resources, possibly including bison. This was followed in the Terminal Late Archaic by a return to the reliance on C_3 resources. Finally, during the Toyah Phase, the individuals examined heavily exploited C_4 resources, including marine protein sources (Munoz et al. 2013).

Previous Skeletal Analyses

Only limited analyses of the human remains have been conducted (Scruggs et al. 1978). Some of the articles published on the Hitzfelder Cave site deal mainly with controversial interpretations of the crania. Givens (Givens 1968a, b) suggested that some of the cranial features were reminiscent of "pre-*sapiens*" morphology rather than Native American, an analysis quickly refuted by Collins (1970). The collection is currently divided between Trinity University, the University of the Incarnate Word in San Antonio, and the Texas Archeological Research Laboratory in Austin, and a complete inventory of the remains has not been located. As the collection is commingled, age and sex information has not been established.

Subsistence

Presumably, the people buried in Hitzfelder Cave practiced a hunter-gatherer lifestyle typical of the Central Texas Archaic. Groups during this period are thought to have hunted bison (except during the Middle Archaic), deer, small mammals, and birds, and caught fish. In addition, paleobotanical analyses indicate they baked geophytes in earth ovens and collected acorns and other nuts, berries, and grass seeds (Collins 2004). While Central Texas hunter-gatherer subsistence practices varied by climatic conditions and according to seasonal availability, stable isotope studies indicate an increasing reliance on geophytes such as camas and sotol as the Archaic period progressed (Mauldin et al. 2013). The hunter-gatherer subsistence strategy persisted into the Late Prehistoric, a period marked primarily by technological shifts from atlatl use to the bow and arrow and the introduction of pottery (Collins 2004).

Mitchell Ridge (41GV66)

Site Location and Excavation

Information on Mitchell Ridge came from a single site report (Ricklis 1994). Mitchell Ridge is located around the midpoint of Galveston Island in Galveston County, on the Upper Texas Coast (see Figure 12). The eastern portion of the site was the focus of survey, testing, and excavations in 1974–1978 by Rice University, the Houston Archaeological Society, and the Texas Archeological Society. In 1994, the site was further tested and excavated by Coastal Archaeological Research, Inc.. The site dates mainly to the Late Prehistoric (AD 1250–1500) through the Protohistoric (AD 1500–1700) and Early Historic (AD 1700–1800) periods, although radiocarbon dates indicate groups in the area began to occupy the site around 2000 years ago and continued to inhabit the site intermittently into the 1700s. Site occupation was mostly seasonal, concentrated in the fall and winter (Ricklis 1994). The remains of 54 individuals were recovered from the Burial and Cross areas during the 1970s, and from areas 1, 3, and 4 of the 1992 excavations (Table 7). Approximately 67 percent of the burials were adults.

Table 7. Age and Sex Distribution of Burials by Component at Mitchell Ridge (adapted from Powell 1994: Tables 9.15–9.17).

COMPONENT	ADULT MALES	ADULT FEMALES	ADULT INDETERMINATE	SUBADULTS	TOTAL
Late Prehistoric	12	6	2	10	30
Protohistoric	1	3	2	3	9
Historic	3	4	3	5	15
Total	16	13	7	18	54

Previous Skeletal Analyses

Paleodemographic analysis was limited by the small sample size, lack of clear temporal assignment for some of the burials, absence of infants, and possible underrepresentation of old adults due to differential burial practices, poor preservation, and/or aging methodology. Thus, the following estimates should be viewed with these caveats in mind. Life expectancy for this group was 36.1 years in the Prehistoric, dropping to 22.7–30.8 years in the Protohistoric, and declining to 25.3 in the Historic. Due to the overlapping age categories used in age estimations for this collection, distribution of adult mortality is unavailable. However, examination of mean ages-at-death given by Powell (1994) shows that figure remaining relatively stable for both sexes through the Late Prehistoric and Protohistoric, then dropping sharply for both sexes in the

Historic period (Table 8). This may reflect changes in the Historic period such as increased fertility, different mortuary patterns, or increased mortality due to conflict, epidemics, or population stress related to European contact (Roberts and Manchester 2005). The presence of cribra orbitalia, porotic hyperostosis, treponemal disease, and high rates of degenerative joint disease and entheseal development indicates the population suffered from nutritional and mechanical stress, particularly during the Historic Period (Powell 1994).

Table 8. Mean Ages-at-Death for Mitchell Ridge Adults (Powell 1994).

COMPONENT	MALES	FEMALES
Late Prehistoric	40.2 ± 7.8	30.4 ± 15.3
Protohistoric	40.0	32.1 ± 7.8
Early Historic	28.0 ± 8.2	26.9 ±13.9

Subsistence

Subsistence was based mostly on fishing, although significant contributions to the diet were made from hunting (mostly deer, and occasionally bison on the mainland) and trapping hispid cotton rats (Ricklis 1994, 2004). The ethnographic record supports analyses suggesting the use of roots and tubers (Huebner 1994). During the Late Prehistoric, site inhabitants relied on marine resources for 60–75 percent of their diet. However, by the Historic period, marine resources only accounted for a third to half of the occupants' diet; this shift may be related to environmental changes as well as sociocultural factors stemming from European contact (Huebner 1994).

Sample Sizes

Following the practice of previous studies utilizing the patella for sex estimation (e.g., Bidmos et al. 2005; Dayal and Bidmos 2005), the research design called for one patella, preferably the left, to be examined from 20 females and 20 males from each group, for a total of 240 individuals (120 females, 120 males). This goal was unobtainable for some groups, and exceeded for others. Ultimately, 228 patellae were examined from the six groups, including 90 females and 90 males (Table 9). One individual from Mitchell Ridge was classified in the TARL archives as Indeterminate, but reanalysis revealed metric and morphological characteristics consistent with an estimation of male, and thus this individual was classified as male for this analysis. Sex estimations have not been established for Hitzfelder Cave, and thus all individuals from the site are classified as Indeterminate. It should also be noted that for Hitzfelder Cave, the remains were commingled, and it is possible that at least some of the patellae are actually matching pairs. Thus the 48 patellae represent an MNI of 27, based on the higher number of rights versus lefts (27 and 21, respectively). For all other groups, only one patella was examined from each individual.

Table 9. Sex Distribution of Samples Examined.

SITE	FEMALE	MALE	INDETERMINATE	TOTAL
Eva (H-G)	20	20	0	40
Thompson Village (Ag)	22	19	0	41
Averbuch (Ag)	20	21	0	41
Larson (Hort)	21	20	0	41
Hitzfelder Cave (H-G)	0	0	48	48
Mitchell Ridge (H-G)	7	10*	0	17
Total	90	90	48	228
*One individual was originally classified as indeterminate, but grouped with males for this analysis.				

Within each group, individuals were chosen based on the presence of patellae and availability for study. Left patellae were examined when possible; if missing or too degraded, the right was substituted. Due to poor preservation, damage, and/or pathology, some observations were not collected on a few individuals, as noted in the results chapter.

CHAPTER III

METHODS

Observations

Both metric and nonmetric data were collected, but only the nonmetric data were analyzed for this study. Nonmetric observations recorded were:

1) the presence of absent to mild or moderate to severe quadriceps femoralis tendon entheses (QFTE);
2) the presence of absent to mild or moderate to severe patellar ligament entheses (PLE);
3) the presence of absent to mild or moderate to severe lipping (LIP) along the margins of the articular surface;
4) the presence or absence of coalesced porosity (CP);
5) the presence or absence of surface osteophytes (SO); and
6) the presence or absence of eburnation (EB).

These observations were recorded separately using a simplified version of scoring methods employed by Buikstra and Ubelaker (1994) and Hawkey and Merbs (1995). (Tables 10–14). While previous studies of MSMs have generated composite scores or arithmetic means for large muscle groups, the method used here allows for comparison of use of the upper leg versus the lower leg within and between groups. By scoring lipping, eburnation, surface osteophytes, and eburnation separately, this avoids the debate over which diagnostic criteria to use for recording osteoarthritis. When a pathology was unobservable on an individual, typically due to taphonomic damage to the area, the pathology was not scored, and that individual was excluded from the data analysis for the unobservable pathology.

All data were recorded onto an Excel spreadsheet, and included age, sex, and temporal component when available. Each patella was photographed on both the anterior and posterior sides at straight and oblique angles to illustrate modifications. Observations were later checked for consistency within and between samples using these photographs.

Table 10. Scoring System Used for Entheses.

PATHOLOGY	SCORE	CRITERIA	EXAMPLE
Quadriceps femoralis tendon entheses (QFTE)	Absent to Mild	Entheses are absent or barely discernible	
	Moderate to Severe	Entheses project above the surface or over the edge of the patellae; in severe cases multiple entheses may coalesce	 
Patellar ligament entheses (PLE)	Absent to Mild	Entheses are absent or barely discernible	
	Moderate to Severe	Entheses project above the surface or over the edge of the patellae; in severe cases multiple entheses may coalesce	

Note: example photographs by Maggie McClain.

Table 11. Scoring System Used for Lipping.

SCORE	CRITERIA	EXAMPLE
Absent to Mild	Lipping is absent or barely discernible	
Moderate to Severe	Sharp ridge around articular margins, sometimes curled with spicules; severe forms may show extensive spicule formation	 
Note: example photographs by Maggie McClain.		

Table 12. Scoring System Used for Coalesced Porosity.

SCORE	CRITERIA	EXAMPLE
Absent	No porosity or only pinpoint porosity is observable on the articular surface	
Present	Porosities have coalesced and are apparent on the articular surface	
Note: example photographs by Maggie McClain.		

Table 13. Scoring System Used for Surface Osteophytes.

SCORE	CRITERIA	EXAMPLE
Absent	No osteophytes are present on the articular surface	
Present	Osteophytes are clearly present on the articular surface	

Note: example photographs by Maggie McClain.

Table 14. Scoring System Used for Eburnation.

SCORE	CRITERIA	EXAMPLE
Absent	Eburnation is absent on the articular surface	
Present	Polish and/or grooving is apparent on the articular surface	
Note: example photographs by Maggie McClain.		

Data Analysis

To identify general patterns, frequencies and percentages of patellar pathologies were calculated by group for all six sites and also by sex for Eva, Thompson Village, Averbuch, Larson, and Mitchell Ridge. In addition, for each site, chi-square tests-of-independence were used to examine whether there was significant variation in the types of patellar pathologies within each group, whether there was a variation in patellar pathology among females and among males, and whether there were significant differences in patellar pathologies between males and females.

No age data were available for Hitzfelder Cave, and only broad, imprecise age categories (e.g., adult, young–middle adult, young–old adult, and middle–old adult) were available for Eva, Larson, Mitchell Ridge, and Thompson Village; thus, analysis of pathologies by age was not possible for these groups. However, precise, five-year age ranges were provided for Averbuch. These were collapsed into broader cohorts (<20, 20–30, 30–40, 40+) to obtain sample sizes sufficient for inferential statistical analysis. Frequencies and percentages were calculated for entheses, lipping, and coalesced porosity, and chi-square tests-of-independence were used to test for significant variation.

Data on temporal component was available for the Eva site. Frequencies and percentages were calculated for both types of entheses and lipping, and chi-square tests-of-independence were used to test for significant variation. Mitchell Ridge also had associated temporal data, but the sample size was too small to lend itself to inferential statistical analysis.

Chi-square tests-of-independence were also used to determine if there was significant variation between sites, between sites within the same region, and between sites engaged in similar subsistence regimes, and between sites engaged in different subsistence regimes. For all chi-square tests, Yate's correction was used for any 2 x 2 contingency table in which any of the expected values fell below 5. When significant variation was encountered, adjusted residuals were analyzed to determine the direction and strength of the variation. All calculations were performed using Microsoft Excel.

CHAPTER IV

RESULTS

The results of analysis are presented below. Sites are presented by region, followed by the results of between-group analyses. The data gathered from each site are presented in Appendix A. Appendix B contains the results of all chi-square tests conducted.

Eastern Woodlands

Eva (40BN12, Archaic Hunter-Gatherers)

Results by Group

Table 15 presents the occurrence of patellar pathologies found in the Eva sample. Percentages of the group affected are depicted in Figure 13. Surface osteophytes and eburnation were entirely absent and thus were excluded from further analysis. Chi-square analysis of quadriceps femoralis tendon (QFT) entheses, patellar ligament (PL) entheses, lipping, and coalesced porosity shows these variables to be highly independent (χ^2=24.5, df=3, p<0.00001). Rates of PL entheses were much higher than expected in the group as defined by adjusted residuals, while coalesced porosity occurred at a much lower frequency (see Table 15).

Table 15. Frequency and Adjusted Residuals of Patellar Pathologies in the Eva Group, Sexes Combined.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	24 (-0.67)	16 (0.67)	40
PL Entheses	16 **(-3.72)**	24 **(3.72)**	40
Lipping	26 (-0.10)	14 (-0.10)	40
Coalesced Porosity	37 **(4.29)**	3 **(-4.29)**	40
Subtotal	103	57	160
Surface Osteophytes	40	0	40
Eburnation	40	0	40
Total	183	57	240
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

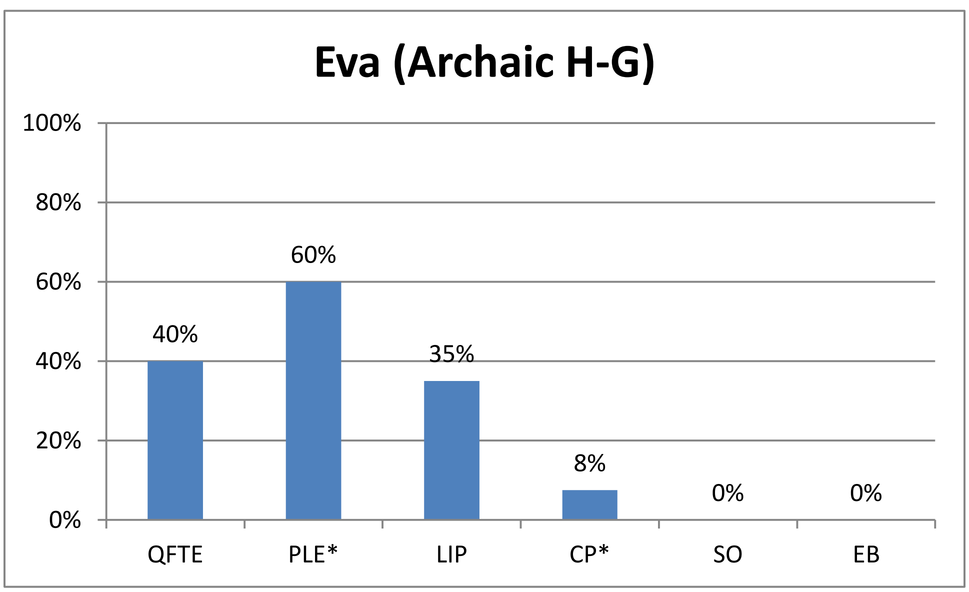

Figure 13. Percent of the Eva group exhibiting patellar pathologies (* indicates a significantly high or low frequency; see Table 15).

Results by Sex

Tables 16 and 17 present the results by sex, which are illustrated in Figure 14. Among females, there was significant variation among QFT and PL entheses, lipping, and coalesced porosity (χ^2=22.1, df=3, p<0.0001), with PL entheses occurring at a much higher rate than expected and coalesced porosity a much lower frequency than expected. Among males, there was also significant variation among the same four variables (χ^2=6.2, df=3, p=0.05), with coalesced porosity occurring at lower rates than expected. While males exhibited slightly higher rates of QFT entheses and lipping, and females exhibited 20 percent higher rates of PL entheses (see Figure 14), only the difference in coalesced porosity rates was statistically significant (χ^2=3.6, df=1, p=0.03). All cases of coalesced porosity occurred in males.

Table 16. Frequency and Adjusted Residuals of Patellar Pathologies among Females in the Eva Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	13 (-0.14)	7 (0.14)	20
PL Entheses	6 **(-3.96)**	14 **(3.96)**	20
Lipping	14 (0.41)	6 (-0.41)	20
Coalesced Porosity	20 **(3.69)**	0 **(-3.69)**	20
Subtotal	53	27	80
Surface Osteophytes	20	0	20
Eburnation	20	0	20
Total	93	27	120
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

Table 17. Counts and Adjusted Residuals of Patellar Pathologies among Males in the Eva Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	11 (-0.80)	9 (0.80)	20
PL Entheses	10 (-1.33)	10 (1.33)	20
Lipping	12 (-0.27)	8 (0.27)	20
Coalesced Porosity	17 (**2.40**)	3 (**-2.40**)	20
Subtotal	50	30	80
Surface Osteophytes	20	0	20
Eburnation	20	0	20
Total	90	30	120
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

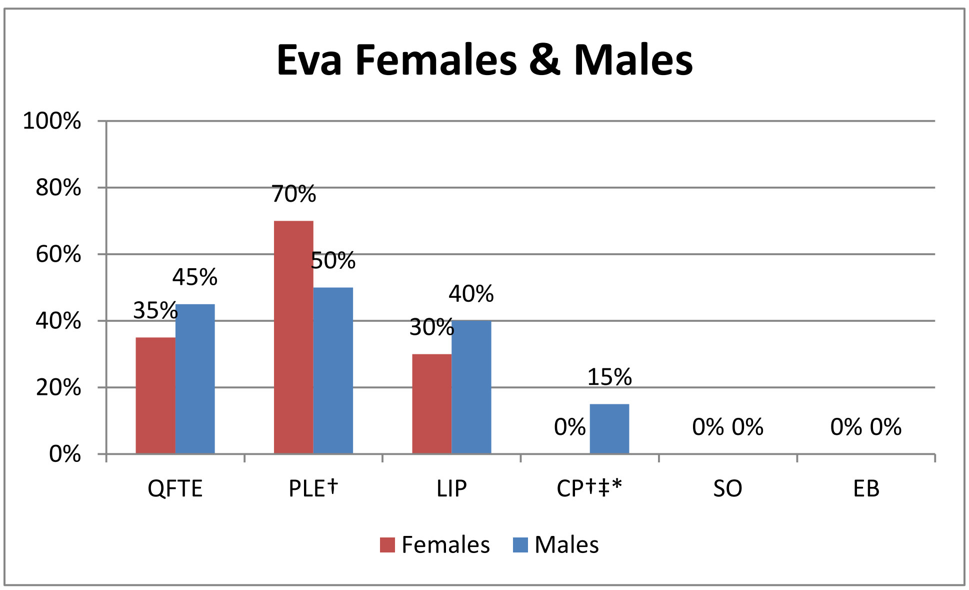

Figure 14. Percent of Eva females and males exhibiting patellar pathologies († indicates a significantly high or low frequency among females; ‡ indicates a significantly high or low frequency among males; * indicates a significant difference between sexes; see Tables 16–17 and Appendix B).

Results by Age

Age estimations were only available for 24 of the 40 individuals in this sample, which did not yield a large enough sample size for inferential statistical analysis.

Results by Component

The Eva group was divided into three temporal components: the earlier Middle Archaic Eva component, the later Middle Archaic Three Mile component, and the Late Archaic Big Sandy component (Table 18). As coalesced porosity occurred only once per component, and surface osteophytes and eburnation were absent in the Eva group, these pathologies were excluded from the component analysis. Tables 19–21 present the results of analysis by component for the Eva group, and the frequencies are depicted in Figure 15. There was no significant variation in QFT entheses, PL entheses, and lipping during either the Eva component or the Three Mile component. QFT entheses, PL entheses, and lipping varied significantly only in the Big Sandy component (χ^2=6.7, df=2, p=0.02), during which time the PL entheses were much higher than expected (see Table 20).

Table 18. Temporal Distribution by Sex for the Eva Sample.

COMPONENT	SEXES COMBINED	FEMALES	MALES
Eva	5	2	3
Three Mile	25	14	11
Big Sandy	10	4	6
Total	40	20	20

Table 19. Frequency of Patellar Pathologies during the Eva Component, Sexes Combined.

PATHOLOGY	ABSENT/MILD	MODERATE/SEVERE	TOTAL
QFT Entheses	3	2	5
PL Entheses	1	4	5
Lipping	3	2	5
Total	7	8	15

Table 20. Frequency of Patellar Pathologies during the Three Mile Component, Sexes Combined.

PATHOLOGY	ABSENT/MILD	MODERATE/SEVERE	TOTAL
QFT Entheses	12	13	25
PL Entheses	11	14	25
Lipping	15	10	25
Total	38	37	75

Table 21. Frequency and Adjusted Residuals of Patellar Pathologies during the Big Sandy Component, Sexes Combined.

PATHOLOGY	ABSENT/MILD	MODERATE/SEVERE	TOTAL
QFT Entheses	9 (1.69)	1 (-1.69)	10
PL Entheses	4 (**-2.54**)	6 (**2.54**)	10
Lipping	8 (0.85)	2 (-0.85)	10
Total	21	9	30
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

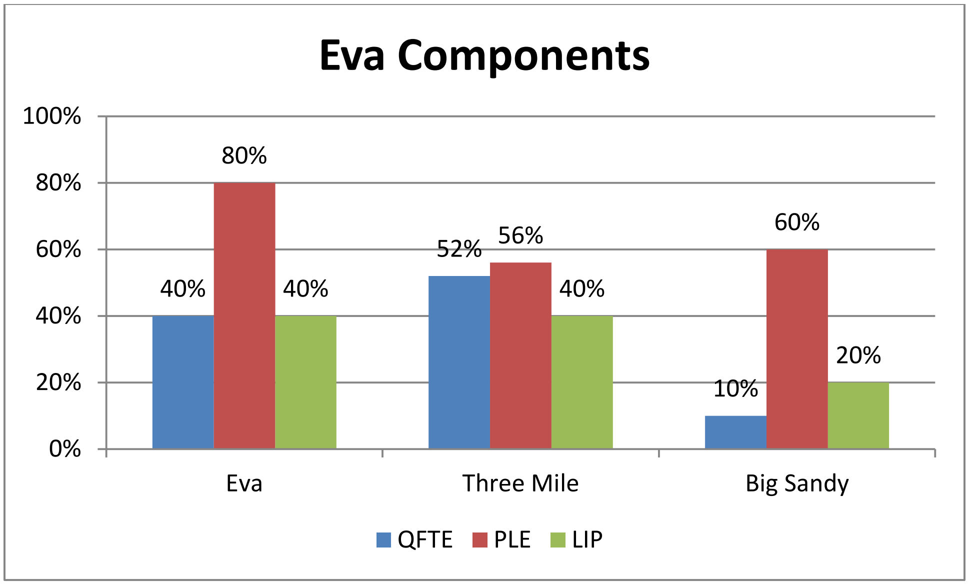

Figure 15. Percent of the Eva group exhibiting patellar pathologies by component, sexes combined.

When change over time was examined for each patellar pathology (Table 22), only QFT entheses showed a significant variation by component (χ^2=5.2, df=2, p=0.04). QFT entheses were much higher in the Three Mile component and much lower in the Big Sandy component. It should be noted, however, that the small sample size might be responsible for the lack of significance between components.

Table 22. Frequency and Adjusted Residuals of Patellar Pathologies by Component, Sexes Combined.

COMPONENT	QFTE			PLE			LIP		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**
Eva	3 (0.00)	2 (0.00)	5	1 (-0.98)	4 (0.98)	5	3 (-0.25)	2 (0.25)	5
Three Mile	12 (**-2.00**)	13 (**2.00**)	25	11 (0.67)	14 (-0.67)	25	15 (-0.86)	10 (0.86)	25
Big Sandy	9 (**2.24**)	1 (**-2.24**)	10	4 (0.00)	6 (0.00)	10	8 (1.15)	2 (-1.15)	10
Total	24	16	40	16	24	40	26	14	40

Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.

Thompson Village (40HY5, Middle Mississippian Agriculturalists)

Results by Group

Many of the patellae from this site are poorly preserved, with the anterior cortex and occasionally the articular margins worn away, which made scoring of entheses and/or lipping impossible in some cases. Nevertheless, all possible observations were recorded. Table 23 presents the occurrence of patellar pathologies found in the Thompson Village sample. Percentages of the group affected are depicted in Figure 16. Surface osteophytes and eburnation were completely absent in this group and were excluded from further analysis. Chi-square analysis indicates that QFT entheses, PL entheses, lipping, and coalesced porosity are highly variable in this group ($\chi2=14.9$, df=3, $p<0.001$). QFT entheses were higher than expected, while PL entheses were lower than expected (see Table 23).

Table 23. Frequency and Adjusted Residuals of Patellar Pathologies in the Thompson Village Group, Sexes Combined.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	12 **(-3.55)**	23 **(3.55)**	35
PL Entheses	29 **(2.13)**	10 **(-2.13)**	39
Lipping	25 (1.58)	10 (-1.58)	35
Coalesced Porosity	24 (-0.22)	17 (0.22)	41
Subtotal	90	60	150
Surface Osteophytes	41	0	41
Eburnation	41	0	41
Total	172	60	232

Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.

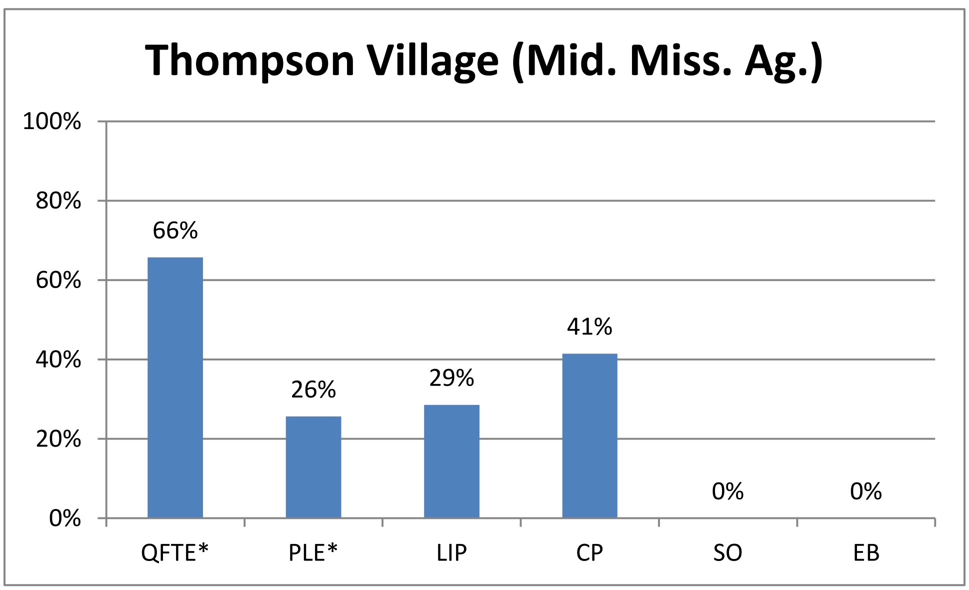

Figure 16. Percent of the Thompson Village group exhibiting patellar pathologies (*indicates a significantly high or low frequency; see Table 22).

Results by Sex

Tables 24 and 25 present the results by sex, and percentages of patellar pathologies by sex are shown in Figure 17. Among females, there was significant variation in patellar pathologies ($\chi2=14.3$, df=3, $p<0.01$), which was driven by high rates of QFT entheses and low rates of PL entheses (see Table 24). There was no significant variation in patellar pathologies among males. While females exhibit a 25 percent higher rate of QFT entheses and a marginally higher rate of coalesced porosity, and males exhibit marginally higher rates of PL entheses and lipping, these sex differences were not statistically significant.

Table 24. Frequency and Adjusted Residuals of Patellar Pathologies among Females in the Thompson Village Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	4 (**-3.44**)	14 (**3.44**)	18
PL Entheses	16 (**2.02**)	5 (**-2.02**)	21
Lipping	14 (1.63)	5 (-1.63)	19
Coalesced Porosity	12 (-0.33)	10 (0.33)	22
Subtotal	46	34	80
Surface Osteophytes	22	0	22
Eburnation	22	0	22
Total	90	34	124
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

Table 25. Frequency and Adjusted Residuals of Patellar Pathologies among Males in the Thompson Village Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	8 (-1.55)	9 (1.55)	17
PL Entheses	13 (0.95)	5 (-0.95)	18
Lipping	11 (0.56)	5 (-0.56)	16
Coalesced Porosity	12 (0.03)	7 (-0.03)	19
Subtotal	44	26	70
Surface Osteophytes	19	0	19
Eburnation	19	0	19
Total	82	26	108
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

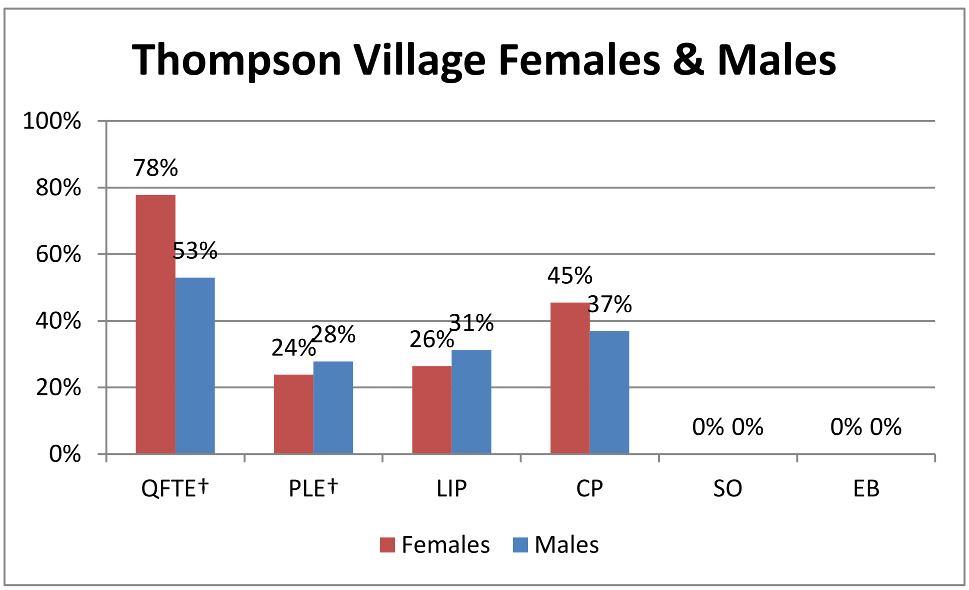

Figure 17. Percent of Thompson Village females and males exhibiting patellar pathologies († indicates a significantly high or low frequency among females; see Table 24).

Results by Age

The nature of the age ranges given in the inventory rendered analysis by age impossible for Thompson Village.

Results by Component

Component data were unavailable, thus analysis by component was not possible for Thompson Village.

Averbuch (40DV60, Late Mississippian Agriculturalists)

Results by Group

Table 26 presents the occurrence of patellar pathologies found in the Averbuch sample. Percentages of the group affected are depicted in Figure 18. Surface osteophytes were rare and eburnation was completely absent in this group, and thus they are excluded from further analysis. Chi-square analysis indicates that QFT entheses, PL entheses, lipping, and coalesced porosity are highly variable in this group (χ^2=10.4, df=3, $p<0.01$). Adjusted residuals indicate that PL entheses were lower than expected (see Table 26).

Table 26. Frequency and Adjusted Residuals of Patellar Pathologies in the Averbuch Group, Sexes Combined.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	14 (-1.78)	26 (1.78)	40
PL Entheses	25 **(2.04)**	16 **(-2.04)**	41
Lipping	14 (-1.94)	27 (1.94)	41
Coalesced Porosity	24 (1.67)	17 (-1.67)	41
Subtotal	77	86	163
Surface Osteophytes	40	1	41
Eburnation	41	0	41
Total	158	87	245
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

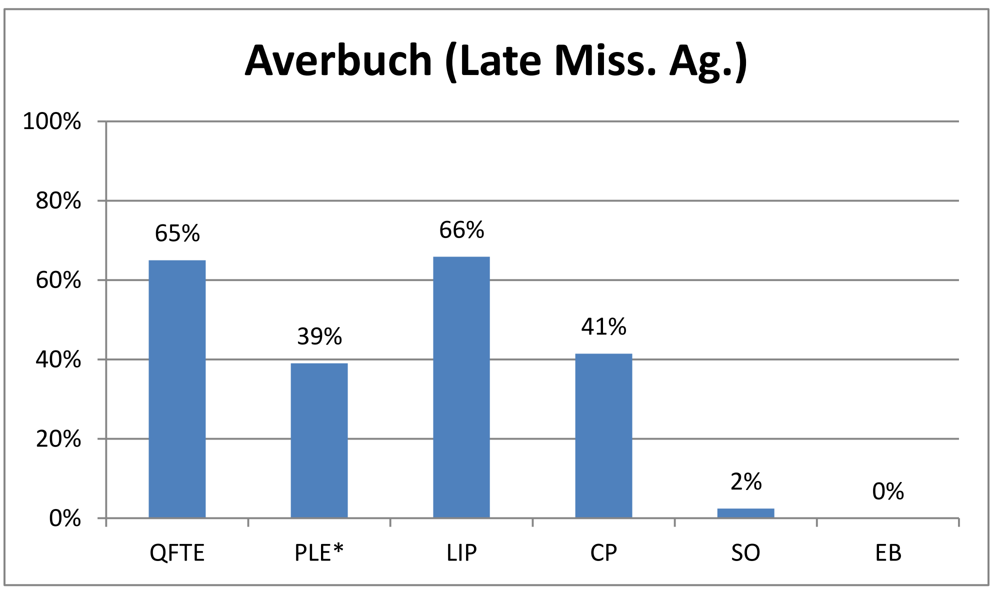

Figure 18. Percent of the Averbuch group exhibiting patellar pathologies (* indicates a significantly low frequency; see Table 25).

Results by Sex

Tables 27 and 28 present the results by sex, with percentages of frequencies illustrated in Figure 19. There was no significant variation among females in QFT entheses, PL entheses, lipping, and coalesced porosity. The only case of surface osteophytes occurred in a female. There was significant variation among males (χ^2=11.8, df=3, p<0.01), who exhibited quite high QFT entheses compared to fairly low PL entheses and coalesced porosity (see Table 28). Although females had 21 percent higher rates of PL entheses and 26 percent higher coalesced porosity than males, chi-square analysis indicated that only the sex difference in coalesced porosity was significant (χ^2=2.9, df=1, p=0.05).

Table 27. Frequency and Adjusted Residuals of Patellar Pathologies among Females in the Averbuch Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	8 (-0.13)	12 (0.13)	20
PL Entheses	10 (0.92)	10 (-0.92)	20
Lipping	6 (-1.18)	14 (1.18)	20
Coalesced Porosity	9 (0.39)	11 (-0.39)	20
Subtotal	33	47	80
Surface Osteophytes	19	1	20
Eburnation	20	0	20
Total	72	48	120
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

Table 28. Frequency and Adjusted Residuals of Patellar Pathologies among Males in the Averbuch Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	6 **(-2.37)**	14 **(2.37)**	20
PL Entheses	15 **(1.96)**	6 **(-1.96)**	21
Lipping	8 (-1.58)	13 (1.58)	21
Coalesced Porosity	15 **(1.96)**	6 **(-1.96)**	21
Subtotal	44	39	83
Surface Osteophytes	21	0	21
Eburnation	21	0	21
Total	86	39	125
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

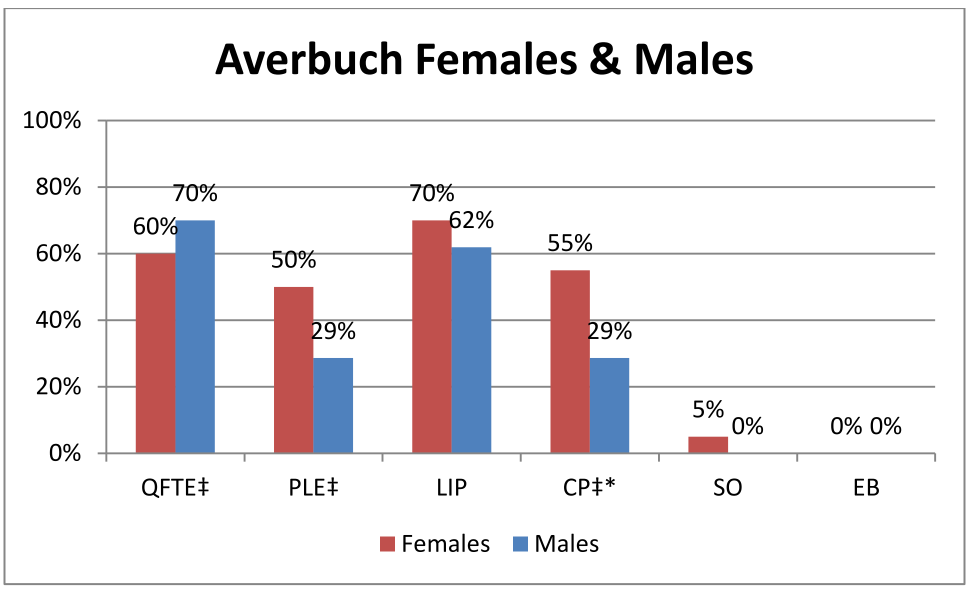

Figure 19. Percent of Averbuch females and males exhibiting patellar pathologies (‡ indicates a significantly high or low frequency among males; * indicates a significant difference between sexes; see Table 28 and Appendix B).

Results by Age

Age data were available for 40 of the 41 individuals at Averbuch (Table 29). The 20–30 age category contained the largest number of individuals overall, among both females and males. Chi-square analysis indicated the distribution of age groups did not significantly differ between males and females.

Table 29. Age Distribution by Sex for the Averbuch Group.

AGE CATEGORY	**SEXES COMBINED**		**FEMALES**		**MALES**	
	No.	%	No.	%	No.	%
<20	6	15	3	16	3	14
20–30	14	35	6	32	8	38
30–40	10	25	5	26	5	24
40+	10	25	5	26	5	24
Total	40	0	19	0	21	0

Results of chi-square showed that frequency of QFT entheses, PL entheses, lipping, and coalesced porosity varied significantly within the 20–30 age group (χ^2=6.8, df=3, p=0.04), 30–40 age group (χ^2=5.8, df=3, p=0.05), and the 40+ age group (χ^2=7.4, df=3, p=0.03). Adjusted residuals indicate that coalesced porosity was significantly lower than the other patellar pathologies in the 30–40 age group, while PL entheses were lower than the other pathologies in the 40+ age group (Table 30).

Table 30. Adjusted Residuals for Each Age Group.

PATHOLOGY	<20			20–30			30–40			40+		
	A/M	M/S	T	A/M	M/S	T	A/M	M/S	T	A/M	M/S	T
QFT Entheses	5 (-0.85)	1 (0.85)	6	4 (-1.66)	9 (1.66)	13	3 (-0.75)	7 (0.75)	10	2 (-0.61)	8 (0.61)	10
PL Entheses	6 (0.85)	0 (-0.85)	6	9 (1.16)	5 (-1.16)	14	4 (0)	6 (0)	10	6 (**2.66**)	4 (**-2.66**)	10
Lipping	5 (-0.85)	1 (0.85)	6	5 (-1.66)	9 (1.66)	14	2 (-1.49)	8 (1.49)	10	2 (-0.61)	8 (0.61)	10
Coalesced Porosity	6 (0.85)	0 (-0.85)	6	10 (1.78)	4 (-1.78)	14	7 (**2.24**)	3 (**-2.24**)	10	1 (-1.43)	9 (1.43)	10
Total	22	2	24	28	27	55	16	24	40	11	29	40

Note: coalesced porosity was scored on an absence/presence basis; adjusted residuals are in parentheses; bold indicates a significant result.

The frequencies of each patellar pathology by age category for the sexes combined as well as for females and males are presented in Tables 31–34. As with the Eva component analysis, the sample sizes are small, and thus significant results may be obscured. Chi-square analysis showed that the frequency of each patellar pathology varied significantly between age groups. The variations by age group in QFT entheses (χ^2=7.3, df=3, p=0.03), PL entheses (χ^2=5.8, df=3, p=0.05), lipping (χ^2=8.1, df=3, p=0.02), and coalesced porosity (χ^2=15.6, df=3, p<0.001) were driven by much lower rates in the <20 age group than expected, as indicated by adjusted residuals (see Tables 31–34). For QFT entheses and lipping, the direction of the variation are consistent with rates rising with age, but the strength of the association in the older three groups was not significant (see Tables 31 and 33). PL entheses exhibited a rise in the first three age groups, but then declined in the 40+ group, although the strength of the directional shift was not significant (see Table 32). The pattern for coalesced porosity rates was also consistent with increase with age. The strength of the association was significant as well, with rates starting out much lower than expected in the <20 group and rising to much higher than expected levels in the 40+ age group (see Table 34).

Table 31. Frequency and Adjusted Residuals of QFT Entheses by Age Category in the Averbuch Group.

AGE CATEGORY	SEXES COMBINED			FEMALES			MALES		
	A/M	M/S	Total	A/M	M/S	Total	A/M	M/S	Total
<20	5 **(2.63)**	1 **(-2.63)**	6	3 **(2.21)**	0 **(-2.21)**	3	2 (0.14)	1 (-0.14)	3
20–30	4 (-0.47)	9 (0.47)	13	0 **(-2.53)**	6 **(2.53)**	6	4 (1.94)	3 (-1.94)	7
30–40	3 (-0.45)	7 (0.45)	10	3 (0.94)	2 (-0.94)	5	0 (-1.69)	5 (1.69)	5
40+	2 (-1.22)	8 (1.22)	10	2 (-0.11)	3 (0.11)	5	0 (-1.69)	5 (1.69)	5
Total	14	25	39	8	11	19	6	14	20
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.									

Table 32. Frequency and Adjusted Residuals of PL Entheses by Age Category in the Averbuch Group.

AGE CATEGORY	SEXES COMBINED			FEMALES			MALES		
	A/M	M/S	Total	A/M	M/S	Total	A/M	M/S	Total
<20	6 **(2.06)**	0 **(-2.06)**	6	3 (1.79)	0 (-1.79)	3	3 (1.18)	0 (-1.18)	3
20–30	9 (0.17)	5 (-0.17)	14	4 (0.83)	2 (-0.83)	6	5 (-0.71)	3 (0.71)	8
30–40	4 (-1.70)	6 (1.70)	10	1 (-1.70)	4 (1.70)	5	3 (-0.65)	2 (0.65)	5
40+	6 (-0.19)	4 (0.19)	10	2 (-0.66)	3 (0.66)	5	4 (0.49)	1 (-0.49)	5
Total	25	15	40	10	9	19	15	6	21
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.									

Table 33. Frequency and Adjusted Residuals of Lipping by Age Category in the Averbuch Group.

AGE CATEGORY	SEXES COMBINED			FEMALES			MALES		
	A/M	**M/S**	**Total**	**A/M**	**M/S**	**Total**	**A/M**	**M/S**	**Total**
<20	5 (**2.69**)	1 (**-2.69**)	6	2 (1.42)	1 (-1.42)	3	3 (**2.38**)	0 (**-2.38**)	11
20–30	5 (0.07)	9 (-0.07)	14	3 (1.17)	3 (-1.17)	6	2 (-0.97)	6 (0.97)	13
30–40	2 (-1.15)	8 (1.15)	10	1 (-0.65)	4 (0.65)	5	1 (-0.95)	4 (0.95)	10
40+	2 (-1.15)	8 (1.15)	10	0 (-1.77)	5 (1.77)	5	2 (0.10)	3 (-0.10)	26
Total	14	26	40	6	13	19	8	13	21
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.									

Table 34. Frequency and Adjusted Residuals of Coalesced Porosity by Age Category in the Averbuch Group.

AGE CATEGORY	SEXES COMBINED			FEMALES			MALES		
	Absent	**Present**	**Total**	**Absent**	**Present**	**Total**	**Absent**	**Present**	**Total**
<20	6 (**2.17**)	0 (**-2.17**)	6	3 (**1.99**)	0 (**-1.99**)	3	3 (1.18)	0 (-1.18)	3
20–30	10 (1.08)	4 (-1.08)	14	4 (1.14)	2 (-1.14)	6	6 (0.28)	2 (-0.28)	8
30–40	7 (0.75)	3 (-0.75)	10	2 (-0.38)	3 (0.38)	5	5 (1.62)	0 (-1.62)	5
40+	1 (**-3.73**)	9 (**3.73**)	10	0 (**-2.47**)	5 (**2.47**)	5	1 (**-2.92**)	4 (**2.92**)	5
Total	24	16	40	9	10	19	15	6	21
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.									

Among females, significant variation existed between age groups only for QFT entheses (χ^2=9.2, df=3, p=0.01) and coalesced porosity (χ^2=8.8, df=3, p=0.01). An examination of the adjusted residuals indicates that QFT entheses were quite low in the <20 age group, unexpectedly high in the 20–30 age group, slightly lower than expected in the 30–40 group, and only slightly higher than expected in 40+ group (see Table 31). A much clearer increase with age is apparent in the direction of variation in coalesced porosity, with rates starting out significantly low in the <20 group, and rising to much higher rates than expected in the 40+ group (see Table 34). A similar pattern in direction occurs with lipping, but the variation between groups was not significant (see Table 33).

Among males, significant variation existed between age groups for QFT entheses (χ^2=8.7, df=3, p=0.02), lipping (χ^2=6.2, df=3, p=0.05) and coalesced porosity (χ^2=9.7, df=3, p<0.01). However, the adjusted residuals do not show a directional pattern of increase with age for any of these pathologies. Furthermore, the strengths in variation are not significant, save for very low rates of lipping in the <20 category and very high rates of coalesced porosity in the 40+ group (see Tables 33 and 34).

Results by Component

Component data were unavailable for the Averbuch sample; therefore, analysis of this type was not possible.

Comparison of Eastern Woodlands Sites

Chi-square tests-of-independence were conducted to determine if the three sites in the Eastern Woodlands region varied in frequency of QFT entheses, PL entheses, lipping, and coalesced porosity (Table 35). Given the rarity of surface osteophytes and eburnation among the Eastern Woodland groups, these pathologies were excluded from the analysis. The results indicate that the three sites do vary significantly in QFT entheses, PL entheses, lipping, and coalesced porosity. When adjusted residuals are examined (Table 36), it is evident that the Eva site is far different from Thompson Village or Averbuch.

Individuals from the Eva site have much lower rates of QFT entheses, much higher rates of PL entheses, and much lower rates of coalesced porosity than Averbuch or Thompson Village. The variation in lipping is primarily due to the low rates at Thompson Village and the very high rates at Averbuch, rather than to variation at Eva.

Table 35. Results of Chi-Square Analysis of the Eastern Woodlands Sites.

SEX	**QFTE**	**PLE**	**LIP**	**CP**
Sexes Combined	**χ2=6.8, df=2, p=0.02**	**χ2=9.8, df=2, p<0.01**	**χ2=12.6, df=2, p<0.001**	**χ2=14.7, df=2, p<0.001**
Females	**χ2=7.2, df=2, p=0.01**	**χ2=8.8, df=2, p<0.01**	**χ2=9.5, df=2, p<0.01**	**χ2=15.5, df=2, p<0.001**
Males	χ2=2.6, df=2, p=0.13	χ2=2.7, df=2, p=0.13	χ2=3.8, df=2, p=0.07	χ2=2.4, df=2, p=0.15
Note: bold indicates a significant result.				

Table 36. Frequency and Adjusted Residuals of Patellar Pathologies from the Eastern Woodlands Sites, Sexes Combined.

SITE	**QFTE**			**PLE**			**LIP**			**CP**		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**	**A**	**P**	**T**
Eva	24 **(2.61)**	16 **(-2.61)**	40	16 **(-2.88)**	24 **(2.88)**	40	26 (1.41)	14 (-1.41)	40	37 **(3.83)**	3 **(-3.83)**	40
Thompson Village	12 (-1.32)	23 (1.32)	35	29 (1.07)	10 (-1.07)	39	25 **(2.20)**	10 **(-2.20)**	35	24 (1.90)	17 (1.90)	41
Averbuch	14 (-1.34)	26 (1.34)	40	25 (0.42)	16 (-0.42)	41	14 **(-3.51)**	27 **(3.51)**	41	24 (1.90)	17 (1.90)	41
Total	50	65	115	70	50	120	65	51	116	85	37	122
Notes: adjusted residuals in parentheses; bold indicates a significant result.												

When examined by sex, females varied significantly in patellar pathologies among the three sites (see Table 35). Among females, the variation in QFT entheses is due to the low rates at Eva and the high rates at Thompson Village (Table 37). The variation in PL entheses is accounted for by an opposite pattern, with Eva individuals showing higher rates and Thompson Village showing lower rates. Averbuch females exhibit high rates of both lipping and coalesced porosity, while Eva females show a significantly lower rate of coalesced porosity. Males did not differ significantly in patellar pathologies among the three sites (see Table 35). When adjusted residuals were examined (Table 38), no discernible pattern in the direction of the variation among males was apparent. Furthermore, no cells were significant.

Table 37. Frequency and Adjusted Residuals of Patellar Pathologies among Females from the Eastern Woodlands Sites.

SITE	**QFTE**			**PLE**			**LIP**			**CP**		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**	**A**	**P**	**T**
Eva	13 (**2.44**)	7 (**-2.44**)	20	6 (**-2.45**)	14 (**2.45**)	20	14 (1.38)	6 (-1.38)	20	20 (**3.89**)	0 (**-3.89**)	20
Thompson Village	4 (**-2.15**)	14 (**2.15**)	18	16 (**2.69**)	5 (**-2.69**)	21	14 (1.72)	5 (-1.72)	19	12 (-1.43)	10 (1.43)	22
Averbuch	8 (-0.35)	12 (0.35)	20	10 (-0.27)	10 (0.27)	20	6 (**-3.08**)	14 (**3.08**)	20	9 (**-2.43**)	11 (**2.43**)	20
Total	25	33	58	32	29	61	34	**25**	59	41	21	62
Notes: coalesced porosity scored on an absence/presence basis; adjusted residuals in parentheses; bold indicates a significant result.												

Table 38. Frequency and Adjusted Residuals of Patellar Pathologies among Males from the Eastern Woodlands Sites.

SITE	QFTE			PLE			LIP			CP		
	A/M	**M/S**	T	**A/M**	**M/S**	T	**A/M**	**M/S**	T	**A**	**P**	T
Eva	11 (1.25)	9 (-1.25)	20	10 (-1.66)	10 (1.66)	20	12 (0.63)	8 (-0.63)	20	17 (1.45)	3 (-1.45)	20
Thompson Village	8 (0.32)	9 (-0.32)	17	13 (0.83)	5 (-0.83)	18	11 (1.36)	5 (-1.36)	16	12 (-1.21)	7 (1.21)	19
Averbuch	6 (-1.55)	14 (1.55)	20	15 (0.84)	6 (-0.84)	21	8 (-1.89)	13 (1.89)	21	15 (-0.24)	6 (0.24)	21
Total	25	32	57	38	21	59	31	26	57	44	16	60

Notes: coalesced porosity scored on an absence/presence basis; adjusted residuals in parentheses; bold indicates a significant result.

<u>Great Plains</u>

Larson (39WW2, Historic Arikara Horticulturalists)

Results by Group

Table 39 presents the occurrence of patellar pathologies found in the Larson sample. Percentages of the group affected are illustrated in Figure 20. Surface osteophytes were rare and eburnation was completely absent in this group, and thus they are excluded from further analysis. Chi-square analysis of QFT entheses, PL entheses, lipping, and coalesced porosity shows these variables to be highly independent ($\chi2$=21.0, df=3, p<0.0001). Adjusted residuals showed lipping to be much higher than the other pathologies, while coalesced porosity was found to be significantly lower (see Table 39).

Table 39. Frequency and Adjusted Residuals of Patellar Pathologies in the Larson Group, Sexes Combined.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	24 (-1.11)	17 (1.11)	41
PL Entheses	26 (-0.10)	14 (0.10)	40
Lipping	19 **(-3.01)**	22 **(3.01)**	41
Coalesced Porosity	38 **(4.21)**	3 **(-4.21)**	41
Subtotal	107	56	163
Surface Osteophytes	40	1	41
Eburnation	41	0	41
Total	188	57	245

Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.

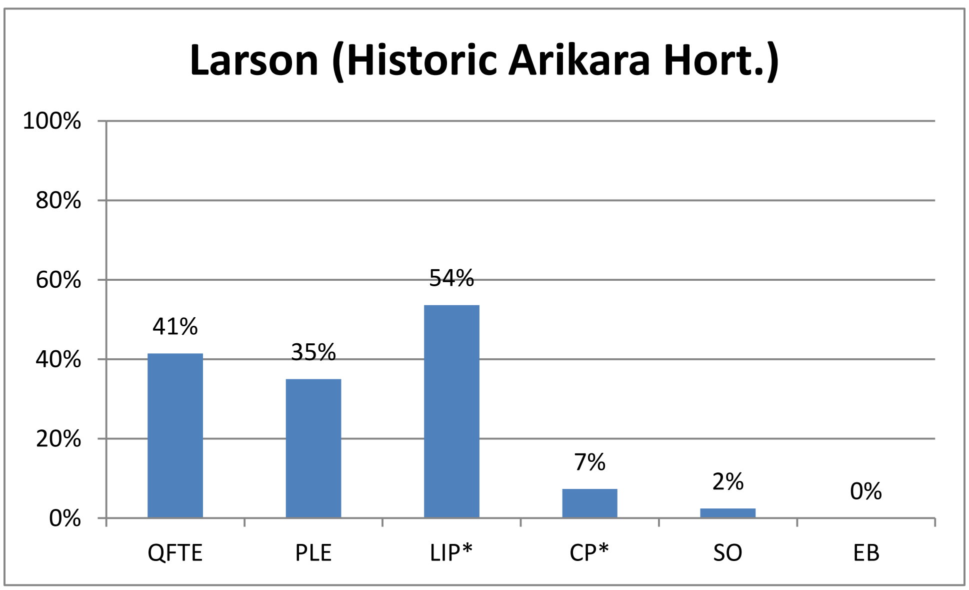

Figure 20. Percent of the Larson group exhibiting patellar pathologies (* indicates a significantly high or low frequency; see Table 42).

Results by Sex

Tables 40 and 41 present the results by sex, with percentages of frequencies illustrated in Figure 21. Among females, there was significant variation in QFT entheses, PL entheses, lipping, and coalesced porosity ($\chi 2$=6.5, df=3, p=0.04), due to extremely low rates of coalesced porosity relative to the other three pathologies (see Table 40). Frequency of QFT entheses, PL entheses, lipping, and coalesced porosity also varied significantly among males ($\chi 2$=18.1, df=3, p< 0.001), due to extremely high lipping and extremely low coalesced porosity (see Table 41). Rates of QFT and PL entheses were roughly the same among males and females, coalesced porosity was slightly more prevalent in females, and surface osteophytes occurred only in a single female. However, the only significant sex difference was in lipping, which was much higher in males than females ($\chi 2$=4.2, df=1, p=0.02).

Table 40. Frequency and Adjusted Residuals of Patellar Pathologies among Females in the Larson Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	12 (-1.32)	9 (1.32)	21
PL Entheses	13 (-0.41)	7 (0.41)	20
Lipping	13 (-0.77)	8 (0.77)	21
Coalesced Porosity	19 (**2.49**)	2 (**-2.49**)	21
Subtotal	57	26	83
Surface Osteophytes	20	1	21
Eburnation	21	0	21
Total	98	27	125

Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.

Table 41. Frequency and Adjusted Residuals of Patellar Pathologies among Males in the Larson Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	12 (-0.27)	8 (0.27)	20
PL Entheses	13 (0.27)	7 (-0.27)	20
Lipping	6 **(-3.47)**	14 **(3.47)**	20
Coalesced Porosity	19 **(3.47)**	1 **(-3.47)**	20
Subtotal	50	30	80
Surface Osteophytes	20	0	20
Eburnation	20	0	20
Total	90	30	120
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalescent porosity are shown in parentheses; bold indicates a significant result.			

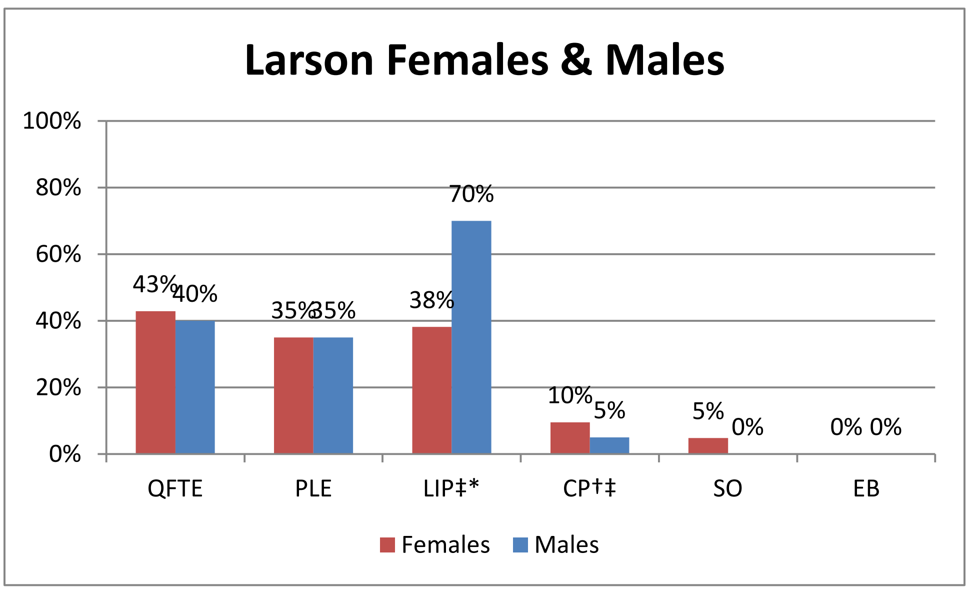

Figure 21. Percent of Larson females and males exhibiting patellar pathologies († indicates a significantly low frequency among females; ‡ indicates a significantly high or low frequency among males; * indicates a significant difference between sexes; see Table 44, Table 45, and Appendix B).

Results by Age

Age data were unavailable for the Larson site.

Results by Component

Component data were not available for the Larson site.

Texas

Hitzfelder Cave (41BX26, Archaic Hunter-Gatherers)

Results by Group

As this collection is commingled, it is possible that at least some of the 27 right patellae could match with some of the 21 left patellae. This could potentially inflate the frequencies of patellar pathologies if they occur bilaterally and both patellae of an individual were examined. Table 42 presents the occurrence of patellar pathologies found in the Hitzfelder Cave sample. Percentages of the group affected are depicted in Figure 22. Chi-square analysis of QFT entheses, PL entheses, lipping, coalesced porosity, surface osteophytes, and eburnation indicates significant variation ($\chi2=57.5$, df=5, $p< 0.0000000001$). Adjusted residuals indicate very high QFT entheses and high PL entheses, low surface osteophytes and eburnation, and very low coalesced porosity (see Table 42). The variation in patellar pathology remains significant even when surface osteophytes and eburnation are removed, as done for other sites ($\chi2=34.8$, df=3, $p< 0.0000001$). In this case, high QFT entheses and extremely low coalesced porosity still accounts for the variation.

Table 42. Frequency and Adjusted Residuals of Patellar Pathologies in the Hitzfelder Cave Group, Sexes Combined.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	20 **(-3.87)** **[-5.26]**	28 **(3.87)** **[5.26]**	48
PL Entheses	28 (-1.07) **[-2.42]**	20 (1.07) **[2.42]**	48
Lipping	29 (-0.50) [-1.82]	18 (0.50) [1.82]	47
Coalesced Porosity	46 **(5.48)** **[4.26]**	1 **(-5.48)** **[-4.26]**	47
Subtotal	123	67	190
Surface Osteophytes	41 **[2.47]**	6 **[-2.47]**	47
Eburnation	42 **[2.83]**	5 **[-2.83]**	47
Total	206	78	284
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; adjusted residuals of all six pathologies are shown in brackets; bold indicates a significant result.			

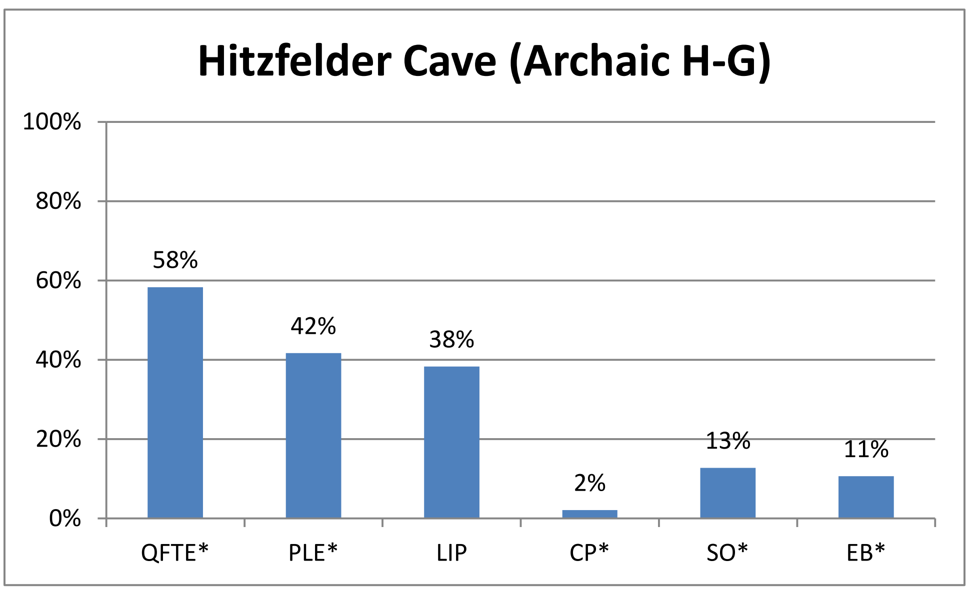

Figure 22. Percent of the Hitzfelder Cave group exhibiting patellar pathologies (* indicates a significantly high or low frequency; see Table 46).

Results by Sex

Due to the commingled nature of the collection, sex estimations have bit been established for Hitzfelder Cave.

Results by Age

Age data were not available for Hitzfelder Cave.

Results by Component

Component information was unavailable for this site.

Mitchell Ridge (41GV66, Late Prehistoric–Historic Hunter-Gatherers)

Results by Group

Table 43 presents the occurrence of patellar pathologies found in the Mitchell Ridge sample. Percentages of the group affected are depicted in Figure 23. Surface osteophytes were not observed, but eburnation was present in one individual. These patellar pathologies were excluded from further analysis. Chi-square analysis of QFT entheses, PL entheses, lipping, and coalesced porosit shows significant variation in these pathologies ($\chi 2=8.2$, df=3, p=0.02). Adjusted residuals show much of this variation is due to very low rates of coalesced porosity relative to the other pathologies (see Table 43).

Table 43. Frequency and Adjusted Residuals of Patellar Pathologies in the Mitchell Ridge Group, Sexes Combined.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	9 (-0.14)	8 (0.14)	17
PL Entheses	6 (-1.83)	11 (1.83)	17
Lipping	8 (-0.70)	9 (0.70)	17
Coalesced Porosity	14 (**2.67**)	3 (**-2.67**)	17
Subtotal	37	31	68
Surface Osteophytes	17	0	17
Eburnation	16	1	17
Total	70	32	102

Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.

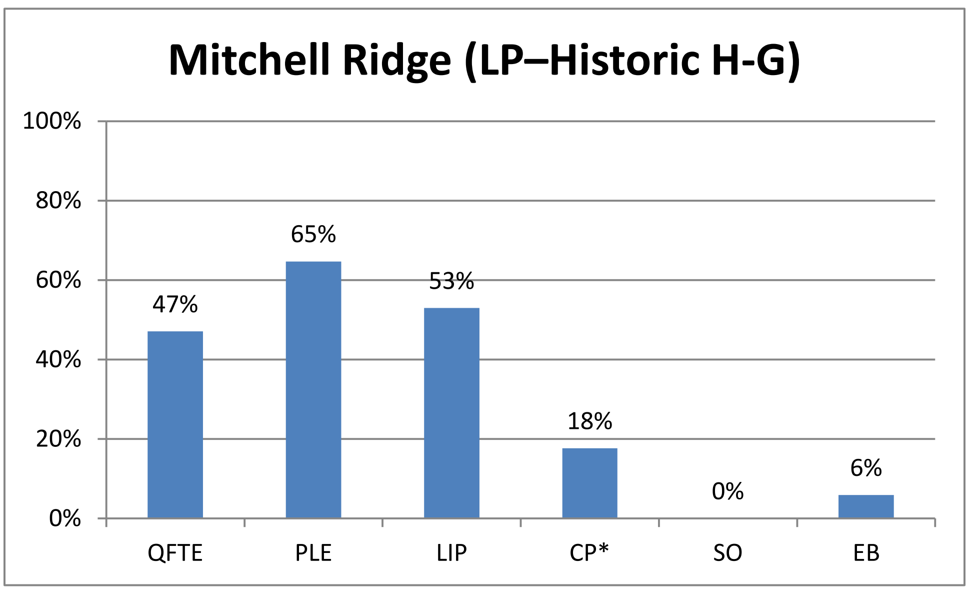

Figure 23. Percent of the Mitchell Ridge group exhibiting patellar pathologies (*indicates a significantly low frequency; see Table 43).

Results by Sex

Tables 44 and 45 present the results by sex, with percentages of frequencies illustrated in Figure 24. There was no significant variation in patellar pathologies among females. Among males, however, the difference between QFT entheses, PL entheses, lipping, and coalesced porosity was significant ($\chi 2=9.2$, df=3, $p=0.01$) due to a very low frequency of coalesced porosity (see Table 45). In all cases, males exhibited higher frequencies of all types of patellar pathologies, in some cases more than twice as high; however, the low overall sample size of Mitchell Ridge and the uneven distribution of males and females in this sample should be reiterated. Nevertheless, significant sex differences were detected in QFT entheses ($\chi 2=5.4$, df=1, $p=0.011556$) and lipping ($\chi 2=3.1$, df=1, $p=0.04928$).

Table 44. Frequency and Adjusted Residuals of Patellar Pathologies among Females in the Mitchell Ridge Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	6 (0.76)	1 (-0.76)	7
PL Entheses	4 (-1.26)	3 (1.26)	7
Lipping	5 (-0.25)	2 (0.25)	7
Coalesced Porosity	6 (0.76)	1 (-0.76)	7
Subtotal	21	7	28
Surface Osteophytes	7	0	7
Eburnation	7	0	7
Total	35	7	42
Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.			

Table 45. Frequency and Adjusted Residuals of Patellar Pathologies among Males in the Mitchell Ridge Group.

PATHOLOGY	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
QFT Entheses	3 (-0.75)	7 (0.75)	10
PL Entheses	2 (-1.49)	8 (1.49)	10
Lipping	3 (-0.75)	7 (0.75)	10
Coalesced Porosity	8 (**2.98**)	2 (**-2.98**)	10
Subtotal	16	24	40
Surface Osteophytes	10	0	10
Eburnation	9	1	10
Total	35	25	60

Notes: coalesced porosity, surface osteophytes, and eburnation were scored on an absence/presence basis; adjusted residuals of QFT entheses, PL entheses, lipping, and coalesced porosity are shown in parentheses; bold indicates a significant result.

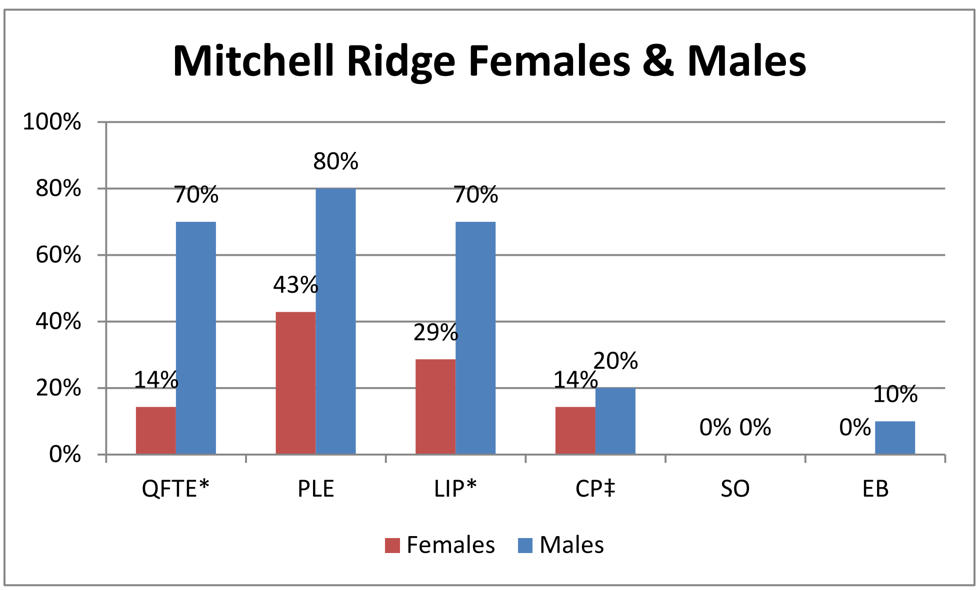

Figure 24. Percent of Mitchell Ridge females and males exhibiting patellar pathologies (‡ indicates a significantly low frequency among males; * indicates a significant difference between sexes; see Table 44, Table 45, and Appendix B).

Results by Age

Due to the overlapping nature of the age estimations provided, analysis by age was not possible.

Results by Component

Due to the small sample size, analysis by component was not examined.

Comparison of Texas Sites

Chi-square tests-of-independence were conducted to determine if the two sites in Texas varied in frequency of patellar pathologies. Chi-square analysis indicates that the two Texas sites were similar, varying significantly only in the frequency of coalesced porosity (Table 46). Adjusted residuals indicate that individuals buried at Hitzfelder Cave had a much lower rate of coalesced porosity than Mitchell Ridge inhabitants (Table 47). The two groups also differed significantly in the frequency of surface osteophytes, although the magnitude of the difference as determined by adjusted residuals was not significant (Table 48).

Table 46. Results of Chi-Square Analysis of the Texas Sites.

	QFTE	PLE	LIP	CP	SO	EB
Sexes Combined	$\chi2$=0.6, df=1, p=0.36	$\chi2$=2.7, df=1, p=0.06	$\chi2$=1.1, df=1, p=0.22	**$\chi2$=4.4, df=1, p=0.02**	**$\chi2$=3.2, df=1, p=0.05**	$\chi2$=0.8, df=1, p=0.31
Note: bold indicates a significant result.						

Table 47. Frequency and Adjusted Residuals of QFT Entheses, PL Entheses, Lipping, and Coalesced Porosity among the Texas Groups, Sexes Combined.

SITE	QFTE			PLE			LIP			CP		
	A/M	M/S	T	A/M	M/S	T	A/M	M/S	T	A	P	T
Hitzfelder Cave	20 (-0.80)	28 (0.80)	48	28 (1.63)	20 (-1.63)	48	29 (1.05)	18 (-1.05)	47	46 **(2.27)**	1 **(-2.27)**	47
Mitchell Ridge	9 (0.80)	8 (-0.80)	17	6 (-1.63)	11 (1.63)	17	8 (-1.05)	9 (1.05)	17	14 **(-2.27)**	3 **(2.27)**	17
Total	29	36	65	34	31	65	37	27	64	60	4	64
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

Table 48. Frequency and Adjusted Residuals of Surface Osteophytes and Eburnation among the Texas Groups, Sexes Combined.

SITE	SO			EB		
	ABSENT	PRESENT	TOTAL	ABSENT	PRESENT	TOTAL
Hitzfelder Cave	41 (-1.55)	6 (1.55)	47	42 (-0.58)	5 (0.58)	47
Mitchell Ridge	17 (1.55)	0 (-1.55)	17	16 (0.58)	1 (-0.58)	17
Total	58	6	64	58	6	64
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.						

Between-Group Comparisons

Comparisons by Patellar Pathologies

Chi-square tests-of-independence were conducted to determine if the six sites varied in frequency of QFT entheses, PL entheses, lipping, and coalesced porosity (Table 49). Surface osteophytes and eburnation were rare in all groups, and thus were excluded from chi-square analysis. Among all six sites, QFT entheses, PL entheses, lipping, and coalesced porosity varied significantly. When the five sites with sex estimations (Eva, Thompson Village, Averbuch, Larson, and Mitchell Ridge) were compared, these differences remain significant, except for QFT entheses among males.

Table 49. Results of Chi-Square Analysis of Comparative Groups.

	QFTE	**PLE**	**LIP**	**CP**
Sexes Combined	**$\chi2$=10.3, df=5, p=0.03**	**$\chi2$=14.1, df=5, p<0.01**	**$\chi2$=15.1, df=5, p<0.01**	**$\chi2$=42.0, df=5, p<0.0000001**
Females	**$\chi2$=12.2, df=4, p<0.01**	**$\chi2$=9.9, df=4, p=0.02**	**$\chi2$=10.2, df=4, p<0.02**	**$\chi2$=23.2, df=4, p<0.0001**
Males	$\chi2$=5.3, df=4, p=0.09	**$\chi2$=9.9, df=4, p=0.02**	**$\chi2$=8.5, df=4, p=0.03**	**$\chi2$=7.1, df=4, p=0.05**
Notes: bold indicates a significant result; the Females and Males groups do not include data from Hitzfelder Cave.				

QFT Entheses

The rates of QFT entheses varied significantly between the six groups, although the strength of the association as measured by adjusted residuals was not significant (Table 50). The frequency of QFT entheses also differed significantly between females from the five sites with available sex data (see Table 49). The high rate of QFT entheses in Thompson Village females and the low rate among Mitchell Ridge females contribute most significantly to this variation (see Figure 25; Table 51). The difference in QFT entheses among males in the five groups was not significant (see Table 49). The adjusted residuals also did not indicate any significant trends in direction or strength of variation (Table 52). While there is a modest disparity in QFT entheses between females and males at Thompson Village, with females showing a 25 percent higher rate, it was not statistically significant (Figure 25). At Mitchell Ridge, there is a quite significant disparity between the sexes, with males exhibiting more than three times the rate of moderate to severe QFT entheseal development ($\chi 2=5.4$, df=1, p=0.01).

Table 50. Frequency and Adjusted Residuals for QFT Entheses among Comparative Groups, Sexes Combined.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	24 (1.88)	16 (-1.88)	40
Thompson Village	12 (-1.59)	23 (1.59)	35
Averbuch	14 (-1.63)	26 (1.63)	40
Larson	24 (1.70)	17 (-1.70)	41
Mitchell Ridge	9 (0.54)	8 (-0.54)	17
Hitzfelder Cave	20 (-0.78)	28 (0.78)	48
Total	103	118	221
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

Table 51. Frequency and Adjusted Residuals for QFT Entheses among Females in Comparative Groups.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	13 (1.53)	7 (-1.53)	20
Thompson Village	4 (**-2.65**)	14 (**2.65**)	18
Averbuch	8 (-1.02)	12 (1.02)	20
Larson	12 (0.75)	9 (-0.75)	21
Mitchell Ridge	6 (**1.97**)	1 (**-1.97**)	7
Total	43	43	86
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

Table 52. Frequency and Adjusted Residuals for QFT Entheses among Males in Comparative Groups.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	11 (0.92)	9 (-0.92)	20
Thompson Village	8 (0.10)	9 (-0.10)	17
Averbuch	6 (-1.63)	14 (1.63)	20
Larson	12 (1.43)	8 (-1.43)	20
Mitchell Ridge	3 (-1.08)	7 (1.08)	10
Total	40	47	87
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

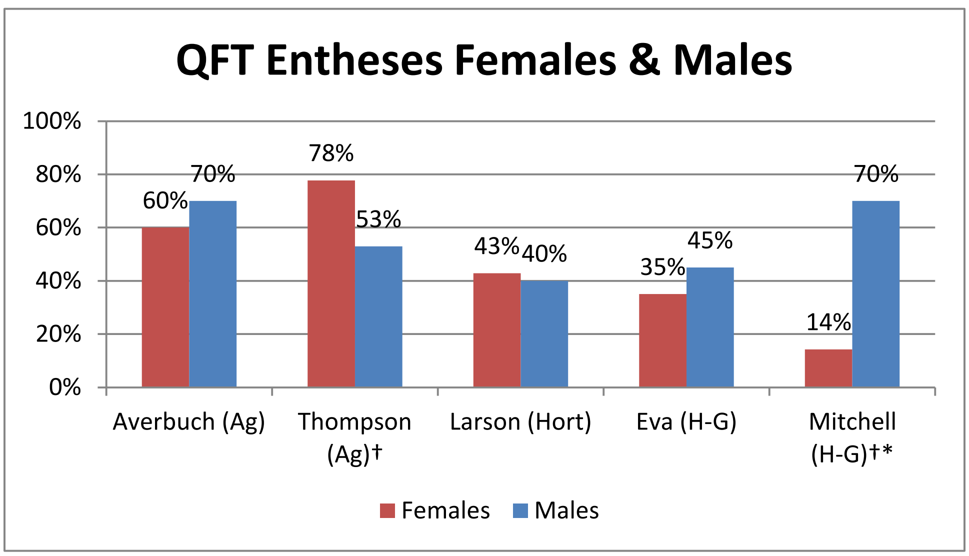

Figure 25. Percent of QFT entheses exhibited by sex († indicates a significantly high or low frequency among females; * indicates a significant difference between sexes; see Table 55 and Appendix B).

PL Entheses

There was significant variability in the rates of PL entheses between the six groups and for both sexes at the five sites with available sex data (see Table 49). PL entheses were significantly higher at Eva and lower at Thompson Village (Table 53). Eva females had significantly higher PL entheses than expected, while Thompson Village females had significantly lower PL entheses (Table 54). Males at Mitchell Ridge had much higher PL entheses than males in the other groups (Table 55). There is no disparity between the sexes in PL entheses at Thompson Village and Larson (Figure 26). Females at Averbuch and Eva have higher rates of PL entheses than males, although the differences are not statistically significant. At Mitchell Ridge, the frequency of moderate to severe PL entheses in males is nearly twice that of females, although it also is not quite significant at the p=0.05 level.

Table 53. Frequency and Adjusted Residuals for PL Entheses among Comparative Groups, Sexes Combined.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	16 **(-2.51)**	14 **(2.51)**	40
Thompson Village	29 **(2.31)**	10 **(-2.31)**	39
Averbuch	25 (0.46)	16 (-0.46)	41
Larson	26 (1.02)	14 (-1.02)	40
Mitchell Ridge	6 (-1.95)	11 (1.95)	17
Hitzfelder Cave	28 (0.09)	20 (-0.09)	48
Total	130	95	225
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

Table 54. Frequency and Adjusted Residuals for PL Entheses among Females in Comparative Groups.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	6 **(-2.63)**	14 **(2.63)**	20
Thompson Village	16 **(2.17)**	5 **(-2.17)**	21
Averbuch	10 (0.58)	10 (0.58)	20
Larson	13 (0.95)	7 (-0.95)	20
Mitchell Ridge	4 (0.08)	3 (-0.08)	7
Total	49	39	88
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

Table 55. Frequency and Adjusted Residuals for PL Entheses among Males in Comparative Groups.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	10 (-0.99)	10 (0.99)	20
Thompson Village	13 (1.23)	5 (-1.23)	18
Averbuch	15 (1.27)	6 (-1.27)	21
Larson	13 (0.56)	7 (-0.56)	20
Mitchell Ridge	2 **(-2.70)**	8 **(2.70)**	10
Total	53	36	89
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

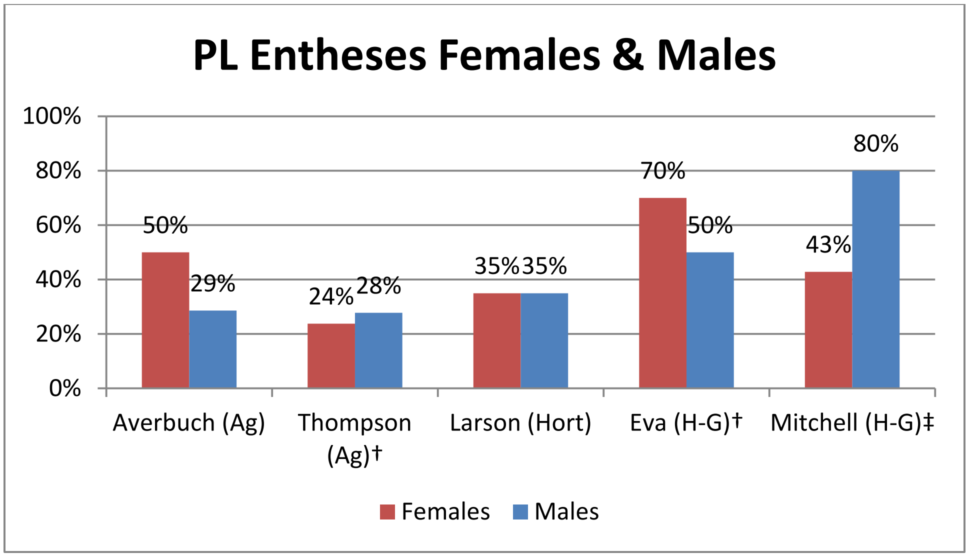

Figure 26. Percent of PL entheses exhibited by sex († indicates a significantly high or low frequency among females; ‡ indicates a significantly high result among males; see Tables 55 and 56).

QFT versus PL Entheses

In the Averbuch and Thompson Village groups, QFT entheses are significantly higher than PL entheses (Averbuch $\chi2$=5.5, df=1, p=0.01; Thompson Village $\chi2$=12.0, df=1, p< 0.001), while in the Larson and Hitzfelder Cave samples the QFT entheses are only marginally higher (Figure 27). The Hitzfelder Cave sample also exhibits higher QFT entheses, although the difference is not significant. At Eva and Mitchell Ridge, PL entheses were higher than QFT entheses, although only the difference in the Eva sample was significant ($\chi2$=3.2, df=1, p=0.05).

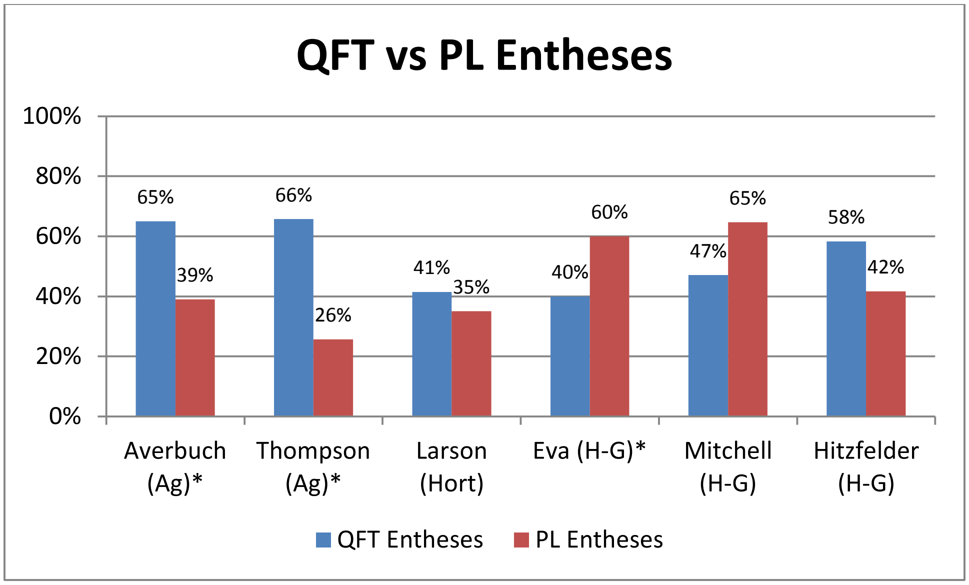

Figure 27. Percent of QFT entheses vs PL entheses exhibited (* indicates a significant difference between frequency of QFT and PL entheses; see Appendix B).

Averbuch and Larson females exhibit slightly higher rates QFT entheses than PL entheses (Figure 28), while females at Thompson Village have much higher rates of QFT entheses ($\chi 2=11.3$, df=1, $p<0.001$). Females at Eva and Mitchell Ridge show the reverse trend, with PL entheses occurring at much higher rates than QFT entheses, although the difference is only statistically significant at Eva ($\chi 2=4.9$, df=1, $p=0.02$). Averbuch, Thompson Village, and Larson males exhibit higher rates QFT entheses than PL entheses (Figure 29), although only significantly so at Averbuch ($\chi 2=7.0$, df=1, $p< 0.01$). Males at Eva and Mitchell Ridge show the reverse trend, with PL entheses occurring at slightly higher rates than QFT entheses, although the difference is not statistically significant.

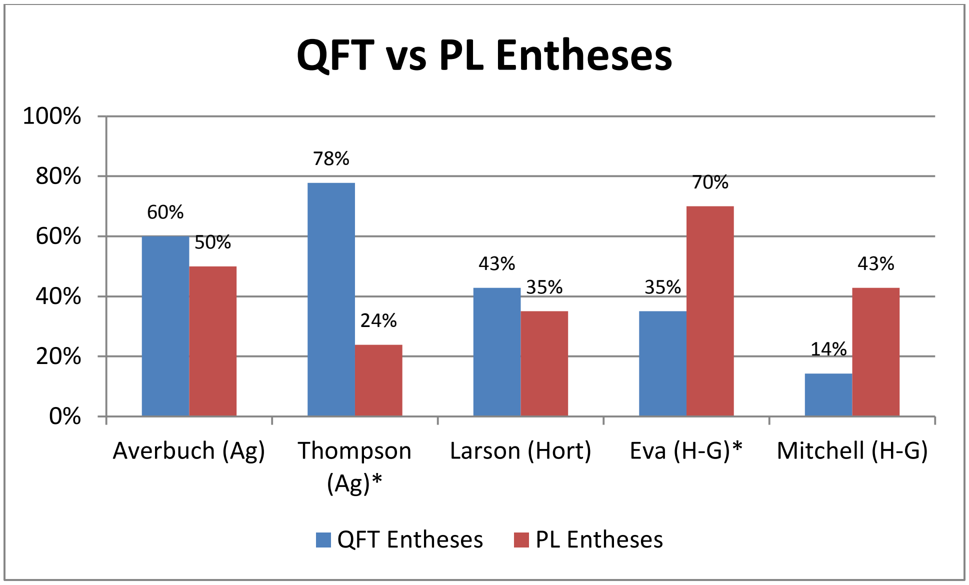

Figure 28. Percent of entheses exhibited among females (* indicates a significant difference between QFT and PL entheses; see Appendix B).

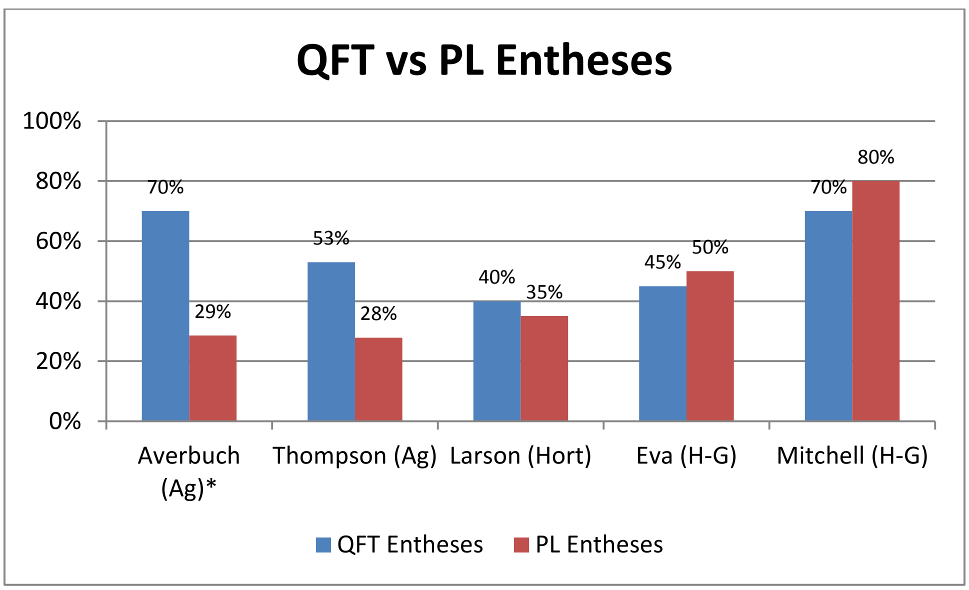

Figure 29. Percent of entheses exhibited among males (* indicates a significant difference between QFT and PL entheses; see Appendix B).

Lipping

The rates of lipping varied significantly among the six groups, as well as among females and males at the five sites with available sex data (see Table 54). Rates of moderate to severe lipping were highest at Averbuch and lowest at Thompson Village (Table 56, Figure 30).

Table 56. Frequency and Adjusted Residuals for Lipping among Comparative Groups, Sexes Combined.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	26 (1.44)	14 (-1.44)	40
Thompson Village	25 (**2.16**)	10 (**-2.16**)	35
Averbuch	14 (**-2.94**)	27 (**2.94**)	41
Larson	19 (-1.20)	22 (1.20)	41
Mitchell Ridge	8 (-0.66)	9 (0.66)	17
Hitzfelder Cave	29 (1.08)	18 (-1.08)	47
Total	121	100	221
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

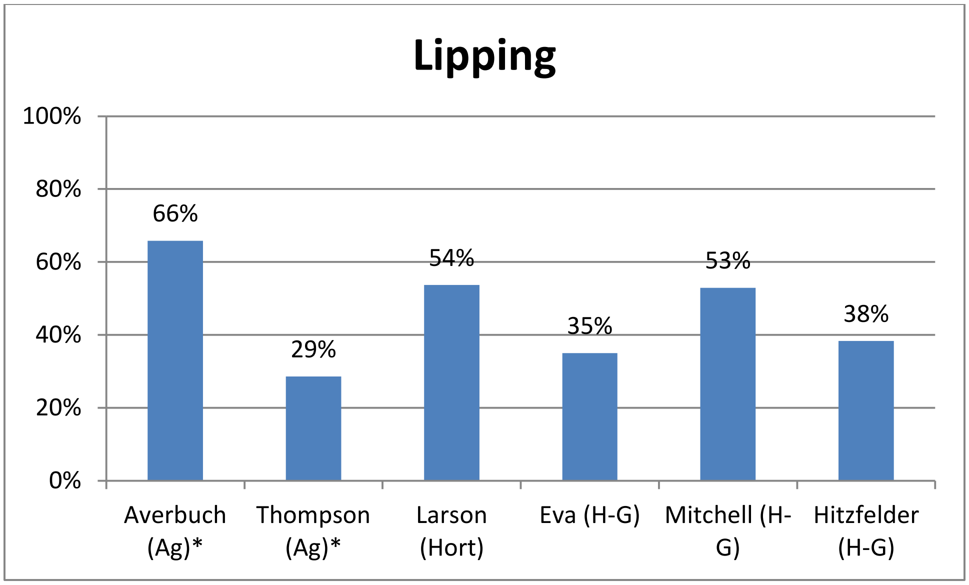

Figure 30. Percent of lippingexhibited (* indicates a significantly high or low frequency; see Table 56, Appendix B).

Females at Averbuch exhibited quite high frequencies of lipping, while males at Thompson Village exhibited much lower frequencies than expected (Tables 57 and 58). Lipping was slightly higher in females than males at Averbuch, and slightly higher in males at Thompson Village and Eva (Figure 31). However, lipping was significantly higher in males at Larson ($\chi2=4.2$, df=1, p=0.02) and at Mitchell Ridge ($\chi2=3.1$, df=1, p=0.05).

Table 57. Frequency and Adjusted Residuals for Lipping among Females in Comparative Groups.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	14 (1.06)	6 (-1.06)	20
Thompson Village	14 (1.40)	5 (-1.40)	19
Averbuch	6 (**-3.09**)	14 (**3.09**)	20
Larson	13 (0.23)	8 (-0.23)	21
Mitchell Ridge	5 (0.66)	2 (-0.66)	7
Total	52	35	87
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

Table 58. Frequency and Adjusted Residuals for Lipping among Males in Comparative Groups.

SITE	ABSENT/ MILD	MODERATE/ SEVERE	TOTAL
Eva	12 (1.43)	8 (-1.43)	20
Thompson Village	11 (**2.02**)	5 (**-2.02**)	16
Averbuch	8 (-0.83)	13 (0.83)	21
Larson	6 (-1.63)	14 (1.63)	20
Mitchell Ridge	3 (-1.08)	7 (1.08)	10
Total	40	47	87
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

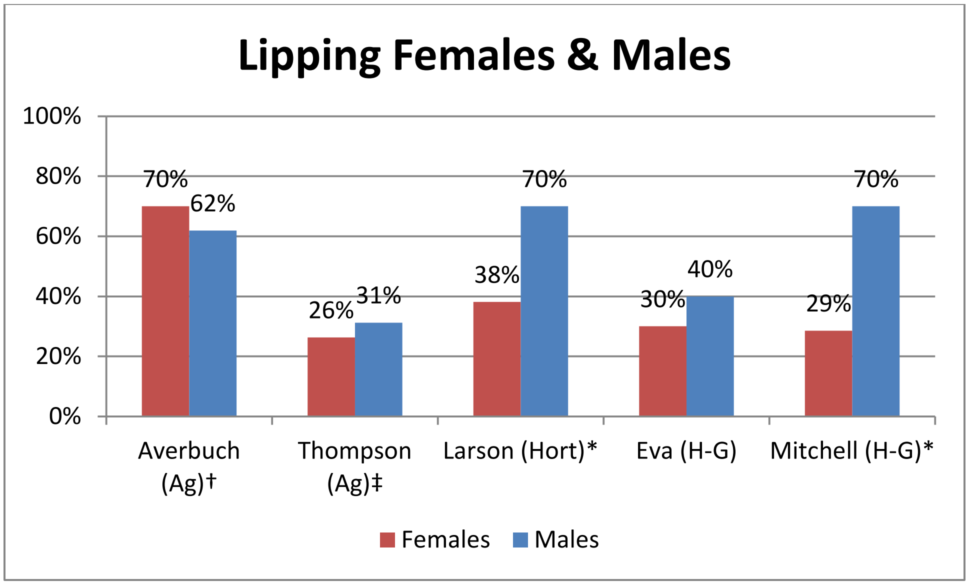

Figure 31. Percent of lipping by sex († indicates a significantly high frequency among females; ‡ indicates a significantly low frequency among males; * indicates a significant difference between sexes; see Table 56, Table 57, and Appendix B).

Coalesced Porosity

Coalesced porosity rates were quite variable among the six groups and among females and females from the five groups with sex data (see Table 54). Coalesced porosity was highest at Averbuch and Thompson Village (Table 59, Figure 32). Frequencies were lowest at Eva, Larson, and Hitzfelder Cave.

Table 59. Frequency and Adjusted Residuals for Coalesced Porosity among Comparative Groups, Sexes Combined.

SITE	ABSENT	PRESENT	TOTAL
Eva	37 **(2.09)**	3 **(-2.09)**	40
Thompson Village	24 **(-3.95)**	17 **(3.95)**	41
Averbuch	24 **(-3.95)**	17 **(3.95)**	41
Larson	38 **(2.16)**	3 **(-2.16)**	41
Mitchell Ridge	14 (0.19)	3 (-0.19)	17
Hitzfelder Cave	46 **(3.36)**	1 **(-3.36)**	47
Total	183	44	227
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

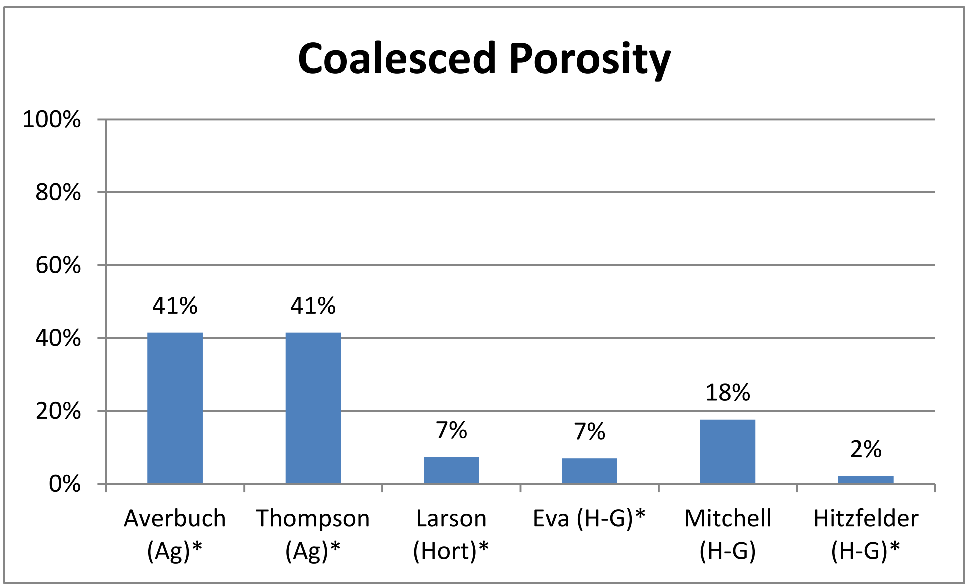

Figure 32. Percent of coalesced porosity exhibited (* indicates a significantly high or low frequency; see Table 58 and Appendix B).

Among females, frequencies were highest at Averbuch and Thompson, and lowest at Larson and Eva (Table 60). Larson males exhibited a lower frequency than expected (Table 61). Coalesced porosity is significantly higher in females than males at Averbuch

($\chi 2$=2.9, df=1, p=0.05), and marginally so at Thompson Village and Larson (Figure 33). The reverse trend occurs at Eva ($\chi 2$=3.6, df=1, p=0.03), with males having higher rates of coalesced porosity than females.

Table 60. Frequency and Adjusted Residuals for Coalesced Porosity among Females in Comparative Groups.

SITE	ABSENT	PRESENT	TOTAL
Eva	20 **(3.06)**	0 **(-3.06)**	20
Thompson Village	12 **(-2.29)**	10 **(2.29)**	22
Averbuch	9 **(-3.25)**	11 **(3.25)**	20
Larson	19 **(2.03)**	2 **(-2.03)**	21
Mitchell Ridge	6 (0.77)	1 (-0.77)	7
Total	66	24	90
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

Table 61. Frequency and Adjusted Residuals for Coalesced Porosity among Males in Comparative Groups.

SITE	ABSENT	PRESENT	TOTAL
Eva	17 (0.76)	3 (-0.76)	20
Thompson Village	12 (-1.89)	7 (1.89)	19
Averbuch	15 (-0.96)	6 (0.96)	21
Larson	19 **(2.00)**	1 **(-2.00)**	20
Mitchell Ridge	8 (0.09)	2 (-0.09)	10
Total	71	19	90
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.			

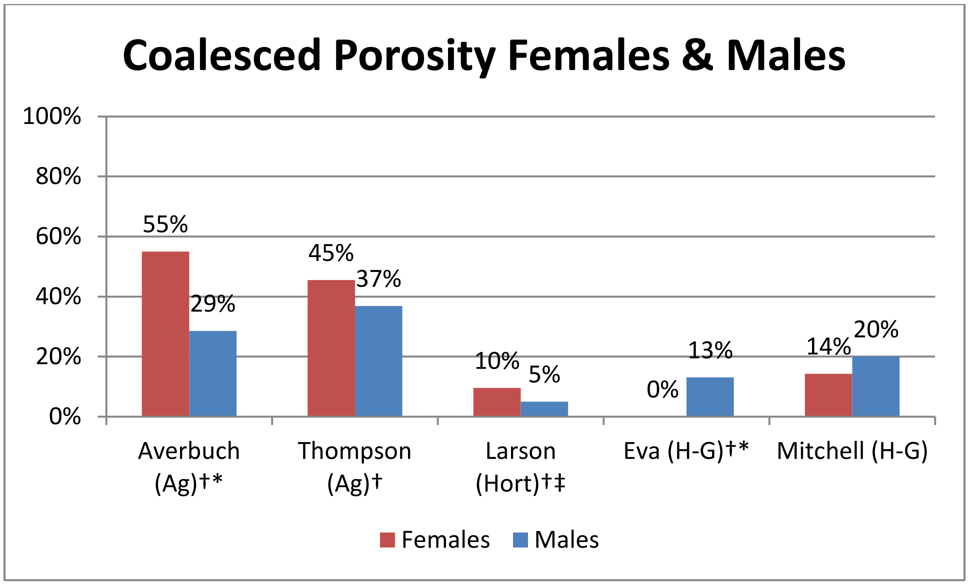

Figure 33. Percent of coalesced porosity by sex († indicates a significantly high or low frequency among females; ‡ indicates a significantly low frequency among males; * indicates a significant difference between sexes; see Table 60, Table 61, and Appendix B).

Surface Osteophytes and Eburnation

These pathologies were rare to absent in all groups. Surface osteophytes were found on individuals at Averbuch (n=1, 2%), Hitzfelder Cave (n=6, 13%), and Larson (n=1, 2%). Eburnation only occurred at Hitzfelder Cave (n=5, 11%) and Mitchell Ridge (n=1, 6%).

Comparisons by Subsistence Regimes

Chi-square analysis was conducted to determine if variation in patellar pathologies existed by subsistence regime. Given their rarity, surface osteophytes and eburnation were excluded from these analyses. The first step was to determine if groups that practiced similar subsistence regimes resembled one another in patellar variation.

The second step was to combine group data into three subsistence groups (agriculturalists, hunter-gatherers, and horticulturalists) and compare patellar variations between subsistence regimes. The third step was to compare a group with unknown subsistence practices to these three groups. Although agriculture is not known to have been practiced during the Archaic period in Central Texas, much is unknown about Hitzfelder Cave, and thus it was used as the unknown subsistence strategy in Step 3.

Step 1

A comparison of the Thompson Village and Averbuch groups, both of which practiced agriculture, indicated similarities in QFT entheses, PL entheses, and coalesced porosity between the groups and between males at the two sites (Table 62). However, the Averbuch group did exhibit significantly higher rates of lipping than the Thompson group, and this pattern held among both females and males (Table 63). Among females, the two sites were quite similar in QFT entheses and coalesced porosity, although Averbuch females exhibited significantly higher rates of lipping and PL entheses (Table 64). Among males, the strength of the difference in lipping between the two sites was not significant (Table 65). With the exception of lipping, the Thompson Village and Averbuch sites exhibit a similar pattern of patellar pathology.

Table 62. Results of Chi-Square Analysis of Thompson Village and Averbuch Groups.

SEX	QFTE	PLE	LIP	CP
Sexes Combined	χ2=0.0, df=1, p=6.14	χ2=1.6, df=1, p=0.14	**χ2=10.5, df=1, p<0.001**	samples are identical
Females	χ2=1.4, df=1, p=0.17	**χ2=3.0, df=1, p=0.05**	**χ2=7.4, df=1, p<0.01**	χ2=0.4, df=1, p=0.53
Males	χ2=1.1, df=1, p=0.21	χ2=0.0, df=1, p=7.25	**χ2=3.4, df=1, p=0.04**	χ2=0.3, df=1, p=0.61
Note: bold indicates a significant result.				

Table 63. Frequency and Adjusted Residuals for the Thompson Village and Averbuch Groups, Sexes Combined.

SITE	QFTE			PLE			LIP			CP		
	A/M	M/S	T	A/M	M/S	T	A/M	M/S	T	A	P	T
Thompson Village	12 (-0.06)	23 (0.06)	35	29 (1.28)	10 (-1.28)	39	25 (**3.24**)	10 (**-3.24**)	35	24 (0.00)	17 (0.00)	41
Averbuch	14 (0.06)	26 (-0.06)	40	25 (-1.28)	16 (1.28)	41	14 (**-3.24**)	27 (**3.24**)	41	24 (0.00)	17 (0.00)	41
Total	26	49	75	54	26	80	39	37	76	48	34	82
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

Table 64. Frequency and Adjusted Residuals for Females in the Thompson Village and Averbuch Groups.

SITE	QFTE			PLE			LIP			CP		
	A/M	M/S	T	A/M	M/S	T	A/M	M/S	T	A	P	T
Thompson Village	4 (-1.18)	14 (1.18)	18	16 (1.74)	5 (-1.74)	21	14 (**2.73**)	5 (**-2.73**)	19	12 (0.62)	10 (-0.62)	22
Averbuch	8 (1.18)	12 (-1.18)	20	10 (-1.74)	10 (1.74)	20	6 (**-2.73**)	14 (**2.73**)	20	9 (-0.62)	11 (0.62)	20
Total	12	26	38	26	15	41	20	19	39	21	21	42
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

Table 65. Frequency and Adjusted Residuals for Males in the Thompson Village and Averbuch Groups.

SITE	QFTE			PLE			LIP			CP		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**	**A**	**P**	**T**
Thompson Village	8 (1.07)	9 (-1.07)	17	13 (0.05)	5 (-0.05)	18	11 (1.85)	5 (-1.85)	16	12 (-0.56)	7 (0.56)	19
Averbuch	6 (-1.07)	14 (1.07)	20	15 (-0.05)	6 (0.05)	21	8 (-1.85)	13 (1.85)	21	15 (-0.56)	6 (-0.56)	21
Total	14	23	37	28	11	39	19	18	37	27	13	40
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

Archaeological evidence strongly indicates that the Eva and Mitchell Ridge groups were both hunter-gatherers. No significant difference was found between the two groups in QFT entheses, PL entheses, lipping, or coalesced porosity (Table 66). No statistically significant results were obtained from a comparison of females from the two sites. Similarly, no significant difference was detected in patellar pathologies among males. The two groups exhibit a similar pattern of patellar pathologies.

Table 66. Results of Chi-Square Analysis of Eva and Mitchell Ridge Groups.

SEX	QFTE	PLE	LIP	CP
Sexes Combined	χ2=0.2, df=1, p=0.72	χ2=0.1, df=1, p=1.13	χ2=1.6, df=1, p=0.14	χ2=1.3, df=1, p=0.18
Females	χ2=1.5, df=1, p=0.15	χ2=1.7, df=1, p=0.13	χ2=0.2, df=1, p=0.70	χ2=2.5, df=1, p=0.07
Males	χ2=1.8, df=1, p=0.12	χ2=2.7, df=1, p=0.06	χ2=2.4, df=1, p=0.08	χ2=0.3, df=1, p=0.61
Notes: bold indicates a significant result.				

Step 2

Data were combined into groups by subsistence regime, with Thompson Village and Averbuch representing agriculturalists, Eva and Mitchell Ridge comprising hunter-gatherers, and Larson representing horticulturalists. Significant differences exist between the three subsistence regimes in QFT entheses, PL entheses, and coalesced porosity (Table 67). The difference in lipping between the three groups was not quite significant. The agriculturalist group had a high frequency of QFT entheses (Table 68). They also had extremely low PL entheses, whereas the hunter-gatherers had very high PL entheses. For coalesced porosity, agriculturalists had a very high rate, while horticulturalists and hunter-gatherers had a significantly lower rate.

Table 67. Results of Chi-Square Analysis of Agriculturalists vs Hunter-Gatherers vs Horticulturalists.

SEX	QFTE	PLE	LIP	CP
Sexes Combined	**$\chi 2=9.4$, df=2, $p<0.01$**	**$\chi 2=23.4$, df=2, $p<0.00001$**	$\chi 2=4.1$, df=2, $p=0.06$	**$\chi 2=20.0$, df=2, $p<0.0001$**
Females	**$\chi 2=10.1$, df=2, $p<0.01$**	**$\chi 2=11.5$, df=2, $p<0.01$**	$\chi 2=3.2$, df=2, $p=0.10$	**$\chi 2=21.0$, df=2, $p<0.0001$**
Males	$\chi 2=2.6$, df=2, $p=0.14$	**$\chi 2=12.4$, df=2, $p=0.001$**	$\chi 2=3.8$, df=2, $p=0.07$	**$\chi 2=6.1$, df=2, $p=0.02$**
Notes: bold indicates a significant result.				

Table 68. Frequency and Adjusted Residuals for Agriculturalists vs Hunter-Gatherers vs. Horticulturalists, Sexes Combined.

SUBSISTENCE REGIME	**QFTE**			**PLE**			**LIP**			**CP**		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**	**A**	**P**	**T**
Agriculturalists	26 (**-3.07**)	49 (**3.07**)	75	54 (**2.41**)	26 (**-2.41**)	80	39 (-0.36)	37 (0.36)	76	48 (**-5.06**)	34 (**5.06**)	82
Hunter-Gatherers	33 (1.83)	24 (-1.83)	57	22 (**-3.53**)	35 (**3.53**)	57	34 (1.25)	23 (-1.25)	57	51 (**2.86**)	6 (**-2.86**)	57
Horticulturalists	24 (1.55)	17 (-1.55)	41	26 (1.07)	14 (-1.07)	40	19 (-0.96)	22 (0.96)	41	38 (**2.83**)	3 (**-2.83**)	41
Total	83	90	173	102	75	177	92	82	174	137	43	180
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

When examined by sex, these differences remain. Females exhibited significant differences in QFT entheses, PL entheses, and coalesced porosity. Female agriculturalists had high QFT entheses, while female hunter-gatherers had very low QFT entheses (Table 69). PL entheses were high in hunter-gatherer females. Agriculturalist females had an extremely high incidence of coalesced porosity, while horticulturalists and hunter-gatherer females were very low. Males differed in frequency of PL entheses and coalesced porosity. Hunter-gatherer males had a high occurrence of PL entheses, while agriculturalist males were lo in PL entheses (Table 70). For coalesced porosity, agriculturalist males were high, and horticulturalist males were low.

Table 69. Frequency and Adjusted Residuals for Female Agriculturalists vs Hunter-Gatherers vs. Horticulturalists.

SUBSISTENCE REGIME	**QFTE**			**PLE**			**LIP**			**CP**		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**	**A**	**P**	**T**
Agriculturalists	12 (**-3.04**)	26 (**3.04**)	38	26 (1.36)	15 (-1.36)	41	20 (-1.46)	19 (1.46)	39	21 (**-4.68**)	21 (**4.68**)	42
Hunter-Gatherers	19 (**2.56**)	8 (**-2.56**)	27	10 (**-2.34**)	17 (**2.34**)	27	19 (1.35)	8 (-1.35)	27	26 (**3.22**)	1 (**-3.22**)	27
Horticulturalists	12 (0.75)	9 (-0.75)	21	13 (0.95)	7 (-0.95)	20	13 (0.23)	8 (-0.23)	21	19 (**2.03**)	2 (**-2.03**)	21
Total	43	43	86	49	39	88	52	35	87	66	24	90
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

Table 70. Frequency and Adjusted Residuals for Male Agriculturalists vs Hunter-Gatherers vs. Horticulturalists.

SUBSISTENCE REGIME	**QFTE**			**PLE**			**LIP**			**CP**		
	A/M	**M/S**	**T**	**A/M**	**M/S**	**T**	**A/M**	**M/S**	**T**	**A**	**P**	**T**
Agriculturalists	14 (-1.31)	23 (1.31)	37	28 (**2.08**)	11 (**-2.08**)	39	19 (0.87)	18 (-0.87)	37	27 (**-2.37**)	13 (**2.37**)	40
Hunter-Gatherers	14 (0.09)	16 (-0.09)	30	12 (**-2.68**)	18 (**2.68**)	30	15 (0.55)	15 (-0.55)	30	25 (0.73)	5 (-0.73)	30
Horticulturalists	12 (1.43)	8 (-1.43)	20	13 (0.56)	7 (-0.56)	20	6 (-1.63)	14 (1.63)	20	19 (**2.00**)	1 (**-2.00**)	20
Total	40	47	87	53	36	89	40	47	87	71	19	90
Notes: adjusted residuals are shown in parentheses; bold indicates a significant result.												

To determine whether any of the patterns of one subsistence regime more closely resembled that of any of the other, each subsistence regime was compared separately against the other two regimes. As a whole, agriculturalists differed quite significantly from hunter-gatherers in QFT entheses, PL entheses, and coalesced porosity (Table 71). When examined by sex, females still differed in QFT entheses, PL entheses, and coalesced porosity, but males differed only in PL entheses.

Table 71. Results of Chi-Square Analysis of Agriculturalists vs. Hunter-Gatherers.

SEX	QFTE	PLE	LIP	CP
Sexes Combined	**χ2=7.1, df=1, p<0.01**	**χ2=11.3, df=1, p<0.001**	χ2=0.9, df=1, p=0.26	**χ2=15.7, df=1, p<0.0001**
Females	**χ2=9.5, df=1, p<0.01**	**χ2=4.5, df=1, p=0.02**	χ2=2.4, df=1, p=0.08	**χ2=16.2, df=1, p<0.0001**
Males	χ2=0.5, df=1, p=0.42	**χ2=7.0, df=1, p<0.01**	χ2=0.0, df=1, p=3.60	χ2=2.2, df=1, p=0.09
Notes: bold indicates a significant result.				

Comparison of agriculturalists versus horticulturalists indicates that the two groups are very similar in PL entheses and lipping among combined sexes and among females (Table 72). Males are similar in these two pathologies as well as in QFT entheses. However, the groups differ in QFT entheses (combined sexes and females) and coalesced porosity.

Table 72. Results of Chi-Square Analysis of Agriculturalists vs. Horticulturalists.

SEX	QFTE	PLE	LIP	CP
Sexes Combined	**χ2=6.2, df=1, p<0.01**	χ2=0.1, df=1, p=1.40	χ2=0.3, df=1, p=0.68	**χ2=15.2, df=1, p<0.0001**
Females	**χ2=3.7, df=1, p=0.03**	χ2=0.0, df=1, p=3.27	χ2=0.6, df=1, p=0.37	**χ2=9.9, df=1, p<0.001**
Males	χ2=2.6, df=1, p=0.07	χ2=0.3, df=1, p=0.64	χ2=2.4, df=1, p=0.08	**χ2=6.0, df=1, p<0.01**
Notes: bold indicates a significant result.				

Horticulturalists more closely resemble hunter-gatherers. They share similar frequencies of QFT entheses, lipping, and coalesced porosity (Table 73). They differed significantly only in PL entheses. This pattern held for sexes combined, as well as for females and males.

Table 73. Results of Chi-Square Analysis of Horticulturalists vs. Hunter-Gatherers.

SEX	QFTE	PLE	LIP	CP
Sexes Combined	$\chi2=0.0$, df=1, p=6.27	**$\chi2=6.6$, df=1, p<0.01**	$\chi2=1.7$, df=1, p=0.13	$\chi2=0.5$, df=1, p=0.46
Females	$\chi2=0.9$, df=1, p=0.27	**$\chi2=3.6$, df=1, p=0.03**	$\chi2=0.4$, df=1, p=0.53	$\chi2=0.9$, df=1, p=0.26
Males	$\chi2=0.9$, df=1, p=0.28	**$\chi2=3.0$, df=1, p=0.05**	$\chi2=2.0$, df=1, p=0.11	$\chi2=1.9$, df=1, p=0.11
Notes: bold indicates a significant result.				

Step 3

Hitzfelder Cave, tested as a group with unknown subsistence regime, was compared with the agriculturalist, horticulturalist, and hunter-gatherer groups. When Hitzfelder was compared to all three groups, there were significant differences in QFT entheses, PL entheses, and coalesced porosity (Table 74). Hitzfelder Cave differed significantly from agriculturalists in QFT entheses and coalesced porosity, and from hunter-gatherers in PL entheses. There were no significant differences in patellar pathologies between Hitzfelder Cave and the horticulturalist group.

Table 74. Results of Chi-Square Analysis of Hitzfelder Cave vs Subsistence Groups.

HITZFELDER CAVE VS	QFTE	PLE	LIP	CP
All Three Groups	**$\chi2=18.0$, df=3, p<0.001**	**$\chi2=12.6$, df=3, p<0.01**	$\chi2=3.0$, df=3, p=0.15	**$\chi2=41.2$, df=3, p<0.00000001**
Agriculturalists	**$\chi2=3.7$, df=1, p=0.03**	$\chi2=1.1$, df=1, p=0.22	$\chi2=1.3$, df=1, p=0.19	**$\chi2=23.4$, df=1, p<0.000001**
Hunter-Gatherers	$\chi2=2.7$, df=1, p=0.06	**$\chi2=4.1$, df=1, p=0.03**	$\chi2=0.0$, df=1, p=1.8	$\chi2=2.9$, df=1, p=0.06
Horticulturalists	$\chi2=2.5$, df=1, p=0.07	$\chi2=0.4$, df=1, p=0.50	$\chi2=2.1$, df=1, p=0.10	$\chi2=1.4$, df=1, p=0.17
Notes: bold indicates a significant result.				

CHAPTER V

DISCUSSION

Research Question 1: Individual/Group Variation

The first research question asked was, do individuals within groups exhibit variation in patellar pathologies? The data indicate that they do. There was not a single group studied in which all individuals showed the same patellar pathologies, or even the same combination of patellar pathologies. In fact, at each site there were between 8 and 13 different combinations exhibited. Furthermore, each archaeological group had a unique pattern of patellar pathologies. Table 75 presents pathologies that were significantly high or low relative to other patellar pathologies within that group.

Table 75. Significant Variations in Patellar Pathologies within Each Archaeological Group.

SITE	QFTE	PLE	LIP	CP	SO	EB
Eva		↑		↓	absent	absent
Thompson Village	↑	↓			absent	absent
Averbuch		↓			rare	absent
Larson			↑	↓	rare	absent
Hitzfelder Cave	↑	↑	↓	rare	↓	↓
Mitchell Ridge				↓	absent	rare
Key: ↑=high, ↓=low, rare=1 individual only, absent=no individuals.						

Research Question 2: Within-Group Variation

The second research question asked was, is there variation in patellar pathologies within each comparative group? Variation between sexes was testable for five of the sites. Averbuch had age data and Eva had temporal component data available. Variation indeed exists between sexes, age groups, and temporal components at the sites for which such data are available. The patterns of variation will be outlined below, while the causes will be explored under Research Question 4.

Sex

At four out of the five sites with sex data available, males and females differed significantly in at least one type of patellar pathology (Table 76). At the Eva site, males exhibited significantly higher rates of coalesced porosity. At Thompson Village, sex differences were not statistically significant. Meanwhile, at Averbuch females had significantly higher coalesced porosity rates. At both Larson and Mitchell Ridge, males exhibited significantly higher rates of lipping. Males at Mitchell Ridge also showed significantly higher quadriceps femoralis tendon (QFT) entheses.

While some previous studies on musculoskeletal markers (MSMs) have shown entheseal rates to be generally higher in males (al-Oumaoui et al. 2004; Molnar 2006; Stevens and Vidarsdóttir 2008), others have shown females to have higher rates (Chapman 1997; Eshed et al. 2004; Weiss et al. 2010; Weiss 2004). The results of this study are also mixed. The only statistically significant finding was at Mitchell Ridge, where males exhibited a higher frequency of QFT entheses. However, in two of the other groups, females exhibited marginally higher rates of QFT entheses, while males were marginally higher in the remaining two groups (see Table 76). For patellar ligament (PL) entheses, the rates were equal between sexes at one site, marginally higher in females at two sites, and marginally higher in males at the other two; the differences were not significant at any site.

Table 76. Sex Differences in Patellar Pathologies in Comparative Groups.

PATHO-LOGY	**EVA (H-G)**		**THOMPSON VILLAGE (AG)**		**AVERBUCH (AG)**		**LARSON (HORT)**		**MITCHELL RIDGE (H-G)**	
	F	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**
QFTE		10% higher	25% higher			10% higher	<10% higher			**56% higher**
PLE	20% higher			<10% higher	21% higher		same	same		37% higher
LIP		10% higher		<10% higher	<10% higher			**32% higher**		**41% higher**
CP	absent	**15% higher**	<10% higher		**26% higher**		<10% higher			<10% higher
SO	absent	absent	absent	absent	<10% higher	absent	absent		absent	absent
EB	absent	absent	absent	absent	absent	absent	absent	absent	absent	10% higher
Note: bold indicates a statistically significant difference.										

Previous literature indicates that osteoarthritis is more common in females (Aufderheide and Rodríguez-Martín 1998; Weiss and Jurmain 2007; Woods 1995). However, in this study lipping was significantly more frequent in males at two sites, marginally more frequent in males at two sites, and only marginally higher in females at a single site (see Table 76). If lipping is considered as an indicator of osteoarthritis, this pattern seems to contradict previous research. While surface osteophytes and eburnation are also diagnostic of osteoarthritis, they were too rare in these groups to yield significant results.

Woods' (1995) research indicated that males and females exhibited different susceptibility to coalesced porosity, which is supported by the findings here. At Thompson Village, Averbuch, and Larson, females had a higher incidence than males. However, males had higher coalesced porosity rates at Mitchell Ridge and Eva. No Eva females exhibited coalesced porosity.

Age

The Averbuch group had associated age data, which allowed me to test for variation by age. Previous work has indicated that entheses (Milella et al. 2012; Weiss 2004) and lipping (Weiss and Jurmain 2007) increase with age. While a correlation between age and coalesced porosity was not found in the work of Rothschild (1997), it is still useful to test for age as a confounding variable of this pathology. In the Averbuch group (sexes combined), there was significant variation between age groups for QFT entheses, lipping, and coalesced porosity. While the directional pattern of adjusted residuals do indicate that QFT entheses, lipping, and coalesced porosity increased with age, the strength of the pattern was only significant for coalesced porosity. No significant pattern was apparent for PL entheses. Among females, the significant increase with age in coalesced porosity held, but no significant patterns emerged for QFT and PL entheses or lipping. Among males, there was significant variation between age groups for QFT entheses, lipping, and coalesced porosity, but there was no clear directional pattern in adjusted residuals to indicate increase with age.

Temporal Component

The Eva sample contained individuals from three different temporal components, which allowed for temporal analysis of QFT entheses, PL entheses, and lipping. The only significant change over time was in QL entheses, which were high in the Three Mile component and low in the Big Sandy. There was no significant variation by component in either sex or between sexes. The change in QFT entheses over time corresponds to a significant shift in subsistence strategy. Faunal analysis indicates that in the Eva component, the inhabitants of the site depended largely on hunting mammals, particularly deer. During the Three Mile component, however, they relied heavily on freshwater mussels, which were entirely absent in the Big Sandy component.

Research Question 3: Between-Group Variation

The third research question asked is if variation in patellar pathologies occurred between groups. To test this, frequencies in patellar pathologies were compared among the six groups (see Table 75). Surface osteophytes and eburnation were rare to absent in all groups. The frequency of QFT entheses, PL entheses, lipping, and coalesced porosity varied significantly among all six groups. Additionally, QFT entheses, PL entheses, lipping, and coalesced porosity varied among females between sites, and PL entheses, lipping, and coalesced porosity varied among males between sites. Groups were then compared to one another to see if QFT and PL entheses, lipping, and coalesced porosity varied by region or subsistence regime.

Regional Variation

The two Texas sites were very similar to one another in QFT entheses, PL entheses, lipping, and coalesced porosity. However, the three sites in the Eastern Woodlands showed significant variation from one another in all four patellar pathologies analyzed. This would indicate that some variable other than geographic region must account for the variation between sites.

Variation by Subsistence Regime

Next, data were compared by subsistence regime based on archaeological data. Groups engaged in the same subsistence regime exhibited similar patterns of patellar pathologies. The two agriculturalist groups (Thompson Village and Averbuch) differed from one another only in lipping. The two hunter-gatherer groups (Eva and Mitchell Ridge) showed no variation in QFT and PL entheses, lipping, and coalesced porosity.

The data were then combined within each subsistence grouping, and the Larson site was used to represent horticulturalists. The three subsistence regimes were compared to see if groups engaging in different subsistence practices exhibited variation in patellar pathologies. The three regimes differed significantly in QFT entheses, PL entheses, and coalesced porosity. Adjusted residuals indicated that agriculturalists were distinguished from the other two groups by dramatically higher rates of QFT entheses and coalesced porosity (Table 77).

Table 77. Significant Variations in Patellar Pathologies among Subsistence Regimes.

SUBSISTENCE STRATEGY	**QFTE**	**PLE**	**LIP**	**CP**	**SO**	**EB**
Agriculturalists	↑	↓		↑	rare	absent
Horticulturalists		↑		↓	rare	absent
Hunter-Gatherers				↓	absent	rare
Key: ↑=significantly high, ↓=significantly low, rare<2 individuals, absent=no individuals.						

Next, subsistence regimes were compared in pairs to see if one more closely resembled any other. Figure 34 illustrates the relationship between the three subsistence groups based on patellar pathologies that were similar (i.e., no significant difference was detected). While horticulturalists share patterns of patellar pathologies with agriculturalists and hunter-gatherers, there were fewer significant differences between horticulturalists and hunter-gatherers.

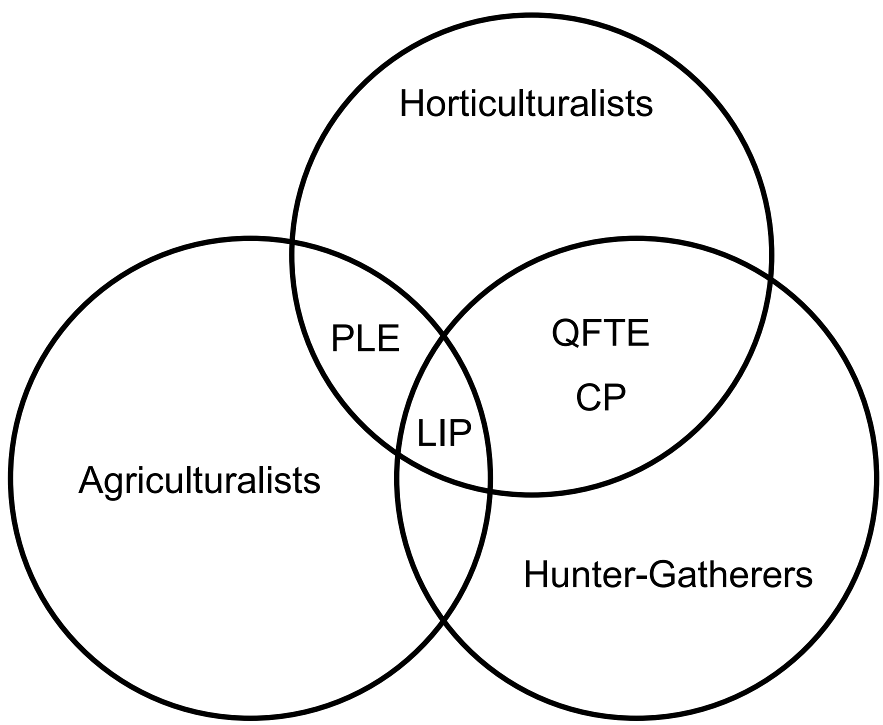

Figure 34. Patellar pathologies shared between subsistence regimes.

Research Question 4: Causes of Variation

This analysis has established that variation in patellar pathologies exists between individuals, between individuals of different sex, age, or from different temporal components within archaeological groups, and between groups engaged in different subsistence regimes. In order to examine causes of variation in patellar pathologies, we should revisit what causes the pathologies, and how this research has contributed to our knowledge of these causes.

Entheses

Bone remodeling theory holds that entheses develop as a response to mechanical stress (Chapman 1997; Weiss 2004; Wolff 1892). Formation of new bone and ossification of the ligaments result when stress at the site leads to an increase in blood flow and the stimulation of osteoblasts. Thus, repeated stress at the site due to physical activity leads to well-developed entheses, or MSMs. A number of studies have been conducted using MSMs to reconstruct prehistoric activity patterns (al-Oumaoui et al. 2004; Chapman 1997; Churchill and Morris 1998; Eshed et al. 2004; Molnar 2006; Molnar et al. 2009; Schrader 2012; Steen and Lane 1998; Stefanović and Porčić 2011; Weiss 2004).

One major critique of reconstructing prehistoric activity patterns via MSMs is that age, sex, and body size are confounding variables for MSMs. As people age, there is a longer amount of time for mechanical stress to initiate a remodeling response (Milella et al. 2012). Furthermore, age-related changes in hormones, declining collagen levels, and osteoblastic response may also affect bone remodeling (Weiss 2004; Woods 1995). Many of these studies employ a composite score for large muscle groups, and compare means of MSM scores between sexes. Proposed explanations for sex differences in MSM scores include division of labor, joint morphology differences, and hormonal factors (al-Oumaoui et al. 2004; Chapman 1997; Eshed et al. 2004; Molnar 2006; Stevens and Vidarsdóttir 2008; Weiss et al. 2010; Weiss 2004). Body size also affects the development of entheses, and sexual dimorphism is yet another possible factor driving sex differences (Weiss et al. 2010; Weiss 2003, 2004).

In this study, it was only possible to explore the effect of age on entheses for the Averbuch site. While entheses were in fact much lower in the <20 group, no significant pattern was discernible in the upper age ranges. This may be an artifact of the small sample size. In addition, the above-mentioned studies were testing the correlation with age and severity of entheses, rather than the just the presence or absence of them. Significant sex differences in entheses were found only at Mitchell Ridge, and indicated a higher prevalence in males, consistent with results obtained by al-Oumaoui et al. (2004), Molnar et al. (2009), and Stefanović and Porčić (2011). However, females did exhibit higher entheses at Eva, Thompson Village, Averbuch, and Larson, and although the differences were not quite significant, they agree with the sex reversals and mixed results found by Chapman (1997), Eshed et al. (2004), Weiss (2004), and Weiss et al. (2010). Although body size was not accounted for in this study, metric data were collected for all groups, and future research could examine this correlation.

A difference between previous studies and the present one is that earlier researchers examined multiple muscle insertion sites using an ordinal scale, and created a composite score for each individual or for each large muscle group, and often compared arithmetic means of these scores between individuals or groups. This study focused on frequency of variation at two attachment sites on a single element using a simpler scoring system. One advantage this provides is to compare relative stress from upper leg use versus lower leg use, while avoiding concerns over using means of ordinal data. Among Averbuch and Thompson Village inhabitants, the frequency of QFT entheses was significantly higher than the frequency of PL entheses, while at Eva PL entheses were much higher. This difference could be related to mobility, as illustrated with the temporal change at the Eva site. During the Three Mile component, the group was engaging in less hunting and more gathering of riverine resources. This change in activity over the three components at Eva coincided with an increase in QFT entheses in the group. Hunting typically involves running and roaming over large areas, which would increase stress on the patellar ligament, and could lead to a higher rate of PL entheses. Fishing, collecting shellfish, and planting crops involves more squatting, which develops the quadriceps muscles, and places more strain on the QFT insertion, thus increasing the rate of QFT entheses.

Lipping

Lipping occurs in response to mechanical stress loading on the joint (Aufderheide and Rodríguez-Martín 1998; Roberts and Manchester 2005), and research examining activity patterns via this pathology is subject to the same confounding variables as MSMs, i.e., age, sex, and body size (Jurmain and Kilgore 1995; Weiss and Jurmain 2007). When examined by age in the Averbuch group, lipping followed the same pattern as QFT entheses, in that the direction of the variation was consistent with increase with age, but that the strength of the association was not significant. At the two sites that exhibited a significant sex difference (Larson and Mitchell Ridge), lipping was far more prevalent in males. These findings are contrary to previous assertions that osteoarthritis, of which lipping is considered by many to be a diagnostic criterion (Klaus et al. 2009; Rothschild 1997), is generally higher in females (Aufderheide and Rodríguez-Martín 1998; Weiss and Jurmain 2007; Woods 1995). While body size was not accounted for, metric data are available for these groups to control for this variable in future studies.

Coalesced Porosity

Woods' (1995) research indicated that groups showed different susceptibility to coalesced porosity, which is supported by the findings here. Coalesced porosity was significantly more prevalent in the two agriculturalist groups, Thompson Village and Averbuch. Investigations of sex differences indicated that coalesced porosity was higher in Averbuch females than males; however, this pattern was reversed at Mitchell Ridge. The data indicate that among the groups practicing agriculture, coalesced porosity is higher in females, while among the hunter-gatherer groups, it is higher in males. Among Averbuch females, coalesced porosity did increase with age, although results were not significant among males.

Habitual postures may result in coalesced porosity. Ubelaker (1979) found evidence for bony changes on the metatarsals and phalanges in individuals buried at the prehistoric Hacienda Ayalan cemetery in Ecuador. He attributed these changes to hyperdorsiflexion of the toes, consistent with habitual, prolonged kneeling (see Ubelaker 1979:Figure 2). Molleson (1989) documented similar changes to the tarsals and metatarsals of Mesolithic farmers from Tell Abu Hureyra, Syria, and connected them with upper limb changes consistent with grain grinding using a saddle quern. This is supported by cultural evidence such as Egyptian statues that depict women grinding grain (Figure 35).

Figure 35. Figurine from Giza of a woman grinding grain (The Oriental Institute of The University of Chicago).

During extreme flexion there is direct contact between the posterior surface of the patella and the intercondylar notch of the femur, with the medial facet of the patella resting against the medial condyle of the femur (Woods 1995). This contact results in structural failure of the cartilage and exposure of the subchondral bone. Increased vascularization of the bone and remodeling follows, which presents as porosity. When the load on the patellofemoral articulation is increased further, as during prolonged activities involving extreme knee flexion, focal necrosis of the subchondral bone may occur, followed by even more vascularization in which the porosities may coalesce (Woods 1995).

In the grain-grinding position illustrated above, the anterior surface of the patella is in direct contact with the ground surface, the patella supports the full weight of the upper body, and the magnitude of the load on patellofemoral articulation is even higher (Figure 36). The groups at Averbuch and Thompson Village grew maize, which was often ground for consumption, and the posture of grinding the maize could thus explain the high rate of coalesced porosity at Averbuch and Thompson Village. Furthermore, while Woods (1995) does not take into account pressure on the patella itself as a result of contact with the ground surface while kneeling, this might also explain a curious pattern noted during the study. The anterior surface of individuals from Averbuch and Thompson Village were highly vascularized compared to those from the other sites (Figures 37 and 38). While this observation was not quantified or recorded in any systematic way, this is a possible area for future research.

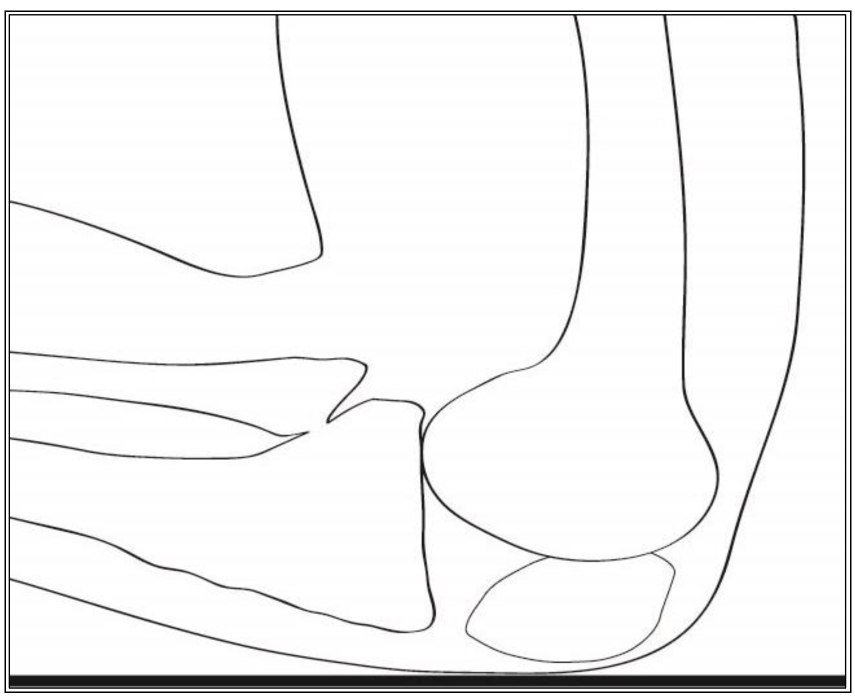

Figure 36. Position of the patella relative to the ground surface (dark line) while in the grain-grinding posture (figure by Shawn and Maggie McClain).

Figure 37. Right (left) and left (right) patellae from Burial 8, a male from Eva, showing typical vascularization of the anterior surface (note: right patella has been treated with alvar, a preservative; photograph by Maggie McClain).

Figure 38. Right (left) and left (right) patellae from Burial 146B, a female from Averbuch, showing increased vascularization of the anterior surface. This individual also exhibited coalesced porosity on the medial facets and crest of both patellae (photograph by Maggie McClain).

If coalesced porosity is indeed caused by habitual, prolonged kneeling, this may give us insights into division of labor. At Averbuch, females had significantly higher rates of coalesced porosity than males, and the rates at Thompson Village were marginally higher in females. Ethnographic accounts of Southeastern tribes indicate that females were more heavily involved in agriculture and food processing, while men were primarily responsible for providing meat (Hudson 1976). A similar division of labor was reported among the Arikara (Rogers 1990). It may be that more females at these sites were grinding maize than males, leading to higher rates of coalesced porosity. The occurrence of coalesced porosity could be a result of these males also grinding maize, or it may be that the males were engaged in a different activity that utilized the same posture.

It was the males rather than females at Eva and Mitchell Ridge that exhibited higher rates of coalesced porosity. As Eva predates the introduction of maize agriculture in the Eastern Woodlands by as much as 5,000 years, and Ricklis (1994) reports no evidence of agriculture at Mitchell Ridge, it is unlikely that the males at the sites were processing maize. So what other activity would require a similar posture? Recall that both Eva and Mitchell Ridge inhabitants relied heavily on fishing (Lewis and Lewis 1961; Ricklis 1994). Habitual kneeling while fishing, either from boats while paddling or from the riverbank, could result in coalesced porosity. If this is indeed the case, it indicates that the males at this site were more frequently involved in this subsistence activity.

Surface Osteophytes and Eburnation

Surface osteophytes and eburnation were rare to absent in all groups. There was not enough evidence to shed light on patterns of variation in these pathologies, or on the underlying causes of them.

Research Question 5: Identifying Subsistence Regimes and Division of Labor

Subsistence Regimes

Agriculturalists were clearly distinguished from other subsistence regimes in this study by a high prevalence of coalesced porosity. This patellar pathology likely results from maize grinding, an activity that is directly related to subsistence practices. Thus, high rates of coalesced porosity may indeed be a useful marker of agriculturalist groups, while low rates among a population may indicate that the group was engaged in other subsistence practices.

Hitzfelder Cave was used as a test population to see if subsistence regime could be ascertained from patterns of patellar pathologies. Indeed, the pattern of patellar pathologies at Hitzfelder Cave did resemble that of one of the subsistence regimes, but it was not hunter-gatherers, as anticipated given what we know of subsistence practices during the Central Texas Archaic. The suite of patellar pathologies exhibited at Hitzfelder Cave most closely resembled that of the horticulturalist group. This deviation from expected results could be due to the confounding variable of mobility, discussed in further detail below.

Division of Labor

Significant sex differences in patellar pathologies may reflect sexual division of labor. At the Averbuch site, significant sex differences in coalesced porosity supported ethnographic accounts of the division of labor, where females performed the majority of the planting, tending, and processing of corn and other crops. At Larson, the higher rates of lipping in males may have resulted from their primary responsibility of obtaining meat through hunting. Among the hunter-gatherers, Eva males exhibited a higher incidence of coalesced porosity, while at Mitchell Ridge males had higher rates of QFT entheses and lipping.

Additional Confounding Variables

In addition to the confounding variables of age, sex, and body size discussed above, other variables were not accounted for in this research that could potentially influence the results of this study. These variables include mobility, environmental factors such as terrain, and cultural differences.

The particular groups representing the horticulturalists and hunter-gatherers in this study had quite variable mobility patterns, which could affect the variation in pathologies of the patella. The horticulturalist group consisted solely of individuals from the Larson site. During the Postcontact Coalescent Tradition of the Middle Missouri River Valley, groups such as the Larson Arikara were known to have gone on long bison hunts during the winter. The entire village would go on the hunt, sometimes traveling hundreds of miles (Blakeslee 1994). Thus for half of the year, the Larson inhabitants may have been sedentary or semi-sedentary, but for half of the year they were highly mobile.

The hunter-gatherer group consisted of inhabitants of Mitchell Ridge (30 percent of the sample) and the Eva site (60 percent). The inhabitants of Mitchell Ridge were seasonally mobile, and native peoples of the area are known to have traveled by dugout canoe (Ricklis 1994). At the Eva site, significant changes in subsistence practices over time may have resulted in shifts in mobility, from highly mobile during the Eva component, to sedentary during the Three Mile component, to semi-sedentary in the Big Sandy. Thus mobility varied greatly among these hunter-gatherer groups. As 44 percent of the hunter-gatherer sample consisted of individuals from the sedentary Three Mile component, the sample is skewed towards a mobility pattern quite different from the presumably highly mobile hunter-gatherers of Central Texas. Furthermore, combining the three components for the between-group comparison may have obscured shifts in mobility, and resulted in a site profile that is not truly representative of the mobility patterns across time at the site.

Thus, the Larson group may have been more mobile overall than the semi-sedentary Eva hunter-gatherers or the seasonally mobile Mitchell Ridge group. It may be the similarities between Larson and Hitzfelder Cave reflect underlying similarities in mobility rather than subsistence practices. However, activity must be considered in conjunction with mobility, particularly with coastal hunter-gatherers such as the Mitchell Ridge inhabitants. Coastal hunter-gatherers are thought to have been highly mobile, but they used boats for travel, rather than walking. Thus, the skeletal signature of this movement may differ dramatically from groups who moved around on foot. Furthermore, mobility itself may be a byproduct of sexual division of labor. If males were engaged in hunting over wide ranges, and females more focused on raising crops or gathering plants closer to home, then the males may exhibit pathologies more reflective of their higher mobility.

Environmental differences such as topography and physical terrain could impact skeletal biology. Studies testing the relationship of physical terrain and lower limb physiology have yielded mixed results. While Ruff (1999) reported significant differences in robusticity of the femur between mountainous and flat regions, Wescott (2001) reported that femoral midshaft robusticity in females grouped by geographic region, but not by terrain. Future research comparing patellar measurements with the pathologies reported here could shed further light on the relationship between topography and pathological processes.

It can easily be envisioned that cultural differences apart from division of labor could affect the prevalence of patellar pathologies. For example, social status could dictate the types of activities and levels of physical labor required of an individual, altering the mechanical stress placed on the joints. In addition, social status may affect access to resources; nutritional stress can lead to anemia and reduced bone density. Among the Arikara, the amount of land allotted to a household was partially dependent upon rank (Rogers 1990), and thus an individual's social status would have had a direct bearing on the amount of food available. Incorporation of social status as determined by grave goods and differential mortuary practices could aid in assessing the role of this variable.

Limitations and Future Research

When possible, future research should account for the effects of confounding variables such as age, sex, body size, mobility, environmental factors such as terrain, and cultural differences on patellar pathologies. In addition, this research would benefit from larger sample sizes and inclusion of more comparative groups. Adding more individuals from the comparative groups in this study would be beneficial. The Averbuch site has many more individuals available for study, as does the Larson site, and age data from these two sites might be used to more thoroughly address the role of age in the development of these pathologies. Study of the change in pathologies over time at the Eva site was hampered by the small samples from the Eva and Big Sandy components, although more individuals from these sites could be gathered. Similarly, the Mitchell Ridge site was too small to analyze by temporal component, although the entire collection was examined during this project. However, adding more coastal Texas groups and comparing them with inland groups may elucidate the skeletal changes resulting from travel by boat vs. travel on foot. In addition, incorporating data from more horticulturalist groups from the Great Plains and other regions such as the Great Basin, as well as agriculturalists from the Southwest and sedentary hunter-gatherer groups of the Pacific Coast, may be useful in teasing out the effects of mobility vs. activity vs. sexual division of labor on the patella. Furthermore, analysis of accompanying artifact collections or comparison with previous artifact analyses may provide more information on the groups themselves and the activities in which they were engaged.

As the puzzle of Hitzfelder Cave remains largely unsolved, much could be done in the future to shed light on the people buried there. Obviously, reuniting the entire collection and the possible future discovery of field notes, lab inventories, and analysis sheets would be invaluable. Second, matching of the patella and estimating sex via measurements are possible given the data currently collected, and could provide additional information on this group even without further original documentation. Finally, dating and stable isotope analysis of the patellae could corroborate and add to recent work done by Munoz et al. (2013), and to help to further contextualize this group within the diverse human ecology of the Central Texas Archaic.

CHAPTER VI

CONCLUSIONS

Despite the limitations inherent in prehistoric activity reconstructions from skeletal pathologies, this research has yielded important information. First, it has established a baseline for future osteological studies utilizing the patella. The practice of scoring quadriceps femoralis tendon (QFT) and patellar ligament (PL) entheses separately allows for comparison of activity patterns that would not necessarily be evident when a composite scoring of entheses is used. Similarly, the practice of scoring pathologies used in diagnosing osteoarthritis separately avoids the confusion and contradiction in other studies of activity reconstruction from patterns of osteoarthritis.

The data quite strongly establish that pathologies of the patella do vary among individuals, and that groups of individuals show a distinct pattern, with a significant difference in at least one pathology at each of the six sites. Furthermore, significant within-group variation was found by sex, age, and temporal component. Significant sex differences were present at Eva, Averbuch, Larson, and Mitchell Ridge. The pattern of the Averbuch and Larson sex differences are consistent with divisions of labor reported in ethnographic sources. Furthermore, the reported connection between entheses and age, and lipping and age were tested, as were the negative findings of coalesced porosity with age. Coalesced porosity was shown to significantly increase with age in the Averbuch group. There was a significant temporal shift in QFT entheses at the Eva site that corresponded with intensification of freshwater mussels.

Between-group comparisons were also quite informative. As the comparison of Eastern Woodlands sites showed, geographic region is not a major factor driving variation in patellar pathologies. Instead, the subsistence regime practiced by the group seems to significantly affect the pattern of variation in patellar pathologies. The case of coalesced porosity illustrates this point most clearly. The two agriculturalist groups showed an extremely high prevalence of coalesced porosity compared to other pathologies in those groups, and also compared to the prevalence of coalesced porosity in the other groups. Examination of the mechanical and physiological causes of coalesced porosity suggests this pathology develops in response to habitual, prolonged kneeling with weight placed directly on the patella. This posture is identical to the one used by many cultural groups when grinding grain on a metate. Comparisons between the three subsistence regimes indicate that horticulturalists in this sample more closely resemble the two hunter-gatherers than the agriculturalist groups. However, mobility may better explain the variation in patellar pathologies among the particular horticulturalist and hunter-gatherer groups used in this study than activities directly related to subsistence regime.

The original objective of this study was elucidate some information on the individuals buried in Hitzfelder Cave, despite the lack of provenience and excavation information. This objective was only partially satisfied. While the overall pattern of pathologies in these patellae was established, its relationship in terms of subsistence, mobility, and division of labor were not fully reconciled. The Hitzfelder Cave group was found to more closely resemble the horticulturalist group than hunter-gatherer group. This unexpected finding is likely a result of the specific groups used in the comparison; the Larson group comprised the horticulturalist category, while the hunter-gatherer group consisted of individuals from the Eva site and Mitchell Ridge. The similarity between Hitzfelder Cave and horticulturalists may be more reflective of the high mobility in the Larson group as opposed to the semi-sedentism of the Eva groups and seasonal mobility of the Mitchell Ridge inhabitants, rather than the subsistence regime practiced by each group.

This preliminary study establishes that pathologies of the patella show variation, and that variation may inform on differences in subsistence activities and division of labor. The ability to identify such patterns using a single skeletal element may prove particularly useful in cases of commingled, unprovenienced, and poorly preserved or highly fragmented remains. Potential future research in this vein includes utilizing metric data for control of body size and for sex estimation of commingled remains; inclusion of comparative groups from other regions; collection of additional data from the groups used here; the addition of more groups employing each subsistence regime, and more individual skeletons from within those groups; and investigation of the interaction between mobility, activity, subsistence, and division of labor and its subsequent impact on pathological changes to the patella.

APPENDIX A

DATA

Table 78. Data Collected from the Eva Group.

BURIAL ID	COMPONENT	SKELETAL AGE	AGE CATEGORY	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
6	Big Sandy	30–35	young–old adult	Male	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
8	Big Sandy	50–55	young–old adult	Male	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Present	Absent	Absent
20	Three Mile		young–old adult	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
37	Three Mile	18–25	young adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
41	Three Mile		young–old adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
44	Eva	35–40	young–old adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
45	Three Mile		adult	Female	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
51	Three Mile	45–50	young adult	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
54	Three Mile	25–30	young adult	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Present	Absent	Absent
57	Eva	60+	young–old adult	Male	Left	Absent/Mild	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
62	Big Sandy	30–35	young adult	Male	Right	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
73	Big Sandy	70+	young–old adult	Male	Right	Moderate /Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
76	Big Sandy	70+	adult	Male	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
80	Big Sandy		young–old adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent

Table 78-Continued. Data Collected from the Eva Group.

BURIAL ID	COMPONENT	SKELETAL AGE	AGE CATEGORY	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
81	Three Mile		young–old adult	Male	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
85	Big Sandy		young adult	Female	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
92	Three Mile	25–30	young adult	Female	Left	Absent/Mild	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
93	Three Mile		young–old adult	Male	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
103	Three Mile	25–30	young adult	Male	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
104	Three Mile	35–40	adult	Female	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
107	Three Mile		young–middle adult	Female	Right	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
125	Big Sandy		young–old adult	Female	Right	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
127	Three Mile	30–35	young–old adult	Female	Left	Moderate/ Severe	Moderate/ Severe e	Moderate/ Severe	Absent	Absent	Absent
141	Three Mile	35–40	young–old adult	Female	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
142	Three Mile	60+	young–old adult	Female	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
144	Three Mile	50–55	middle–old adult	Male	Left	Moderate/ Severe	Moderate/ Severe e	Moderate/ Severe	Absent	Absent	Absent
145	Big Sandy		young–old adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
149	Eva		young–old adult	Female	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent

Table 78-Continued. Data Collected from the Eva Group.

BURIAL ID	COMPONENT	SKELETAL AGE	AGE CATEGORY	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
152	Three Mile		young–old adult	Female	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
153	Three Mile		adult	Female	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
158	Three Mile		young–old adult	Female	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
161A	Three Mile	20–25	middle adult	Female	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
164	Three Mile	20–25	young–middle adult	Female	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
166	Big Sandy	30–35	adult	Male	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
167	Three Mile	30–35	adult	Female	Right	Absent/Mild	Moderate/ Severe e	Absent/Mild	Absent	Absent	Absent
171	Three Mile		adult	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
178	Three Mile	20–25	young adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
179	Three Mile		young–old adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
181	Eva	60+	adult	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Present	Absent	Absent
182	Eva	25–30	young adult	Female	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent

Table 79. Data Collected from the Thompson Village Group.

BURIAL ID	AGE	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
4	middle adult	Male	Right	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Present	Absent	Absent
6	middle adult	Male	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Present	Absent	Absent
8	middle adult	Female	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
10	young–middle adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
12	young–middle adult	Female	Left	-	Absent/Mild	-	Absent	Absent	Absent
17	middle adult	Male	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
21	adult	Female	Right	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Present	Absent	Absent
31	young adult	Male	Left	Absent/Mild	-	Absent/Mild	Absent	Absent	Absent
36	young–middle adult	Female	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
39	young–middle adult	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Present	Absent	Absent
51	young adult	Female	Left	-	-	Absent/Mild	Present	Absent	Absent
59	young adult	Female	Left	-	Moderate/ Severe	Absent/Mild	Present	Absent	Absent
68	young adult	Female	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Present	Absent	Absent
75	young–middle adult	Male	Left	Absent/Mild	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
80A	old adult	Male	Left	-	Absent/Mild	-	Present	Absent	Absent
86	adult	Female	Right	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent

Table 79-Continued. Data Collected from the Thompson Village Group.

BURIAL ID	AGE	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
91	young adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
94	old adult	Male	Left	-	Absent/Mild	-	Absent	Absent	Absent
95	middle adult	Female	Left	Moderate/ Severe	Absent/Mild	-	Present	Absent	Absent
99	adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
101	young–old adult	Male	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
105	middle adult	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
108	adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Present	Absent	Absent
126A	middle adult	Female	Left	Absent/Mild	Absent/Mild	-	Present	Absent	Absent
127	adult	Female	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
133	middle adult	Female	Right	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
134	middle adult	Male	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Present	Absent	Absent
135	young adult	Male	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
136	middle adult	Male	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
146	young adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Present	Absent	Absent
148	adult	Female	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
150	old adult	Female	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Present	Absent	Absent
151	adult	Female	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Present	Absent	Absent

Table 79-Continued. Data Collected from the Thompson Village Group.

BURIAL ID	AGE	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
152	middle adult	Male	Right	Moderate/ Severe	Absent/Mild	Absent/Mild	Present	Absent	Absent
154	middle adult	Female	Right	-	Absent/Mild	Absent/Mild	Absent	Absent	Absent
155	young adult	Female	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Present	Absent	Absent
159	middle adult	Female	Right	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
182	middle adult	Female	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
187	middle adult	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
193	middle adult	Male	Left	Absent/Mild	Absent/Mild	-	Absent	Absent	Absent
195	young adult	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent

Table 80. Data Collected from the Averbuch Group.

BURIAL ID	CEMETERY	AGE CATEGORY	SEX	SIDE	QFTE	PLE	LIP	EB	SO	CP
10 A	1	25–29	Female	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
14 A	1	40–49	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
15	1	30–34	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
16 A	1	20–24	Female	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
28	1	25–29	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
33 A	1	40–49	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
101	1	30–34	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
102	1	30–34	Female	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
106	1	40–49	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Present
107 A	1	17.5–18.5	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
121 B	1	20–24	Male	Left	Absent/Mild	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
122	1	adult	Female	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
123 A	1	18.5–19.5	Female	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
124	1	35–39	Female	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Present	Present

Table 80-Continued. Data Collected from the Averbuch Group.

BURIAL ID	CEMETERY	AGE CATEGORY	SEX	SIDE	QFTE	PLE	LIP	EB	SO	CP
130 A	1	30–34	Female	Left	Absent/Mild	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
136 B	1	25–29	Male	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
139	1	35–39	Male	Left	Moderate/ Severe	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
143	1	17.5–18.5	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
146 B	1	40+	Female	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
148	1	25–29	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
149	1	25–29	Male	Left	-	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
152 A	1	40–49	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
156 A	1	20–24	Female	Right	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
157	1	30–34	Male	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
158 A	1	25–29	Female	Left	Moderate/ Severe	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
159	1	35–39	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
166	1	25–29	Male	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
171	1	18.5–19.5	Male	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent

Table 80-Continued. Data Collected from the Averbuch Group.

BURIAL ID	CEMETERY	AGE CATEGORY	SEX	SIDE	QFTE	PLE	LIP	EB	SO	CP
175 A	1	18.5–19.5	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
176 C	1	40–49	Female	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
194 A	1	20–24	Female	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
203 A	1	25–29	Male	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
220 A	1	18.5–19.5	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
356	1	30–34	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
374	1	20–24	Male	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
417 A	1	20–24	Female	Left	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
418	2	35–39	Female	Left	Absent/Mild	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
432 A	2	50+	Female	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
432 A	2	50+	Female	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Present
433	2	40–49	Female	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
442 A	1	40–49	Male	Right	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent

Table 81. Data Collected from the Larson Group.

FEATURE	BURIAL ID	AGE	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
F301	B1I	adult	Male	Left	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F301	B2B	adult	Female	Right	Absent/Mild	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
F201	B2D	adult	Male	Left	Absent/Mild	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
F301	B2F	adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B3A	adult	Female	Left	Moderate/Severe	Moderate/Severe	Absent/Mild	Present	Absent	Absent
F201	B3F	adult	Female	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F301	B3H	adult	Male	Left	Absent/Mild	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F301	B7	adult	Male	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F201	B8C	adult	Male	Right	Absent/Mild	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F201	B9A	adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F101	B9B	adult	Female	Left	Moderate/Severe	-	Absent/Mild	Absent	Absent	Absent
F101	B9C	adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F301	B11	adult	Male	Right	Moderate/Severe	Absent/Mild	Moderate/Severe	Present	Absent	Absent
F301	B12C	adult	Male	Right	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F301	B12F	adult	Female	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F201	B13A	adult	Female	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Present	Present	Absent
F301	B16	adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B19D	adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B22B	adult	Male	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F201	B26B	adult	Female	Left	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent

Table 81-Continued. Data Collected from the Larson Group.

FEATURE	BURIAL ID	AGE	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
F101	B27C	adult	Male	Right	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F101	B29C	adult	Male	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F101	B32B	adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B32B	adult	Male	Left	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F201	B32C	adult	Male	Left	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F101	B32D	adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B33	adult	Female	Left	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F101	B33B	adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F101	B33E	adult	Male	Left	Absent/Mild	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F201	B34B	adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B36	adult	Female	Left	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
F201	B38C	adult	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B38D	adult	Female	Left	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F101	B40B	adult	Male	Left	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F201	B54A	adult	Male	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B54B	adult	Male	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B55F	adult	Female	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
F201	B56E	adult	Male	Right	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F201	B124F	adult	Female	Left	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
F201	B132	adult	Female	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
F201	B146B	adult	Male	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent

Table 82. Data Collected from the Hitzfelder Cave Group.

SPECIMEN ID	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
TU-PTX1	Indeterminate	Right	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
TU-PTX2	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
TU-PTX3	Indeterminate	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX4	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX5	Indeterminate	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX6	Indeterminate	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX7	Indeterminate	Left	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX8	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Present	Present	Present
TU-PTX9	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX10	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX11	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Present	Absent
TU-PTX12	Indeterminate	Right	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX13	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX14	Indeterminate	Left	Absent/Mild	Absent/Mild	-	-	-	-
TU-PTX15	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Present	Absent
TU-PTX16	Indeterminate	Left	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
TU-PTX17	Indeterminate	Right	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX18	Indeterminate	Left	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX19	Indeterminate	Right	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Present	Absent

Table 82-Continued. Data Collected from the Hitzfelder Cave Group.

SPECIMEN ID	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
TU-PTX20	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX21	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX22	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
TU-PTX23	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Present	Absent
TU-PTX24	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
TU-PTX25	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX26	Indeterminate	Right	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
TU-PTX27	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Present	Present
TU-PTX28	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX29	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX30	Indeterminate	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX31	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Present
TU-PTX32	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX33	Indeterminate	Right	Absent/Mild	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX34	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
TU-PTX35	Indeterminate	Left	Moderate/Severe	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
TU-PTX36	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX37	Indeterminate	Right	Absent/Mild	Absent/Mild	Moderate/Severe	Absent	Absent	Absent
TU-PTX38	Indeterminate	Left	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX39	Indeterminate	Left	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent

Table 82-Continued. Data Collected from the Hitzfelder Cave Group.

SPECIMEN ID	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
TU-PTX40	Indeterminate	Left	Moderate/Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX41	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Present
TU-PTX42	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX43	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Absent/Mild	Absent	Absent	Absent
TU-PTX44	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX45	Indeterminate	Left	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent
TU-PTX46	Indeterminate	Right	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
TU-PTX47	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Present
TU-PTX48	Indeterminate	Right	Moderate/Severe	Moderate/Severe	Moderate/Severe	Absent	Absent	Absent

Table 83. Data Collected from the Mitchell Ridge Group.

BURIAL ID	AREA	COMPONENT	AGE	SEX	SIDE	QFTE	PLE	LIP	CP	SO	EB
B-4	Burial Area	Prehistoric	25–45	Male	Right	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
B.7	Cross Area	Prehistoric	35–50+	Male	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Present
B.9	Cross Area	Prehistoric?	20–30	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
B.12	Cross Area	Prehistoric	10–20	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
Fea. 30	Area 1	Protohistoric	20–50+	Female	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
Fea. 35	Area 1	Prehistoric?	30–50+	Female	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Present	Absent	Absent
Fea. 52	Area 3	Prehistoric	50+	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Present	Absent	Absent
F. 61-A	Area 4	Protohistoric	25–35	Female	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
F. 62-1	Area 4	Historic	25–35	Female	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
F. 62-2	Area 4	Historic	18–20	Female	Left	Absent/Mild	Absent/Mild	Absent/Mild	Absent	Absent	Absent
Fea. 63-1	Area 4	Historic	25–35	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
Feat. 64-4	Area 4	Historic	18–20	Male	Left	Absent/Mild	Moderate/ Severe	Absent/Mild	Absent	Absent	Absent
Feat. 65	Area 4	Historic	30–40	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
F. 84	Area 4	Pre/Protohist.?	50+	Male	Left	Absent/Mild	Absent/Mild	Moderate/ Severe	Absent	Absent	Absent
Fea. 86	Area 4	Prehistoric	35–45	Male	Left	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Absent	Absent	Absent
Fea. 87	Area 4	Prehistoric	35–39	Male	Right	Moderate/ Severe	Moderate/ Severe	Moderate/ Severe	Present	Absent	Absent
Fea. 92-1A	Area 1	Protohistoric	30–50+	Male	Right	Moderate/ Severe	Absent/Mild	Absent/Mild	Absent	Absent	Absent

APPENDIX B

CHI-SQUARE RESULTS

Table 84. Chi-Square Results from the Eva Site.

GROUP	COMPARED VARIABLES	X^2	df	p VALUE
Sexes Combined	QFTE, PLE, LIP, CP	24.5	3	<0.00001
Sexes Combined	QFTE & PLE	3.2	1	0.05
Females	QFTE, PLE, LIP, CP	22.1	3	<0.0001
Females	QFTE & PLE	4.9	1	0.02
Males	QFTE, PLE, LIP, CP	6.2	3	0.05
Males	QFTE & PLE	0.1	1	1.20
QFTE	Females & Males	0.4	1	0.50
PLE	Females & Males	1.7	1	0.13
LIP	Females & Males	0.4	1	0.48
CP	Females & Males	3.6	1	0.03

Table 85. Chi-Square Results from Thompson Village.

GROUP	COMPARED VARIABLES	X^2	df	p VALUE
Sexes Combined	QFTE, PLE, LIP, CP	14.9	3	<0.001
Sexes Combined	QFTE & PLE	12.0	1	<0.001
Females	QFTE, PLE, LIP, CP	14.3	3	<0.01
Females	QFTE & PLE	11.3	1	<0.001
Males	QFTE, PLE, LIP, CP	2.7	3	0.17
Males	QFTE & PLE	2.3	1	0.08
QFTE	Females & Males	2.4	1	0.08
PLE	Females & Males	0.2	1	0.79
LIP	Females & Males	0.2	1	0.73
CP	Females & Males	0.3	1	0.61

Table 86. Chi-Square Results from the Averbuch Site.

GROUP	COMPARED VARIABLES	X^2	df	p VALUE
Sexes Combined	QFTE, PLE, LIP, CP	10.4	3	0.01
Sexes Combined	QFTE & PLE	5.5	1	0.01
Females	QFTE, PLE, LIP, CP	1.8	3	0.22
Females	QFTE & PLE	0.4	1	0.51
Males	QFTE, PLE, LIP, CP	11.8	3	<0.01
Males	QFTE & PLE	7.0	1	<0.01
QFTE	Females & Males	0.4	1	0.48
PLE	Females & Males	2.0	1	0.11
LIP	Females & Males	0.3	1	0.63
CP	Females & Males	2.9	1	0.05

Table 87. Chi-Square Results from the Larson Site.

GROUP	COMPARED VARIABLES	X^2	df	p VALUE
Sexes Combined	QFTE, PLE, LIP, CP	21.0	3	<0.0001
Sexes Combined	QFTE & PLE	0.4	1	0.56
Females	QFTE, PLE, LIP, CP	6.5	3	0.04
Females	QFTE & PLE	0.3	1	0.68
Males	QFTE, PLE, LIP, CP	18.1	3	<0.001
Males	QFTE & PLE	0.1	1	1.16
QFTE	Females & Males	0.0	1	2.11
PLE	Females & Males	0.0	1	identical
LIP	Females & Males	4.2	1	0.02
CP	Females & Males	0.7	1	0.34

Table 88. Chi-Square Results from Hitzfelder Cave.

GROUP	COMPARED VARIABLES	X^2	df	p VALUE
Sexes Combined	QFTE, PLE, LIP, CP, OS, EB	57.5	5	<0.0000000001
Sexes Combined	QFTE, PLE, LIP, CP	34.8	3	<0.0000001
Sexes Combined	QFTE & PLE	2.7	1	0.06

Table 89. Chi-Square Results from Mitchell Ridge.

GROUP	COMPARED VARIABLES	X^2	df	p VALUE
Sexes Combined	QFTE, PLE, LIP, CP	8.2	3	0.02
Sexes Combined	QFTE & PLE	1.1	1	0.23
Females	QFTE, PLE, LIP, CP	2.1	3	0.20
Females	QFTE & PLE	1.8	1	0.13
Males	QFTE, PLE, LIP, CP	9.2	3	0.01
Males	QFTE & PLE	0.5	1	0.42
QFTE	Females & Males	5.4	1	0.01
PLE	Females & Males	2.7	1	0.06
LIP	Females & Males	3.1	1	0.05
CP	Females & Males	0.6	1	0.41

Table 90. Chi-Square Analysis of QFT Entheses.

GROUP	COMPARED VARIABLES	SEX	X^2	df	p VALUE
	E, TV, A, L, HC, MR	Sexes Combined	10.3	5	0.03
	E, TV, A, L, MR	Females	12.2	4	0.01
	E, TV, A, L, MR	Males	5.3	4	0.09
EW	E, TV, A	Sexes Combined	6.8	2	0.02
EW	E, TV, A	Females	7.2	2	0.01
EW	E, TV, A	Males	2.6	2	0.13
TX	HC, MR	Sexes Combined	0.6	1	0.36
Ag	TV, A	Sexes Combined	0.0	1	6.14
Ag	TV, A	Females	1.4	1	0.17
Ag	TV, A	Males	1.1	1	0.21
H-G	E, MR	Sexes Combined	0.2	1	0.72
H-G	E, MR	Females	1.5	1	0.15
H-G	E, MR	Males	1.8	1	0.12
	Ag, Hort, H-G	Sexes Combined	9.4	2	<0.01
	Ag, Hort, H-G	Females	10.1	2	<0.01
	Ag, Hort, H-G	Males	2.6	2	0.14
	Ag, H-G	Sexes Combined	7.1	1	<0.01
	Ag, H-G	Females	9.5	1	<0.01
	Ag, H-G	Males	0.5	1	0.42
	Ag, Hort	Sexes Combined	6.2	1	0.01
	Ag, Hort	Females	3.7	1	0.03
	Ag, Hort	Males	2.6	1	0.07
	H-G, Hort	Sexes Combined	0.0	1	6.27
	H-G, Hort	Females	0.9	1	0.27
	H-G, Hort	Males	0.9	1	0.28
	Ag, Hort, H-G, HC	Sexes Combined	18.0	3	<0.001
	Ag, HC	Sexes Combined	3.7	1	0.03
	H-G, HC	Sexes Combined	2.7	1	0.06
	Hort, HC	Sexes Combined	2.5	1	0.07

Table 91. Chi Square Analysis of PL Entheses.

GROUP	COMPARED VARIABLES	SEX	X^2	df	p VALUE
	E, TV, A, L, HC, MR	Sexes Combined	14.1	5	0.01
	E, TV, A, L, MR	Females	9.9	4	0.02
	E, TV, A, L, MR	Males	9.9	4	0.02
EW	E, TV, A	Sexes Combined	9.8	2	<0.01
EW	E, TV, A	Females	8.8	2	0.01
EW	E, TV, A	Males	2.7	2	0.13
TX	HC, MR	Sexes Combined	2.7	1	0.06
Ag	TV, A	Sexes Combined	1.6	1	0.14
Ag	TV, A	Females	3.0	1	0.05
Ag	TV, A	Males	0.0	1	7.25
H-G	E, MR	Sexes Combined	0.1	1	1.13
H-G	E, MR	Females	1.7	1	0.13
H-G	E, MR	Males	2.7	1	0.06
	Ag, Hort, H-G	Sexes Combined	23.4	2	<0.00001
	Ag, Hort, H-G	Females	11.5	2	<0.01
	Ag, Hort, H-G	Males	12.4	2	<0.01
	Ag, H-G	Sexes Combined	11.3	1	<0.001
	Ag, H-G	Females	4.5	1	0.02
	Ag, H-G	Males	7.0	1	<0.01
	Ag, Hort	Sexes Combined	0.1	1	1.40
	Ag, Hort	Females	0.0	1	3.27
	Ag, Hort	Males	0.3	1	0.64
	H-G, Hort	Sexes Combined	6.6	1	0.01
	H-G, Hort	Females	3.6	1	0.03
	H-G, Hort	Males	3.0	1	0.05
	Ag, Hort, H-G, HC	Sexes Combined	12.6	3	<0.01
	Ag, HC	Sexes Combined	1.1	1	0.22
	H-G, HC	Sexes Combined	4.1	1	0.03
	Hort, HC	Sexes Combined	0.4	1	0.51

Table 92. Chi Square Analysis of Lipping.

GROUP	COMPARED VARIABLES	SEX	X^2	df	p VALUE
	E, TV, A, L, HC, MR	Sexes Combined	15.1	5	<0.01
	E, TV, A, L, MR	Females	10.2	4	0.02
	E, TV, A, L, MR	Males	8.5	4	0.03
EW	E, TV, A	Sexes Combined	12.6	2	<0.001
EW	E, TV, A	Females	9.5	2	<0.01
EW	E, TV, A	Males	3.8	2	0.07
TX	HC, MR	Sexes Combined	1.1	1	0.22
Ag	TV, A	Sexes Combined	10.5	1	<0.001
Ag	TV, A	Females	7.4	1	<0.01
Ag	TV, A	Males	3.4	1	0.04
H-G	E, MR	Sexes Combined	1.6	1	0.14
H-G	E, MR	Females	0.2	1	0.70
H-G	E, MR	Males	2.4	1	0.08
	Ag, Hort, H-G	Sexes Combined	4.1	2	0.06
	Ag, Hort, H-G	Females	3.2	2	0.10
	Ag, Hort, H-G	Males	3.8	2	0.07
	Ag, H-G	Sexes Combined	0.9	1	0.26
	Ag, H-G	Females	2.4	1	0.08
	Ag, H-G	Males	0.0	1	3.60
	Ag, Hort	Sexes Combined	0.3	1	0.68
	Ag, Hort	Females	0.6	1	0.37
	Ag, Hort	Males	2.4	1	0.08
	H-G, Hort	Sexes Combined	1.7	1	0.13
	H-G, Hort	Females	0.4	1	0.53
	H-G, Hort	Males	2.0	1	0.11
	Ag, Hort, H-G, HC	Sexes Combined	3.0	3	0.15
	Ag, HC	Sexes Combined	1.3	1	0.19
	H-G, HC	Sexes Combined	0.0	1	1.83
	Hort, HC	Sexes Combined	2.1	1	0.10

Table 93. Chi Square Analysis of Coalesced Porosity.

GROUP	COMPARED VARIABLES	SEX	X^2	df	p VALUE
	E, TV, A, L, HC, MR	Sexes Combined	42.0	5	<0.0000001
	E, TV, A, L, MR	Females	23.2	4	<0.0001
	E, TV, A, L, MR	Males	7.1	4	0.05
EW	E, TV, A	Sexes Combined	14.7	2	<0.001
EW	E, TV, A	Females	15.5	2	<0.001
EW	E, TV, A	Males	2.4	2	0.15
TX	HC, MR	Sexes Combined	4.4	1	0.02
Ag	TV, A	Sexes Combined	0.0	1	identical
Ag	TV, A	Females	0.4	1	0.53
Ag	TV, A	Males	0.3	1	0.61
H-G	E, MR	Sexes Combined	1.3	1	0.18
H-G	E, MR	Females	2.5	1	0.07
H-G	E, MR	Males	0.3	1	0.61
	Ag, Hort, H-G	Sexes Combined	20.0	2	<0.0001
	Ag, Hort, H-G	Females	21.0	2	<0.0001
	Ag, Hort, H-G	Males	6.1	2	0.02
	Ag, H-G	Sexes Combined	15.7	1	<0.0001
	Ag, H-G	Females	16.2	1	<0.0001
	Ag, H-G	Males	2.2	1	0.09
	Ag, Hort	Sexes Combined	15.2	1	<0.0001
	Ag, Hort	Females	9.9	1	<0.001
	Ag, Hort	Males	6.0	1	0.01
	H-G, Hort	Sexes Combined	0.5	1	0.46
	H-G, Hort	Females	0.9	1	0.26
	H-G, Hort	Males	1.9	1	0.11
	Ag, Hort, H-G, HC	Sexes Combined	41.2	3	<0.00000001
	Ag, HC	Sexes Combined	23.4	1	<0.000001
	H-G, HC	Sexes Combined	2.9	1	0.06
	Hort, HC	Sexes Combined	1.4	1	0.17

LITERATURE CITED

al-Oumaoui, I., S. Jiménez-Brobeil, and P. Du Souich
2004 Markers of Activity Patterns in Some Populations of the Iberian Peninsula. *International Journal of Osteoarchaeology* 14:343–359.

Aufderheide, Arthur C., and Conrado Rodríguez-Martín
1998 *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge University Press, Cambridge, UK.

Bartholomew, Roger
1973 Hitzfelder's Bone Hole. *The Texas Caver* 18(11):321–322.

Benfer, Robert A.
1967 Comment on Radiocarbon date Tx-334. *Radiocarbon* 9:448.

Benfer, Robert A., and Reuben M. Frank
n.d. Inverted Burial Grounds: A New Type of Archeological Site. Manuscript on file, Texas Archeological Research Laboratory, The University of Texas at Austin.

Berryman, Hugh E.
1984 The Averbuch Skeletal Series: A Study of Biological and Social Stress at a Late Mississippian Period Site from Middle Tennessee. In *Averbuch: A Late Mississippian Manifestation in the Nashville Basin*, Vol. I, Observations, edited by W. E. Klippel and W. M. Bass, pp. I.5.1–I.5.134. The University of Tennesee, Knoxville, Tennessee.

Bidmos, M. A., N. Steinberg, and K. L. Kuykendall
2005 Patella Measurements of South African Whites as Sex Assessors. *HOMO—Journal of Comparative Human Biology* 56:69–74.

Blakeslee, Donald J.
1994 The Archaeological Context of Human Skeletons in the Northern and Central Plains. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, edited by D. W. Owsley and R. L. Jantz, pp. 9–32. Smithsonian Institution Press, Washington DC.

Buikstra, Jane E., and Douglas H. Ubelaker
1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archeological Survey Research Series No. 44. Arkansas Archeological Survey, Fayetteville, Arkansas.

Chapman, Nancy E. Munson
1997 Evidence for Spanish Influence on Activity Induced Musculoskeletal Stress Markers at Pecos Pueblo. *International Journal of Osteoarchaeology* 7:497–506.

Churchill, Steven E., and Alan G. Morris
1998 Muscle Marking Morphology and Labour Intensity in Prehistoric Khoisan Foragers. *International Journal of Osteoarchaeology* 8:390–411.

Coggon, D., S. Kellingrey, H. Inskip, P. Croft, C. Campbell, and C. Cooper
1998 Osteoarthritis of the Hip in Occupational Lifting. *American Journal of Epidemiology* 147:523–528.

Collins, Michael B.
1970 On the Peopling of Hitzfelder Cave. *Bulletin of the Texas Archeological Society* 41:301–304.
2004 Archeology in Central Texas. In *The Prehistory of Texas*, edited by T. K. Perttula, pp. 101–126. Texas A&M University Press, College Station, Texas.

Davis, E. Mott
1966 Radiocarbon Dating Results. Letter to Robert A. Benfer from Radiocarbon Dating Laboratory, Balcones Research Center, dated December 6, 1966. Manuscript on file, Texas Archeological Research Laboratory, The University of Texas at Austin

Dayal, Manisha Ramanlal, and Mubarak Ariyo Bidmos
2005 Discriminating Sex in South African Blacks Using Patella Dimensions. *Journal of Forensic Sciences* 50(6):1–4.

Eshed, Vered, Avi Gopher, Ehud Galili, and Israel Hershkovitz
2004 Musculoskeletal Stress Markers in Natufian Hunter-Gatherers and Neolithic Farmers in the Levant: The Upper Limb. *American Journal of Physical Anthropology* 123:303–315.

Fagan, Brian M.
2005 *Ancient North America: The Archaeology of a Continent*. 4th ed. Thames & Hudson, New York, New York.

Givens, R. Dale
1968a A Preliminary Report on Excavations at Hitzfelder Cave. *Bulletin of the Texas Archeological Society* 38:47–50.
1968b On the Peopling of America. *Current Anthropology* 9:219.

Hawkey, D. E., and C. F. Merbs
1995 Activity-Induced Musculoskeletal Stress Markers (MSM) and Subsistence Strategy Changes among Ancient Hudson Bay Eskimos. *International Journal of Osteoarchaeology* 5:324–338.

Hester, Thomas R.
2004 The Prehistory of South Texas. In *The Prehistory of Texas*, edited by T. K. Perttula, pp. 127–151. Texas A&M University Press, College Station, Texas.

Hudson, Charles
1976 *The Southeastern Indians*. The University of Tennessee Press, Knoxville, Tennessee.

Huebner, Jeffery A.
1994 Stable Carbon and Nitrogen Isotope Analysis of Human Diets at the Mitchell Ridge Site. In *Aboriginal Life and Culture on the Upper Texas Coast: Archaeology at the Mitchell Ridge Site, 41GV66, Galveston Island*, edited by R. A. Ricklis, pp. 406–416. Coastal Archaeological Research, Inc., Corpus Christi, Texas.

Introna, Francesco, Jr., Giancarlo Di Vella, and Carlo Pietro Campobasso
1998 Sex Determination by Discriminant Analysis of Patella Measurements. *Forensic Science International* 95:39–45.

Johnson, Craig M.
1998 The Coalescent Tradition. In *Archaeology on the Great Plains*, edited by W. R. Wood, pp. 308–344. University Press of Kansas, Lawrence, Kansas.

Jurmain, Robert D., and Lynn Kilgore
1995 Skeletal Evidence of Osteoarthritis: A Paleopathological Perspective. *Annals of Rheumatic Diseases* 54:443–450.

Kelley, M. A., and L. E. Eisenberg
1987 Blastomycosis and Tuberculosis in Early American Indians: A Biocultural View. *Midcontinental Journal of Archaeology* 11:89–116.

Kemkes-Grottenhaler, Ariane
2005 Sex Determination by Discriminant Analysis: An Evaluation of the Reliability of Patella Measurements. *Forensic Science International* 147:129–133.

Klaus, Haagen D., Clark Spencer Larsen, and Manuel E. Tam
2009 Economic Intensification and Degenerative Joint Disease: Life and Labor on the Postcontact North Coast of Peru. *American Journal of Physical Anthropology* 139:204–221.

Klippel, Walter E.
1984 The Late Mississippian in the Nashville Basin: An Overview of Investigations at Averbuch. In *Averbuch: A Late Mississippian Manifestation in the Nashville Basin*, Vol. I, Observations, edited by W. E. Klippel and W. M. Bass, pp. I.14.11–11.14.14. The University of Tennessee, Knoxville, Tennessee.

Klippel, Walter E., and William M. Bass (editors)
1984 *Averbuch: A Late Mississippian Manifestation in the Nashville Basin*, Vol. I, Observations. The University of Tennssee, Knoxville, Tennessee.

Konigsberg, Lyle W., and S. R. Frankenberg
1995 Applications of Monte Carlo Methods to Radiocarbon Dating Problems in the Southeast. Paper presented at the 52nd Annual Meeting of the Southeastern Archaeological Conference, Knoxville, Tennessee.

Lewis, Thomas M. N., and Madeline Kneberg Lewis
1961 *Eva: An Archaic Site*. The University of Tennessee Press, Knoxville, Tennessee.

Mahfouz, Mohamed, Ahmed Badawi, Brandon Merkl, Emam E. Abdel Fatah, Emily Pritchard, Katherine Kesler, Megan Moore, Richard Jantz, and Lee Jantz
2007 Patella Sex Determination by 3D Statistical Shape Models and Nonlinear Classifiers. *Forensic Science International* 173:161–170.

Mauldin, Raymond P., Robert J. Hard, Cynthia M. Munoz, Jennifer L. Z. Rice, Kirsten Verostick, Daniel R. Potter, and Nathanael Dollar
2013 Carbon and Nitrogen Stable Isotope Analysis of Hunter‑Gatherers from the Coleman Site, a Late Prehistoric Cemetery in Central Texas. *Journal of Archaeological Science* 40(2):1369–1381.

Mendez-Ramirez, Krys
2012 "Thanksgiving and the Native American Holocaust," *Decolonize Krys*, November 20, 2012, http://decolonizechris.wordpress.com/2012/11/20/thanksgiving-and-the-native-american-holocaust/ (accessed January 23, 2013).

Milella, Marco, Maria Giovanna Belcastro, Christoph P. E. Zollikofer, and Valentina Mariotti
2012 The Effect of Age, Sex, and Physical Activity on Entheseal Morphology in a Contemporary Italian Skeletal Collection. *American Journal of Physical Anthropology* 148:379–388.

Molleson, Theya
1989 Seed Preparation in the Mesolithic: the Osteological Evidence. *Antiquity* 63:356–362.

Molnar, Petra

2006 Tracing Prehistoric Activities: Musculoskeletal Stress Marker Analysis of a Stone-Age Population on the Island of Gotland in the Baltic Sea. *American Journal of Physical Anthropology* 129:12–23.

Molnar, Petra, Torbjorn P. Ahlstrom, and Ido Leden

2009 Osteoarthritis and Activity—An Analysis of the Relationship Between Eburnation, Musculoskeletal Stress Markers (MSM) and Age in Two Neolithic Hunter–Gatherer Populations from Gotland, Sweden. *International Journal of Osteoarchaeology*.

Moore, Clarence B.

2002 *The Tennessee, Green, and Lower Ohio Rivers Expeditions of Clarence Bloomfield Moore*. University of Alabama Press, Tuscaloosa, Alabama.

Munoz, Cynthia M., Jennifer L. Z. Rice, Kirsten Verostick, Robert Har, and Raymond Mauldin

2013 A Stable Isotope Analysis of Hunter-gatherers from Hitzfelder Cave, Texas. Paper presented at the 116th Annual Meeting of the Texas Academy of Science, Kerrville, Texas, March 1, 2013.

Ortner, Donald J.

2003 *Identification of Pathological Condition in Human Skeletal Remains*. 2nd ed. Academic Press, London.

Owsley, Douglas W., and William M. Bass

1979 A Demographic Analysis of Skeletons from the Larson Site (39WW2), Walworth County, South Dakota: Vital Statistics. *American Journal of Physical Anthropology* 51:145–154.

Owsley, Douglas W., Hugh E. Berryman, and William M. Bass

1977 Demographic and Osteological Evidence for Warfare at the Larson Site, South Dakota. *Plains Anthropologist* 22(78):119–131.

Owsley, Douglas W., and Richard L. Jantz

1994 An Integrative Approach to Great Plains Skeletal Biology. In *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, edited by D. W. Owsley and R. L. Jantz, pp. 3–8. Smithsonian Institution Press, Washington.

Perttula, Timothy K.

2004 An Introduction to Texas Prehistoric Archeology. In *The Prehistory of Texas*, edited by T. K. Perttula, pp. 5–14. Texas A&M University Press, College Station, Texas.

Powell, Joseph F.
1994 Bioarchaeological Analyses of Human Skeletal Remains from the Mitchell Ridge Site. In *Aboriginal Life and Culture on the Upper Texas Coast: Archaeology at the Mitchell Ridge Site, 41GV66, Galveston Island*, edited by R. A. Ricklis, pp. 287–405. Coastal Archaeological Research, Inc., Corpus Christi, Texas.

Reed, Ann
1984 Site Investigations. In *Averbuch: A Late Mississippian Manifestation in the Nashville Basin*, Vol. I, Observations, edited by W. E. Klippel and W. M. Bass, pp. I.3.1–I.3.20.. The University of Tennessee, Knoxville, Tennesse.

Reed, Ann, and Walter E. Klippel
1984 Averbuch Features and Structures. In *Averbuch: A Late Mississippian Manifestation in the Nashville Basin*, Vol. I, Observations, edited by W. E. Klippel and W. M. Bass, pp. I.4.1–I.4.26. The University of Tennessee, Knoxville, Tennessee.

Ricklis, Robert A.
1994 *Aboriginal Life and Culture on the Upper Texas Coast: Archaeology at the Mitchell Ridge Site, 41GV66, Galveston Island*. Coastal Archaeological Research, Inc., Corpus Christi, Texas.

2004 The Archeology of the Native American Occupation of Southeast Texas. In *The Prehistory of Texas*, edited by T. K. Perttula, pp. 181–202. Texas A&M University Press, College Station, Texas.

Roberts, Charlotte, and Keith Manchester
2005 *The Archaeology of Disease*. 3rd ed. Cornell University Press, Ithaca, New York.

Rogers, J. Daniel
1990 *Objects of Change: The Archaeology and History of Arikara Contact with Europeans*. Smithsonian Institution Press, Washington DC.

Rossignol, M.
2004 Osteoarthritis and Occupation in the Quebec National Health and Social Survey. *Occupational and Environmental Medicine* 61:729–735.

Rothschild, Bruce M.
1997 Porosity: A Curiosity Without Diagnostic Significance. *American Journal of Physical Anthropology* 104:529–533.

Ruff, C. B.
1999 Skeletal Strucutre and Bhavioral Patterns of Prehistoric Great Basin Populations. In *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretations*, edited by B. E. Hemphill and C. S. Larsen, pp. 290–320. The University of Utah Press, Salt Lake City, Utah.

Schrader, Sarah A.
2012 Activity Patterns in New Kingdom Nubia: An Examination of Entheseal Remodeling and Osteoarthritis at Tombos. *American Journal of Physical Anthropology* 149:60–70.

Schroedl, Gerald F., C. Clifford Boyd, Jr., and R. P. Stephen Davis, Jr.
1990 Explaining Mississippian Origins in East Tennessee. In *The Mississippian Emergence*, edited by B. D. Smith, pp. 175–196. Smithsonian Institution Press, Washington DC.

Scruggs, Lang, Joel Gunn, and Norman Hitzfelder
1978 The Hitzfelder Bone Collection. *La Tierra* 5(2):20–31.

Steele, D. Gentry, and Claud A. Bramblett
1988 *The Anatomy and Biology of the Human Skeleton*. Texas A&M University Press, College Station, Texas.

Steen, Susan L., and Robert W. Lane
1998 Evaluation of Habitual Activities among Two Alaskan Eskimo Populations Based on Musculoskeletal Stress Markers. *International Journal of Osteoarchaeology* 8:341–353.

Stefanović, S., and M. Porčić
2011 Between-group Differences in the Patterning of Musculo-skeletal Stress Markers: Avoiding Confounding Factors by Focusing on Qualitative Aspects of Physical Activity. *International Journal of Osteoarchaeology*.

Stevens, S. D., and U. Strand Vidarsdóttir
2008 Morphological Changes in the Shape of the Non-pathological Bony Knee Joint with Age: A Morphometric Analysis of the Distal Femur and Proximal Tibia in Three Populations of Known Age at Death. *International Journal of Osteoarchaeology* 18:352–371.

Sullivan, Lynne P.
2007 A WPA Déjà Vu on Mississippian Architecture. In *Architectural Variability in the Southeast*, edited by C. H. Lacquement. The University of Alabama Press, Tuscaloosa.

Toumi, I., I. Higashiyama, D. Suzuki, T. Kumai, G. Bydder, D. McGonagle, P. Emery, J. Fairclough, and M. Benjamin
2006 Regional Variations in Human Patellar Trabecular Architecture and the Structure of the Proximal Patellar Tendon Enthesis. *Journal of Anatomy* 208:47–57.

Turner, Ellen S., and Thomas R. Hester
1999 *A Field Guide to Stone Artifacts of Texas Indians*. 3rd ed. Texas Monthly Field Guide Series. Gulf Publishing Company, Houston.

Ubelaker, Douglas H.
1979 Skeletal Evidence for Kneeling in Prehistoric Ecuador. *American Journal of Physical Anthropology* 51:679–686.

Weiss, E., L. Corona, and B. Schultz
2010 Sex Differences in Musculoskeletal Stress Markers: Problems with Activity Pattern Reconstructions. *International Journal of Osteoarchaeology*.

Weiss, E., and R. Jurmain
2007 Osteoarthritis Revisited: A Contemporary Review of Aetiology. *International Journal of Osteoarchaeology* 17:437–450.

Weiss, Elizabeth
2003 Understanding Muscle Markers: Aggregation and Construct Validity. *American Journal of Physical Anthropology* 121:230–240.
2004 Understanding Muscle Markers: Lower Limbs. *American Journal of Physical Anthropology* 125:232–238.

Wescott, Daniel J.
2001 Structural Variation in the Humerus and Femur in the American Great Plains and Adjacent Regions: Differences in Subsistence Strategy and Physical Terrain. Unpublished PhD dissertation, Department of Anthropology, The University of Tennessee, Knoxville, Tennessee.

White, Tim D., and Pieter A. Folkens
2005 *The Human Bone Manual*. Academic Press, Inc, San Diego, California.

Wolff, J.
1892 *Das Gesetz der Transformation der Knochen*. A. Hirschwald, Berlin.

Woods, Robert Jeffrey
1995 Biomechanics and Osteoarthritis of the Knee. Dissertation, Department of Anthropology, The Ohio State University, Columbus, Ohio.

VITA

Maggie Lynn McClain was born in Bryan, Texas, on December 29, 1980, the daughter of Danette Lynn Baylor and Ronald Keith Moore. After graduating from Taylor High School, Taylor, Texas, in 1998, she entered Trinity University in San Antonio, Texas. She received her Bachelor of Arts in Anthropology from Trinity University in 2002. During the following years, she served as the Laboratory Director for the Yalahau Human Regional Ecology Project in Quintana Roo, Mexico; worked as an archaeological field and laboratory technician for several Cultural Resources Management firms; served as editor and archaeologist for the Center for Archaeological Studies and Ecological Communications Corporation (now AmaTerra, Inc.); and taught English to Japanese high school students as an Assistant Language Teacher for the Japanese Exchange and Teaching Programme. In August 2010, she entered the Graduate College of Texas State University-San Marcos. Her interests include bioarchaeology, human variation, activity-related changes to the skeleton, and paleopathology.

Permanent E-mail Address: maggiemcclain@gmail.com

This thesis was typed by Maggie L. McClain.

Table 77. Significant Variations in Patellar Pathologies among Subsistence Regimes.

SUBSISTENCE STRATEGY	QFTE	PLE	LIP	CP	SO	EB
Agriculturalists	↑	↓		↑	rare	absent
Horticulturalists		↑		↓	rare	absent
Hunter-Gatherers				↓	absent	rare
Key: ↑=significantly high, ↓=significantly low, rare<2 individuals, absent=no individuals.						

Next, subsistence regimes were compared in pairs to see if one more closely resembled any other. Figure 34 illustrates the relationship between the three subsistence groups based on patellar pathologies that were similar (i.e., no significant difference was detected). While horticulturalists share patterns of patellar pathologies with agriculturalists and hunter-gatherers, there were fewer significant differences between horticulturalists and hunter-gatherers.

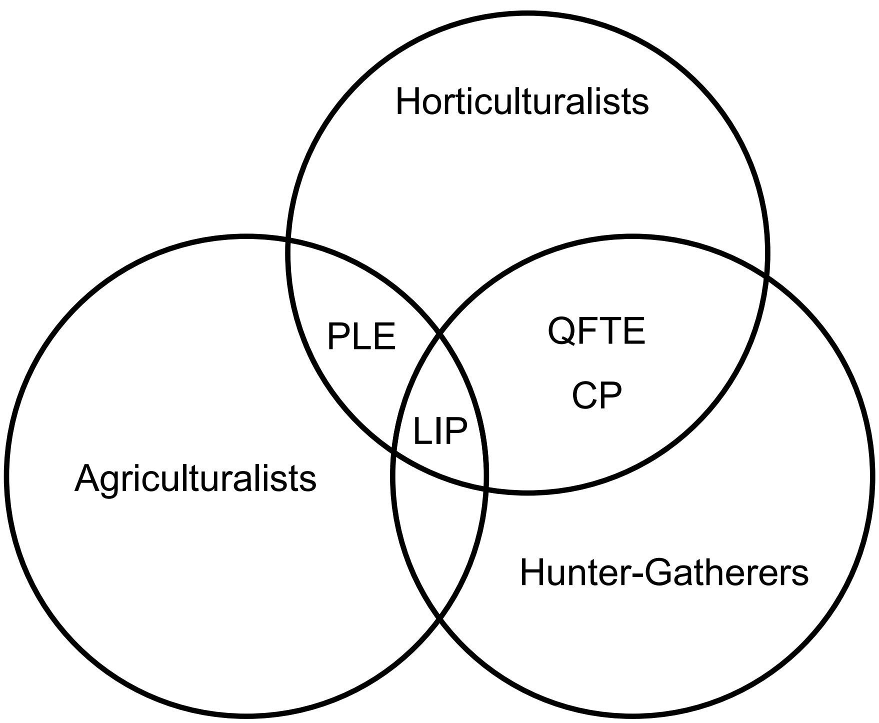

Figure 34. Patellar pathologies shared between subsistence regimes.