2002

A study of the Poole-Rose ossuary ulnae: demography, defleshing and degenerative joint disease

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A STUDY OF THE POOLE-ROSE OSSUARY ULNAE: DEMOGRAPHY, DEFLESHING AND DEGENERATIVE JOINT DISEASE

A Thesis
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in
The Department of Geography and Anthropology

By
Natalie Anne Bodin
B.G.S., Louisiana State University, 2000
August, 2002

ACKNOWLEDGMENTS

I would like to thank the Alderville First Nation, especially Chief Nora Bothwell, for understanding the valuable information to be gained from studying the Poole-Rose ossuary.

I would like to thank my thesis committee. Thanks to Dr. Heather McKillop for allowing me the opportunity to study the Poole-Rose ossuary which she excavated. Dr. Jill Brody, thank you for stepping in at the last minute to be on my thesis committee and for always being interested in my future. And most of all, thank you to Mrs. Mary H. Manhein, my advisor, for always pushing me to do my best, giving me so much of her time, and allowing me to get invaluable experience working in her lab. I will always be grateful for your support.

I would like to thank Mrs. Mary Lee Eggart. The drawings that you provided me are beautiful. They make this thesis complete.

I would like to dedicate this thesis to Patricia Palmer and L.A. Martin. Mom, thank you for always being excited to help me in any way that I needed, loving me unconditionally and supporting my decisions even when you might not have agreed with me. You are the best mom in the world. I could not have done it without you. I miss you very much! L.A., thank you for all of your love and support, and believing in me when I didn’t believe in myself. And of course, thank you for taking the wonderful pictures of my bones and for keeping me company during all of those late night hours in the lab.

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ABSTRACT

The Poole-Rose ossuary, a prehistoric Native Canadian population from Ontario, Canada, represents a Late Woodland period communal burial that has been radio-carbon dated to 1550 A.D. +/- 50 years. The location and attributes of this ossuary, a secondary burial deposit, led the site's excavator, Dr. Heather McKillop, to believe that it is a part of the "Feast of the Dead" ceremony.

Due to commingling of the individuals, the human remains from this ossuary have been analyzed by element. This thesis examines the ulnae, one of the bones of the forearm, for evidence of degenerative joint disease. Additionally, the thesis includes analysis of cutmarks on the ulnae associated with defleshing of the remains as part of a burial preparation ceremony.

A minimum number of 221 individuals (MNI) are represented by the left ulnae in this population. Analysis of degenerative joint disease (DJD) included examination of pitting, lipping and eburnation on all joint surfaces. A chi-square analysis of DJD on the ulnae indicates a significant relationship ($p \leq 0.05$) between locations where the DJD is present. However, no significant relationship exists in terms of the side of occurrence of DJD (left versus right), with the exception of distal lipping.

Cutmark analysis reflects that defleshing cutmarks on the ulnae are randomly distributed between left and right ulnae and on the shafts.

CHAPTER 1
INTRODUCTION

Analysis of human skeletal remains can help researchers identify many aspects of everyday life of the population being studied. Features of population demographics, such as sex and age, as well as health and disease, can be generated from analyzing skeletal remains. Trauma on the bones can tell researchers about injuries that occurred while the person was living (antemortem), injuries that may have caused the person’s death (perimortem), and customs that the population may have practiced that alter the bones after death (postmortem). The researcher must be able to distinguish between cultural alterations, such as defleshing cutmarks, and trauma that occurred during excavation.

Occasionally, researchers have the opportunity to study human remains which have been buried over a brief span of time and which represent a window into the past regarding a particular population. Such is the case of the Poole-Rose ossuary in Southern Ontario, Canada.

The Poole-Rose ossuary was discovered in the summer of 1990 when a contractor was making additions to a house. A trench was dug, exposing skeletal remains that appeared to be only a small burial (McKillop and Jackson 1991). Chief

Nora Bothwell of Alderville First Nation asked Dr. Heather McKillop to excavate the site. The ossuary contained disarticulated human remains representing several hundred individuals and three flexed burials of adults that remained articulated (McKillop and Jackson 1991).

A late prehistoric date of 1550 +/- 50 years was obtained for this site (McKillop and Jackson 1991). The burial patterning resembles the Huron ceremony, the “Feast of the Dead.” Dr. McKillop and the Alderville First Nation made an agreement for the study of the remains and they were brought to Louisiana State University for a comprehensive analysis.

The current study focuses on the ulnae that were excavated from the Poole-Rose ossuary. The ulnae were analyzed for degenerative joint disease (DJD). Additionally, cutmark alterations were observed that may have occurred during preparation for the “Feast of the Dead”.

CHAPTER 2:
THE HURON AND THE FEAST OF THE DEAD

The Poole-Rose ossuary resembles the “Feast of the Dead” ceremony performed by the Huron. The region occupied by the Huron people included southern Ontario on the peninsula between Lake Simcoe and the Georgian Bay. The Poole-Rose ossuary is indicated by the dot (see Figure 2.1). The Huron were farmers.

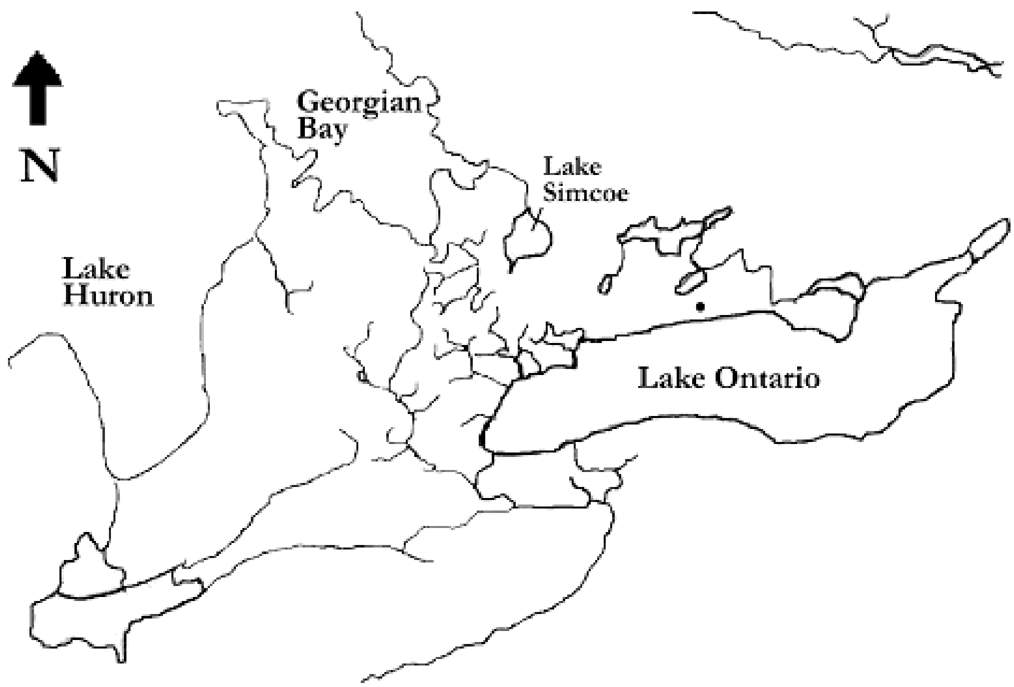

Figure 2.1: Map of Southern Ontario Showing the Location of the Poole-Rose Ossuary (Modified from McKillop and Jackson 1991)

Overlapping hunting territories led four tribes in the area to form a common hunting territory called the Huron

Confederacy (Trigger 1969). The Huron Confederacy was formed around A.D. 1500-1600. All of the tribes in the Huron Confederacy shared a common language.

The Huron villages were made up of clusters of longhouses, which provided living quarters for extended families as well as meeting places. The largest villages housed 1,500-2,000 people in 40 or more longhouses (Melbye 1985; Trigger 1969). Palisades, consisting of three rows of wooden poles woven together and filled with branches and bark, surrounded villages for protection (Trigger 1969). Each longhouse functioned independently of the others and contained many nuclear families that shared in housework (Trigger 1969).

The Huron were predominately agriculturists but their subsistence activity also included fishing, hunting and gathering (Melbye 1985). The Huron had a sexual division of labor. Women were responsible for the agricultural component of the diet, including planting, harvesting and processing of crops such as maize, beans, pumpkin and squash. They also were responsible for gathering wild berries, acorns and other plants. Duties for the males consisted of hunting, fishing, and clearing land for planting. The men would leave in the fall for one month's time on hunting excursions. Deer was the principal game but the Huron also hunted duck, muskrat, rabbit and bear (Trigger 1969). Hunting was more important to the Huron for the skin that it provided for clothing rather than for the meat. Fishing, practiced year round, was the main source of meat for the Huron.

Farm plots belonged to nuclear families, who cultivated as much land as possible (Trigger 1969). Any uncleared land was community property for anyone to use. The Huron were slash and burn agriculturists. They burned the fields and continuously weeded the land and planted crops to prevent the depletion of nutrients in the soil for as long as possible. However, the Huron villages still had to move every eight to ten years (Melbye 1985; Trigger 1969).

Death and the afterlife were important aspects of the Huron community. Typically, the Huron buried their dead in a grave, log crib or on a scaffold in a village cemetery immediately following death (Trigger 1969). This was a primary burial. Every eight to ten years when the community moved, the Feast of the Dead ceremony took place.

The Huron believed that the afterlife was like life on earth. The dead participated in activities similar to those practiced during life as they would if alive. Protection of the dead was important to the Huron: if a fire broke out in a village, the initial efforts were to protect the cemetery. The Huron believed that when the deceased was brought to the cemetery for initial burial, the spirit of that person walked before the body and wandered the village until the Feast of the Dead, at which time the soul would then leave the community for the afterlife (Trigger 1969).

The Feast of the Dead was a celebration where the Huron re-interred, in a communal burial pit called an ossuary, all who died the previous eight to ten years (except those who drowned, died in war, committed suicide, died very young or very old) (McKillop and Jackson 1991, Trigger 1969). The Feast of the Dead ceremony lasted ten days, throughout which continuous feasting, dancing and games took place.

This feast began with excavation of the primary burial site by the family members of the deceased. A female family member was responsible for cleaning the bones, including stripping any remaining tissue. The preparation took eight days to complete. The clean bones were then wrapped in beaver pelts and stored in a longhouse with gifts until time for the ceremony to take place (Trigger 1969).

Neighboring tribes were told about the Feast of the Dead so they could include their dead in the ceremony. This helped to promote good relations between tribes. The Huron believed that since their relatives’ bones were united, they should also be united (Trigger 1969). Everyone who wished to attend the ceremony would move in a slow procession from village to village, also strengthening friendships.

Near the end of the time of re-interment, the bodies were placed around the edge of the pit, which was approximately ten feet deep and fifteen feet or more across. The skeletons were possibly packed into baskets, carried to the edge of the pit and scattered over the bottom of the grave (Churcher and Kenyon 1960). All attendees spent the final night around the ossuary. At sunrise, the bones were thrown into the pit. Five or six men stirred the bones in the pit to create a homogeneous mass (Trigger 1969). After the pit was refilled, the remainder of the morning was spent distributing gifts to those present. The Feast of the Dead ceremony was important to the Huron for religious purposes, for building inter-tribal relationships, for economic reasons, such as showing off wealth by giving gifts, for honoring the deceased and for bringing closure for the grieving families.

CHAPTER 3:
LITERATURE REVIEW

This thesis research centers around the analysis of the ulna, one of the two bones of the forearm. An understanding of the form and function of the ulna will assist in understanding the disease processes and cultural alterations that might affect it.

The ulna is the longest bone in the forearm. The proximal ulna articulates with the trochlea of the humerus and the head of the radius. The distal ulna articulates with the ulnar notch of the radius and with an articular disk that separates the ulna and the carpal bones of the hand (White 1991). Movement at joints is controlled and limited by the shape of the articular surfaces and the ligaments that hold the joints stable. The joints that the ulna participates in are freely moving joints called synovial joints.

Synovial joints are coated with a thin layer of slick articular cartilage called hyaline cartilage. The joint cavity, the area between the two bones, is filled with synovial fluid that acts as a lubricant and nourishes the cartilage cells of the joint (White 1991). The synovial fluid is held in the joint cavity by the joint capsule, connective tissue attached to the bone by ligaments. The hyaline cartilage and the synovial fluid allow the bones to move without much friction.

Cutmarks

The Huron clearly practiced defleshing and disarticulation during the Feast of the Dead. They probably removed the flesh from a body by cutting the muscle with chert stone tools. The sharp tips of these instruments would cause damage that is fine, linear, and subparallel (Fernandez-Jalvo et al. 1999). Cutmarks created, as a result of the Feast of the Dead, should follow this pattern. If the bone shows any signs of healing at the cutmark, then the mark would have been made antemortem and, thus, is not a result of defleshing or disarticulation. The color on a bone that had been marked at the time of placement into the ossuary should be the same color as the rest of the bone. A mark lighter in color than the surrounding bone would suggest the cut occurred during excavation or storage.

The time since death (postmortem interval or PMI) may have attributed to the degree in difficulty in defleshing and disarticulation. A body that had been decomposing for a longer period of time would likely have less tissue to be removed than a recently deceased body. However, if the body had been allowed to dry out and become mummified, the tissue may be tenacious and hard to remove. Thus, requiring more pressure and possibly causing more cutmarks.

The muscles of the ulna are not very robust and probably did not require much pressure to cut for the people who prepared the bodies of the Poole-Rose ossuary. Four major muscles attach to the ulna: triceps brachii, brachialis, supinator, and pronator quadratus (White 1991). However, many smaller muscles may also have played a role in cutmarks left on the ulna from defleshing. These muscles are: abductor pollicis longus, anconeus, extensor indicis, extensor pollicis longus, flexor carpi ulnaris, flexor digitorum profundus, flexor digitorum superficialis, flexor pollicis longus, and pronator teres.

The long head of the triceps brachii originates at the infraglenoid tubercle of the scapula (see Figure 3.1). The medial head originates on the distal two-thirds of the medial and posterior surfaces of the humerus. The lateral head originates on the upper half of the posterior surface of the humerus. The triceps brachii stretches the length of the humerus and inserts on the posterior surface of the olecrenon process of the ulna. The function of the triceps brachii is to extend the forearm.

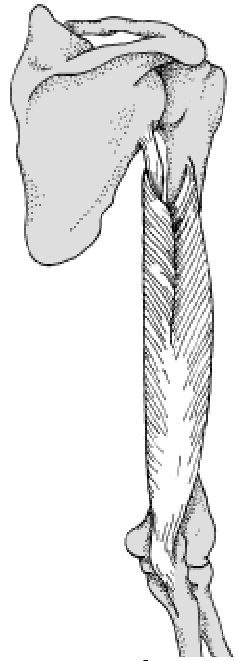

Figure 3.1: Triceps Brachii
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The brachialis muscle originates from the anterior surface of the humerus and inserts onto the ulna on the brachial tuberosity and on the coronoid process (see Figure 3.2). The function of the brachialis is flexion of the forearm.

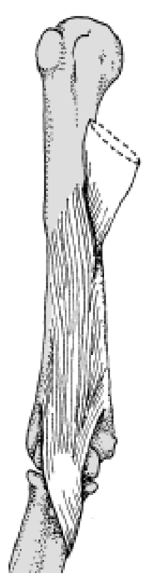

Figure 3.2: Brachialis
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The supinator is a large muscle that wraps around the ulna and radius (Bowden and Bowden 2002). The supinator is covered by more superficial muscles. The supinator originates on the lateral epicondyle of the humerus and supinator crest of the ulna (see Figure 3.3). The supinator inserts on the lateral surface of the upper one-third of the radius. The function of the supinator is supination of the forearm (see Figure 3.4).

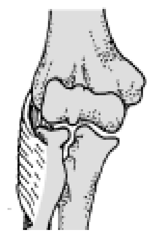

Figure 3.3: Supinator
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

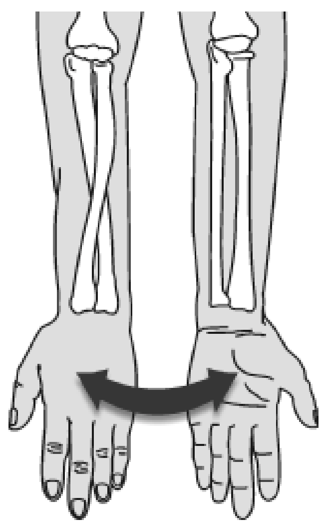

Figure 3.4: Pronation/Supination
adapted from Bowden and Bowden (2002) by Mary Lee Eggart
Pronation   Supination

The pronator quadratus muscle is the deepest muscle of the distal forearm (Bowden and Bowden 2002). The pronator quadratus originates on the medial anterior surface of the distal one-fourth of the ulna, along the pronator ridge (see Figure 3.5). The pronator quadratus inserts on the lateral anterior surface of the distal one-fourth of the radius. The function of the pronator quadratus is pronation of the forearm (see Figure 3.4).

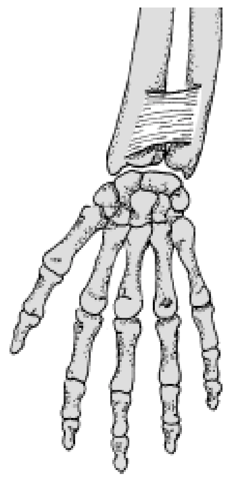

Figure 3.5: Pronator Quatratus
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The abductor pollicis longus muscle originates on the posterior surface of the ulnar body, distal to the supinator muscle, and also on the interosseous membrane and middle one-third of the radial body (see Figure 3.6). It inserts on the base of the dorsal surface of the first metacarpal. The function of this muscle is to abduct and extend the thumb and abduct the wrist.

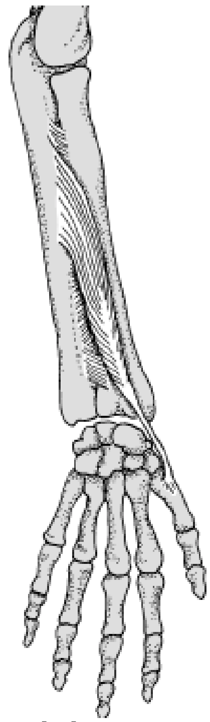

Figure 3.6: Abductor Pollicis Longus
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The anconeus muscle is a small muscle that aids the triceps brachii (Bowden and Bowden 2002). It originates on the posterior surface of the lateral epicondyle of the humerus (see Figure 3.7). The anconeus inserts on the lateral surface of the olecrenon process and the posterior proximal surface of the ulna. The function of the anconeus is extension of the forearm and stabilization of the elbow.

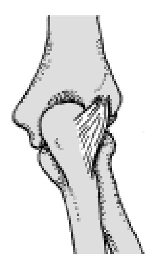

Figure 3.7: Anconeus
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The extensor indicis originates on the interosseous membrane and posterior surface of the ulna (see Figure 3.8). The extensor indicis inserts onto the dorsal surface of the proximal phalanx of the index finger. The function of this muscle is extension of the index finger.

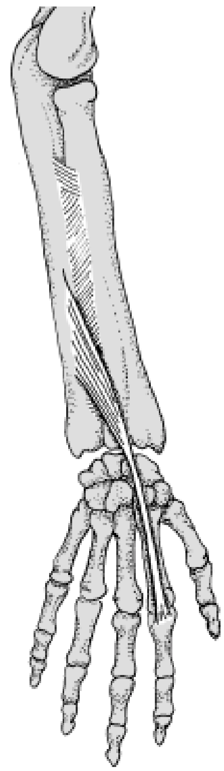

Figure 3.8: Extensor Indicis
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The extensor pollicis longus originates on the interosseous membrane and middle one-third posterior surface of the ulna (see Figure 3.9). This muscle inserts on the dorsal surface of the distal phalanx on the thumb. The function of the extensor pollicis longus is extension of the interphalanangeal joint and assistance in extension of the metacarpophalangeal joint of the thumb. Also, it aids in abduction and extension of the wrist and lateral rotation of the thumb.

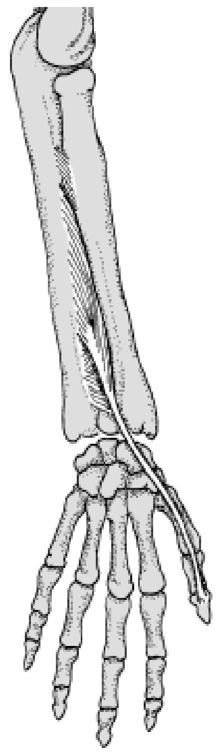

Figure 3.9: Extensor Pollicis Longus
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The humeral head of the flexor carpi ulnaris originates on the medial epicondyle of the humerus (see Figure 3.10). The ulnar head of the flexor carpi ulnaris originates on the olecrenon process and proximal two thirds of the posterior surface of the ulna. The insertion points of the flexor carpi ulnaris are on the pisiform, hamate, and base of the fifth metacarpal. The function is flexion and adduction of the wrist.

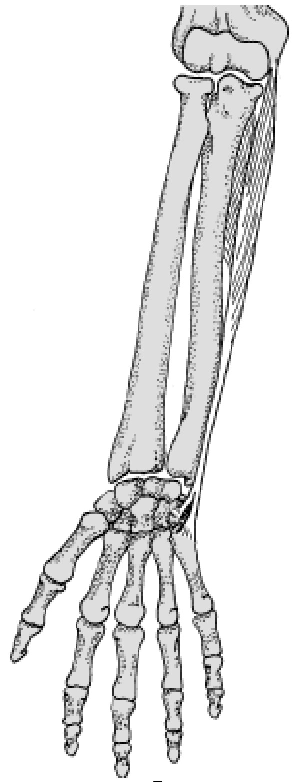

Figure 3.10: Flexor Carpi Ulnaris
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The flexor digitorum profundus originates on the interosseous membrane, the medial and anterior surface of the proximal three-fourths of the ulna (see Figure 3.11). The muscle inserts, through tendons, on digits two through four of the distal phalanges. The function is flexion of the distal interphalangeal joints of digits two through four, the adduction of the index, ring, and little fingers, and flexion of the wrist.

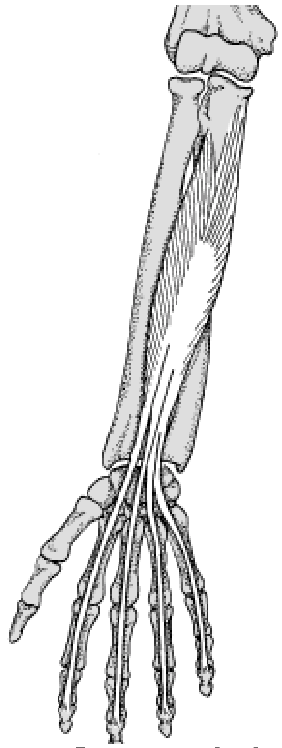

Figure 3.11: Flexor Digitorum Profundus
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The humeral head of the flexor digitorum superficialis originates on the epicondyle of the humerus and the medial margin of the coronoid process of the ulna (see Figure 3.12). The radial head of the flexor digitorum superficialis originates on the anterior surface of the shaft of the radius. The muscle inserts, through tendons, on the middle phalanges of digits two through four. The function is flexion of the wrist and middle phalanges of the four fingers.

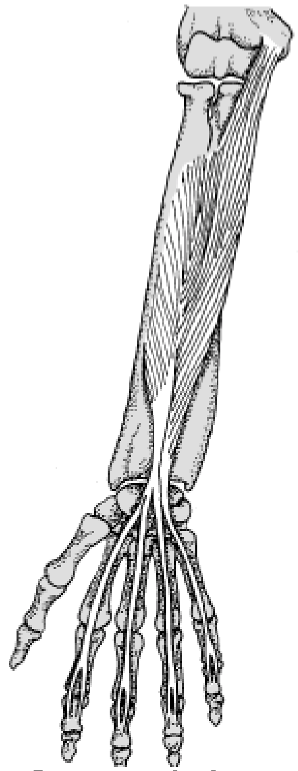

Figure 3.12: Flexor Digitorum Superficialis
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The flexor pollicis longus originates on the interosseous membrane and middle anterior shaft of the radius, the medial epicondyle of the humerus and the coronoid process of the ulna (see Figure 3.13). It inserts on the base of the palmar surface of the distal phalanx of the thumb. The function is flexion of the thumb.

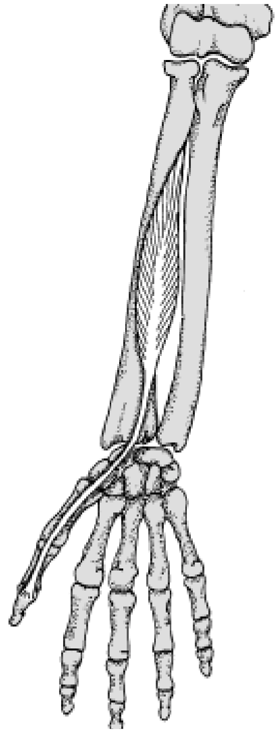

Figure 3.13: Flexor Pollicis Longus
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

The humeral head of the pronator teres originates above the medial epicondyle of the humerus (see Figure 3.14). The ulnar head of the pronator teres originates on the medial surface of the coronoid process of the ulna. The insertion point is the lateral surface of the radius. The function is pronation of the forearm and assisting flexion of the elbow.

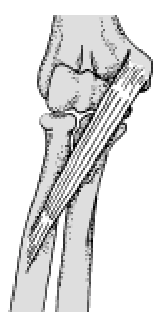

Figure 3.14: Pronator Teres
adapted from Bowden and Bowden (2002) by Mary Lee Eggart

All muscles that attach to the ulna must be examined when analyzing cutmarks. Cutmarks should be more numerous where there are stronger muscle attachments. Close analysis of the areas where these muscles attach will help us to understand what the family members of the people of the Poole-Rose ossuary did to prepare their bodies for the Feast of the Dead.

Degenerative Joint Disease

Arthritic conditions are many of the most common diseases that affect the human body, in modern humans as well as past populations. Even fossil remains of dinosaurs show evidence of arthritic changes at the joints (Wells 1964). The term arthritis, literally inflammation of the joints, incorporates many conditions that affect the joint, though all such problems do not always involve inflammation. The most commonplace condition that is included under the rubric arthritis is degenerative joint disease (DJD). DJD is a disorder that involves the mechanical deterioration of skeletal articulations that result in the buildup of bone along the joint edges or the disintegration of the bone on the joint surface, or both (Larsen 1995). DJD is caused by “wear and tear” of the joints. The occurrence of DJD in a population is often used by physical anthropologists to suggest the activity level of that population.

There are two subcategories of DJD, primary and secondary. Primary DJD involves failure at local or general (three or more) sites. The joint failure has no apparent preexisting condition that contributes to the joint deterioration (Aufderheide and Rodriguez-Martin 1998, Resnick and Niwayama 1995). Primary DJD is also called idiopathic osteoarthritis. Primary DJD is the cause of 80% of the cases of DJD (Aufderheid and Rodriguez-Martin 1998). Secondary DJD is a result of inflammatory changes of joint tissue that cause degeneration of the joint. Secondary DJD involves secondary arthritic changes of joints due to a preexisting condition or abnormality, i.e. trauma or disease.

Although DJD has been studied intensely in a clinical and anthropological setting, there has been no clear-cut finding as to the primary cause of the disease. Multiple factors have been used to explain DJD, including mechanical-functional and systemic factors (Jurmain 1978). Mechanical-functional factors that affect DJD are injury, weight gain, physical activity, and environmental or occupational stress. Systemic factors that affect DJD are sex, metabolism, hormones, age and nutrition.

Skeletal analysis is the most useful method for determining the etiology of DJD. Mechanical-functional factors, such as stress, cause degeneration of the joints in an asymmetrical fashion. Conversely, systemic factors, such as age, should affect both sides of the body equally. Both categories potentially would have affected the people of the Poole-Rose ossuary.

In terms of etiology, age is the most common cause of arthritic degenerative changes. However, advancing age cannot be used as the only explanation for degeneration. DJD is seen in older individuals but also on rare occasion in young individuals as well. There have been cases of young individuals who are severely affected by DJD and cases of older individuals who are completely unaffected by the disease (Jurmain 1977). These findings indicate that no one cause is completely responsible for the development of DJD.

The primary cause of DJD is not entirely agreed upon. The most common explanation for the cause of DJD is that the loss of articular cartilage is the vehicle for arthritis. DJD is the destruction of articular cartilage of synovial or freely movable joints that leads to characteristic changes, including bony lipping, porosity of the joint surface and eburnation (Bridges 1992).

Eburnation refers to areas where cartilage has been destroyed and the underlying bone is exposed. This exposed bone becomes dense and smooth from chronic rubbing of bone on bone. Eburnation can be identified by the shiny surface created.

An alternative explanation for the cause of DJD involves mini-fractures compiled over time on the joint surface (Resnick and Niwayama 1995). These fractures are caused by excessive joint overload. New bone will continually add to old bone to repair the fractures. This causes the bone at the joint to become thick, which inhibits the joint’s ability to absorb stress and strain properly. The articular cartilage that surrounds the joint must take up the excess pressure, causing the cartilage to become overloaded and to break down.

Degenerative joint disease follows the same developmental stages in both modern and prehistoric people (Brothwell 1961). The first step is the destruction of the cartilage at the joint. Next, the surface of the bone becomes worn down from the action of bone on bone. As this happens, bony lipping develops at the edges of the joints.

Since modern groups show an increase in DJD caused by direct injury to a joint and/or excessive stress and strain to the joint, many anthropologists believe that humans have always been affected by DJD. Some have also noted obvious cases of DJD in Neandertal populations from thousands of years ago.

Degenerative joint disease is a useful tool for creating a profile of a prehistoric population. Bridges (1992) states that in prehistoric Native American groups, the knee is the most common location of DJD, with the elbow being the second most common location. However, in most modern cases, the hip and shoulders are the most common locations for DJD, and the elbow is the least common (Bridges 1991). This difference in location is indicative of lifestyle differences between the two populations.

Harris (1994) found that the remains from the ossuary of Cahiague showed considerable DJD in the spine but rarely in other joints. Analysis of the Fairty ossuary showed that DJD occurred on about 19% of the proximal ends of the ulna and about 15% of the distal ends of the ulna (Anderson 1964). Pfeiffer (1985) found that archaic people from the Great Lakes region had mild cases of DJD. Jurmain (1990) also found only mild expression of DJD in his studies of prehistoric people from California.

In general, the joints of the shoulder and elbow show more arthritis on the right side of the body than the left side of the body. Since most humans are right-handed, one would not be surprised to see this bilateral asymmetry between the left and right arm. Asymmetry seen in the arms may also suggest the use of tools such as tools used for agriculture or spears.

The presence and location of DJD are used by physical anthropologists to suggest such things as sex roles and technological levels in prehistoric communities. In communities that are known to have been agriculturalists, researchers have found more widespread difference between the sexes for the presence of DJD. Males show more prevalence of arthritis at the elbow, knee, and the vertebrae (Larsen 1982). Hunter-gatherer communities from Alabama show few sexual differences at all of the major joints with virtually no sexual differences seen in the vertebrae (Bridges 1992). Jurmain (1977) found high levels of arthritis in Eskimo males showing extreme differences between males and females at the elbow, hip, knee and especially the shoulder. Brothwell (1961), who studied early British skeletal remains, found that the femur is by far the most susceptible long bone to arthritis, followed closely by the humerus, with the ulna demonstrating the least amount of arthritic change. He found no significant differences between the sexes.

Some physical anthropologists suggest that the presence of more arthritis in males than females is evidence of more rigidly defined sex roles in prehistoric communities than modern communities. However, Bridges (1991) found that hunter-gather groups from the Southeastern United States, where males did the majority of the high impact work acquiring food, show fewer differences between the sexes with regard to arthritis than do agricultural groups from the same region. Goodman et al. (1984) states an increase in both occurrences of arthritis and sexual differences as the society changed from hunter-gatherer to agriculture at the Dickson Mounds. Agriculturists had a more sedentary lifestyle than hunter-gathers and, therefore, one would expect that agriculturalists had less injury due to food gathering. Also, many scientists commonly agree that females did most of the work in agricultural societies and males still show the most arthritis.

Variation in the presence and location of DJD must also be taken into account when analyzing a community. It is seen not only between groups but also within groups. Variation is seen in the degree and location of DJD as well as in distribution between the sexes.

Larsen (1995) suggests that bilateral elbow arthritis in women from American Southwest communities demonstrates the equal use of both arms. He believes that this is evidence of actions such as cereal making by pounding flour with grinding stones. Larsen also believes that these distinctive patterns of DJD wear are useful in distinguishing between hunter-gatherer groups and agricultural groups.

Distinguishing DJD from postmortem trauma may be especially challenging for ossuary remains because of bone friction within the burial. Porosity in DJD is identified as pits in the cortical bone that are symmetrical in shape (Rogers and Waldron 1995). The edges of the pits may be undercut, which helps to distinguish porosity from postmortem damage. Porosity itself is not a good indicator of DJD because even healthy bone can exhibit pitting. A hole that may be identified as caused by thinning bone in DJD may actually be caused by vascular invasion, which occurs in healthy bone (Jurmain 1999).

Lipping, also called marginal osteophytes, results from cartilage metaplasia occurring at the periphery of the joint (McCarthy and Frassica 1998). Lipping appears as a slightly raised ridge around the margin of the joint or as thick bony protrusions along the articular rim.

Eburnation occurs only in advanced stages of DJD when two bones are rubbing directly against each other because the articular cartilage is completely eroded or severely damaged. The rubbing action of the two bones causes the surface to become smooth and shiny. Eburnation is considered diagnostic of DJD (Rogers and Waldron 1995).

The major research problem with DJD is the lack of consistency in classifying degenerative joint disease. There have been numerous studies concerning DJD. However, there is a serious problem with comparing the studies. Each study uses the researcher’s own method for classifying and scoring the DJD.

The coding of arthritis is somewhat subjective because the scores rely on visual inspection. Yet, the number and size of pitting or the amount of the bone that shows lipping can be measured and seriated.

This study followed the guidelines described in the book, *Standards for Data Collection from Human Skeletal Remains, Research Series No. 44*, by Buikstra and Ubelaker (1994) to help standardize data collection. This may allow future researchers to compare and contrast this work with others.

CHAPTER 4:
MATERIALS AND METHODS

My study includes the ulnae of the Poole-Rose ossuary. The ulnae had been cleaned and catalogued by students and faculty prior to this study. The workers then entered the catalogued specimens into a computer database.

In this research, complete and fragmented ulnae were examined. It is possible that there were additional fragmented ulnae that were not analyzed due to the inability to identify them. The ulnae were sorted by their unit number. Any fragments that could be matched and reconnected were recorded for my study using the lowest of the numbers assigned to the fragments. The ulnae then were sided or put into an “unknown” category. Additionally, the complete ulnae were measured for maximum length using an osteometric board as described in Bass (1987).

Minimum number of individuals (MNI), cut-mark locations, sex and adult versus subadult were also estimated and recorded. To determine MNI, the ulna joint surfaces were counted. The proximal ulnae were used to determine MNI because they were the most numerous. The radial notch, proximal olecrenon process and the most projecting point of the coronoid process were each counted to calculate MNI.

To determine sex, this researcher employed seriation. Left, right and unknown sides were separated. The seriated ulnae for each side were divided into four groups based on size.

The top one-fourth was designated as male. The bottom one-fourth was designated as female. And the middle one-half was designated as unknown.

Adult was distinguished from subadult by epiphyseal fusion. If epiphyseal fusion was partial or incomplete, the ulna was classified as subadult.

All ulnae were examined under a 10X-magnifying binocular microscope for cut-marks. The ulnae with cut-marks were recorded on diagrams that had been divided into six zones: proximal anterior, proximal posterior, shaft anterior, shaft posterior, distal anterior and distal posterior.

Each joint surface (the olecrenon process, the coronoid process, the radial notch, all on the proximal end, and the radial articulation on the distal end) was examined for degenerative joint disease (DJD). The ulnae were analyzed under a 10X-magnifying binocular microscope to determine postmortem (taphonomy) from premortem (DJD) pitting. Lipping and eburnation were examined macroscopically. Each category of DJD was classified as not present, slight, or moderate/severe. Those with moderate and severe DJD were grouped together because of the small numbers in both groups.

The data were entered into a Microsoft Excel XP spreadsheet for statistical analysis. Two-way frequency tables were created to compare the presence and severity of DJD by joint location, side, and in relation to other DJD traits. Chi-square tests were used to determine which frequencies were statistically significant. The level of significance was 0.05. Where they are higher, this information is noted on the tables.

CHAPTER 5:
RESULTS

The total number of specimens in this study, including whole bones and fragments, was 825, including 377 right, 354 left and 94 unknown. Of the 825 total ulna specimens, 48 were from subadult and 777 were from adult. Sixty-six of the ulnae are complete and 759 are fragments. Table 5.1 shows the distribution of bones.

Table 5.1 Distribution of Ulna in the Poole-Rose Ossuary by Age and Side

	Adult Complete	Adult Fragmented	Subadult	Total
Right	30	339	8	377
Left	36	303	15	354
Unknown	0	69	25	94

Minimum Number of Individuals

The minimum number of individuals (MNI) was calculated for this analysis of the Poole-Rose ossuary by examining the proximal joints: radial notch, olecrenon process, and coronoid process. At least 51% of the feature had to be present to be included in MNI. A maximum MNI of 221 was computed using the left radial notch (See Table 5.2). This figure is somewhat low when compared to the MNIs of 337 and 250 of analyses of the cranium and hips; yet, this simply may represent a loss of smaller bones due to lack of preservation or during movement from the primary burial location. Due to the difficulty in distinguishing individual features of juvenile ulnae, they were not included in MNI. This also may be a factor in the lower MNI of the ulnae when compared to the other studies that have been completed on the Poole-Rose ossuary.

Table 5.2: Minimum Number of Adult Individuals (MNI) for the Ulnae from the Poole-Rose Ossuary

	Radial Notch	**Olecrenon Process**	**Coronoid Process**
Left	**221**	183	215
Right	215	194	215

This MNI calculation is consistent with previous studies completed on the Poole-Rose ossuary (See Table 5.3). The highest MNI calculated has been 337, using the right petrous portion of the skull(Seidemann 1999). The lowest MNI calculated has been 161, using the supraorbital notch of the skull (Smith 1997).

Table 5.3: MNI Reports from Previous Studies on the Poole-Rose Ossuary

Reference	Feature	MNI
Seidemann, 1999	Right Petrous Portion of the Skull	337
Tague, et al. 1998	Left Illium of the Innominates	250
Lundin, 2000	Deltoid Tuberosity of the Humerus	249
Parks, 2002	Left Nutrient Foramen of the Radius	205
Dunne, 1999	Second Cervical Vertebra	204
Smith, 1997	Supraorbital Notch of the Skull	161

Sex Assessment

Sex was assigned to the ulna by seriation. The location along the seriated line was based strictly on the overall robustness of the ulna. The ulnae were subjectively divided into three groups; male, unknown and female (see Table 5.4).

Table 5.4: Sex Assessment of the Ulnae from the Poole-Rose Ossuary

	Male	Unknown	Female
Left	88	163	88
Right	85	182	102

Measurements of Complete Ulna

The maximum length of the ulna was measured on all of the complete bones. Using an osteometric board, the maximum length of the ulna was taken from the top of the olecrenon process to the tip of the styloid process (Bass 1987). The

Poole-Rose ossuary contained 66 complete ulnae. The average maximum length for all of the whole ulnae is 275.4 mm, for female ulnae is 240.8 mm and, for male ulnae is 293.4 mm. The average height of the males from the Poole-Rose ossuary, based on the stature estimation described by Bass (1987) for Mongoloid males, is between 68.8 inches and 72.5 inches. There is no formula to calculate Mongoloid female's height using the ulnae.

Cutmarks

Cultural alteration of the ulna in the form of cutmarks should correspond to the origin and insertion points of muscles of the ulna if the cutmarks are from defleshing and disarticulation (See Table 5.5). The cutmarks were classified into zones as described in *McMinn's Color Atlas of Human Anatomy* (Abrahams et al. 1998)(see Table 5.6, Figure 5.1). The results of this classification are seen in Table 5.7. For an example of cutmarks on an ulna from the Poole-Rose ossuary, see Figure 5.2.

Table 5.5: Muscle Insertion/Origin Sites on the Ulna

Insertion/Origin	Muscle
Posterior Olecrenon Process	Triceps Brachii
Brachial Tuberosity, Coronoid Process	Brachialis
Supinator Crest	Supinator
Pronator Ridge	Pronator Quadratus
Posterior Body	Abductor Pollicis Longus
Lateral Olecrenon Process, Posterior Proximal Surface	Anconeus
Interosseous Membrane, Posterior Surface	Extensor Indicis
Olecrenon Process, Posterior Surface	Flexor Carpi Ulnaris
Interosseous Membrane, Medial and Anterior Surface	Flexor Digitorum Profundus
Medial Margin of Coronoid Process	Flexor Digitorum Superficialis
Coronoid Process	Flexor Pollicis Longus
Medial Coronoid Process	Pronator Teres

Table 5.6: Legend for Cutmark Zones

1. Abductor Pollicis Longus
2. Anconeus
3. Flexor Digitorum Profundus, Flexor Carpi Ulnaris, Extensor Carpi Ulnaris
5. Brachalis
7. Extensor Indicis
9. Extensor Pollicis Longus
10. Flexor Digitorum Profundus
12. Flexor Digitorum Superficialis
14. Pronator Quadratis
15. Pronator Teres
17. Supinator
18. Triceps

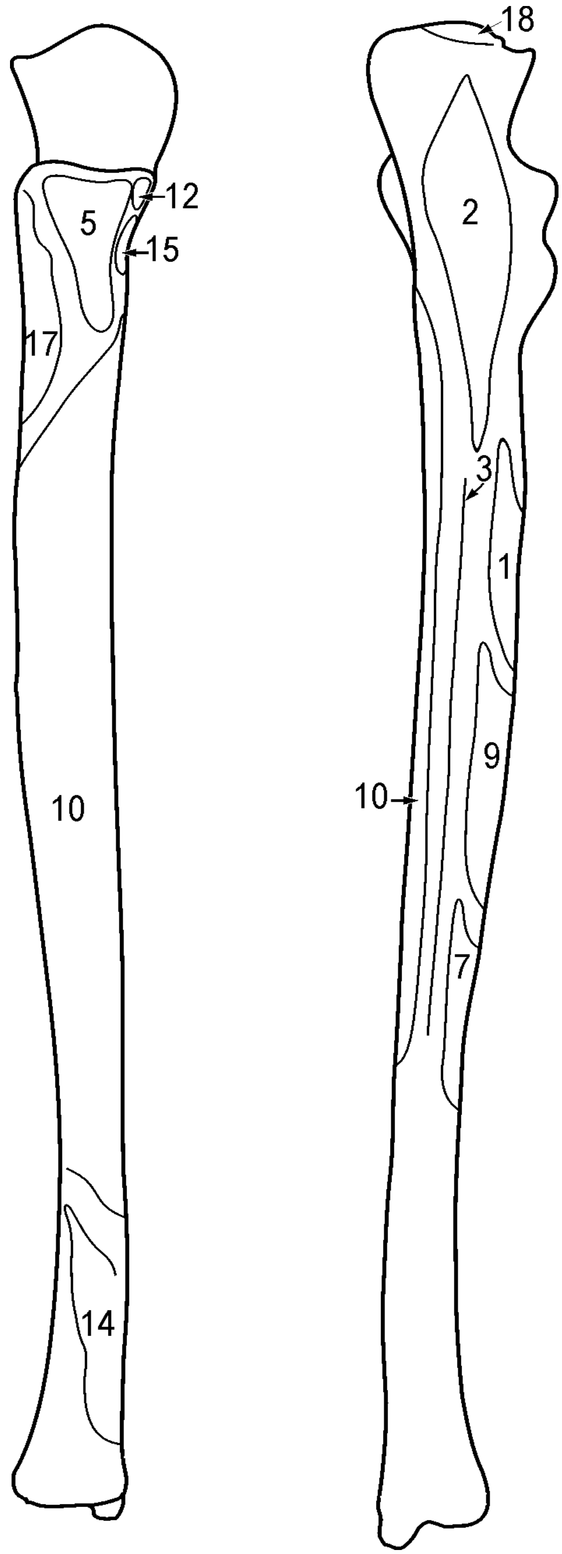

Figure 5.1: Muscle/Cutmark Zones
adapted from Abrahams et al. (1998) by Mary Lee Eggart

Table 5.7: Number of Ulnae with Cutmarks Divided into Zones

Muscle Zones	Left	Right
Flexor Digitorum Profundus (10)	15	22
Anconeus (2)	8	3
Pronator Quadratis (14)	4	6
Flexor Digitorum Profundus, Flexor Carpi Ulnaris, Extensor Carpi Ulnaris (3)	6	4
Abductor Pollicis Longus (1)	4	1
Brachalis (5)	1	3
Extensor Indicis (7)	4	2
Extensor Pollicis Longus (9)	5	1
Pronator Teres (15)	0	1
Supinator (17)	5	0
Flexor Digitorum Superficialis (12)	0	0
Triceps (18)	0	0
No Muscle Attachment	5	10

Figure 5.2: Cutmarks on an Ulna from the Poole-Rose Ossuary Specimen Number 11-24-273

As shown in Table 5.8, the distribution of cutmarks between male and female ulnae is statistically significant. The raw numbers show three times as many males having cutmarks on the left ulnae and almost twice as many females having cutmarks on the right ulnae.

Table 5.8: Distribution of Cutmarks on Left and Right Ulna in the Poole-Rose Ossuary

	Male	Female
Left	15	4
Right	7	12

$X^2 = 6.91$, $p \leq 0.001$ (Significant)

Degenerative Joint Disease Results

The results of the analysis of DJD, including porosity and lipping, are presented in terms of frequencies to evaluate the relationships between observed trait and location. Eburnation was not seen in any of the ulnae examined and will not be discussed further in this paper.

As a supplement to qualitative analysis of presence and severity of DJD, side and patterning of DJD were also analyzed.

Pitting

In this study, pitting was seen most often in combination with lipping. Pitting can be caused by factors other than degeneration. A hole that may be identified as thinning bone in DJD actually may be caused by vascular invasion, which occurs in healthy bone (Jurmain 1999). In the sample of Poole-Rose ulnae, 13% of all ulnae analyzed showed slight pitting on the proximal end and 5.6% of all ulnae showed slight pitting on the distal end (see Table 5.9). Thirteen percent showed moderate/severe pitting on the proximal end and 15% showed moderate/severe pitting on the distal end (see Figures 5.3 and 5.4).

Table 5.9: Number and Percentage of DJD Observations for the Ulnae from the Poole-Rose Ossuary

Observation	Slight	Moderate/Severe
Proximal Pitting	60/449 = 13%	59/449 = 13%
Distal Pitting	12/216 = 5.6%	32/316 = 15%
Proximal Lipping	145/449 = 32%	85/449 = 19%
Distal Lipping	28/216 = 13%	20/216 = 9%

Figure 5.3: Moderate/Severe Pitting on the Proximal Ulna Specimen Number 6-23-294

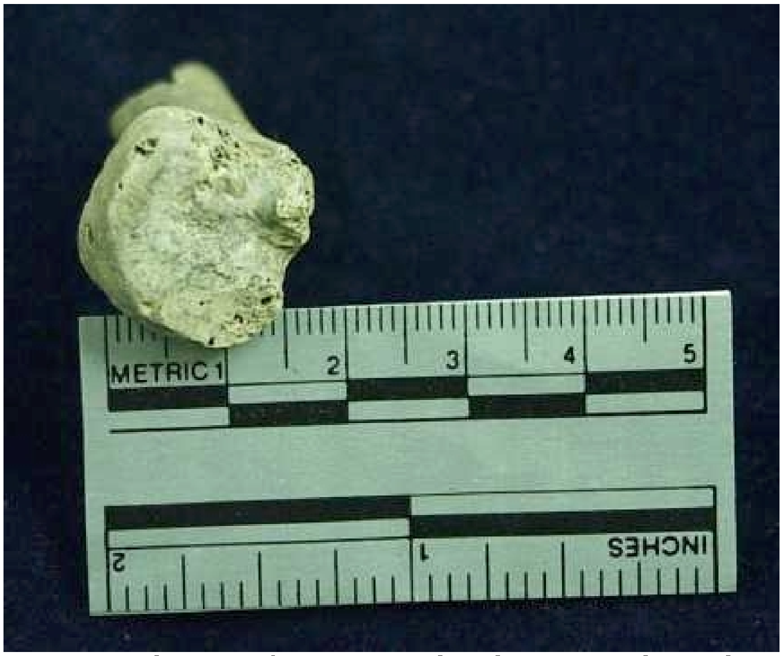

Figure 5.4: Moderate/Severe Pitting on the Distal Ulna Specimen Number 6-23-279

Lipping

Lipping was the most frequently seen DJD in the ulnae from this study. Thirty-two percent of all ulnae examined showed slight proximal lipping and 13% showed slight distal lipping (see Figures 5.5 and 5.6). Nineteen percent of the ulnae showed moderate/severe proximal lipping and nine percent showed moderate/severe distal lipping (see Figures 5.7 and 5.8). Lipping, most often seen around joint edges, was also noted on the line dividing the olecrenon process and the coronoid process. Tables 5.10 through 5.29 represent the results for each joint for lipping and pitting observed on the joint surfaces.

Figure 5.5: Slight Lipping on the Proximal Ulna
Specimen Number 6-22-477

Figure 5.6: Slight Lipping on the Distal Ulna
Specimen Number 12-99-127

Figure 5.7: Moderate/Severe Lipping on the Proximal Ulna
Specimen Number 7-23-224

Figure 5.8: Moderate/Severe Lipping on the Distal Ulna
Specimen Number 1-23-790

Table 5.10 shows that there is a significant relationship between pitting on the Olecrenon Process and lipping on the Olecrenon Process.

Table 5.10: Pitting and Lipping on the Olecrenon Process

			Pitting		
		Absent	Slight	Moderate/ Severe	**Total**
Lipping	Absent	206	15	1	**222**
	Slight	66	14	12	**92**
	Moderate/ Severe	45	10	10	**65**
	Total	**317**	**39**	**23**	**379**

$X^2 = 40.16$, $p \leq 0.001$ (Significant)

Table 5.11 shows that there is a significant relationship between pitting on the Olecrenon Process and pitting on one or more other joint surfaces.

Table 5.11: Olecrenon Process Pitting and Other Pitting

		Olecrenon	**Pitting**		
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	325	11	11	**347**
Pitting	Slight	38	20	3	**61**
	Moderate/ Severe	31	3	11	**45**
	Total	**394**	**34**	**25**	**453**

$X^2 = 101.14$, $p \leq 0.001$ (Significant)

Table 5.12 shows that there is a significant relationship between lipping on the Olecrenon process and lipping on one or more other joint surfaces.

Table 5.12: Olecrenon Process Lipping and Other Lipping

		Olecrenon	Lipping			
		Absent	Slight	Moderate/ Severe	**Total**	
Other	Absent	194	18	8	**220**	
Lipping	Slight	19	63	16	**98**	
	Moderate/ Severe	4	19	49	**72**	
	Total	**217**	**100**	**73**	**390**	

$X^2 = 301.39$, $p \leq 0.001$ (Significant)

Table 5.13 shows that there is a significant relationship between pitting on the Olecrenon Process and lipping on one or more other joint surfaces.

Table 5.13: Olecrenon Process Pitting and Other Lipping

		Olecrenon	Pitting			
		Absent	Slight	Moderate/ Severe	**Total**	
Other	Absent	188	15	1	**204**	
Lipping	Slight	81	10	11	**102**	
	Moderate/ Severe	44	9	16	**69**	
	Total	**313**	**34**	**28**	**375**	

$X^2 = 44.82$, $p \leq 0.001$ (Significant)

Table 5.14 shows that there is a significant relationship between lipping on the Olecrenon Process and pitting on one or more other joint surfaces.

Table 5.14: Olecrenon Process Lipping and Other Pitting

		Olecrenon	**Lipping**		
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	188	48	24	**260**
Pitting	Slight	22	26	10	**58**
	Moderate/ Severe	4	20	20	**44**
	Total	**214**	**94**	**54**	**362**

$X^2 = 84.06$, $p \leq 0.001$ (Significant)

Table 5.15 shows that there is a significant relationship between pitting on the Coronoid Process and lipping on the Coronoid Process.

Table 5.15: Pitting and Lipping on the Coronoid Process

			Pitting		
		Absent	Slight	Moderate/ Severe	**Total**
Lipping	Absent	193	11	2	**206**
	Slight	61	19	13	**93**
	Moderate/ Severe	33	6	24	**63**
	Total	**287**	**36**	**39**	**362**

$X^2 = 90.94$, $p \leq 0.001$ (Significant)

Table 5.16 shows that there is a significant relationship between pitting on the Coronoid Process and pitting on one or more other joint surfaces.

Table 5.16: Coronoid Process Pitting and Other Pitting

		Coronoid	**Pitting**		
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	290	16	23	**329**
Pitting	Slight	32	22	3	**57**
	Moderate/ Severe	19	3	13	**35**
	Total	**341**	**41**	**39**	**421**

$X^2 = 98.51$, $p \leq 0.001$ (Significant)

Table 5.17 shows that there is a significant relationship between lipping on the Coronoid Process and lipping on one or more other joint surfaces.

Table 5.17: Coronoid Process Lipping and Other Lipping

		Coronoid	**Lipping**		
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	215	20	5	**240**
Lipping	Slight	26	69	21	**116**
	Moderate/ Severe	15	11	47	**73**
	Total	**256**	**100**	**73**	**429**

$X^2 = 299.81$, $p \leq 0.001$ (Significant)

Table 5.18 shows that there is a significant relationship between pitting on the Coronoid Process and lipping on one or more other joint surfaces.

Table 5.18: Coronoid Process Pitting and Other Lipping

		Coronoid	**Pitting**		
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	223	15	5	**243**
Lipping	Slight	77	17	22	**116**
	Moderate/ Severe	48	11	16	**75**
	Total	**348**	**43**	**43**	**434**

$X^2 = 51.65$, $p \leq 0.001$ (Significant)

Table 5.19 shows that there is a significant relationship between lipping on the Coronoid Process and pitting on one or more other joint surfaces.

Table 5.19: Coronoid Process Lipping and Other Pitting

		Coronoid	**Lipping**		
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	232	59	39	**330**
Pitting	Slight	21	13	9	**43**
	Moderate/ Severe	9	12	14	**35**
	Total	**262**	**84**	**62**	**408**

$X^2 = 35.45$, $p \leq 0.001$ (Significant)

Table 5.20 shows that there is a significant relationship between pitting on the Radial Notch and lipping on the Radial Notch.

Table 5.20: Pitting and Lipping on the Radial Notch

			Pitting		
		Absent	Slight	Moderate/ Severe	**Total**
Lipping	Absent	323	18	3	**344**
	Slight	50	6	6	**62**
	Moderate/ Severe	33	0	9	**42**
	Total	**406**	**24**	**18**	**448**

$X^2 = 51.28$, $p \leq 0.001$ (Significant)

Table 5.21 shows that there is a significant relationship between pitting on the Radial Notch and pitting on one or more other joint surfaces.

Table 5.21: Radial Notch Pitting and Other Pitting

		Radial	**Notch**	**Pitting**	
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	306	8	5	**319**
Pitting	Slight	43	14	2	**59**
	Moderate/ Severe	53	1	7	**61**
	Total	**402**	**23**	**14**	**439**

$X^2 = 63.38$, $p \leq 0.001$ (Significant)

Table 5.22 shows that there is a significant relationship between lipping on the Radial Notch and lipping on one or more other joint surfaces.

Table 5.22: Radial Notch Lipping and Other Lipping

		Radial	**Notch**	**Lipping**		
		Absent	Slight	Moderate/ Severe	**Total**	
Other	Absent	239	0	0	**239**	
Lipping	Slight	76	42	6	**124**	
	Moderate/ Severe	31	19	37	**87**	
	Total	**346**	**61**	**43**	**450**	

$X^2 = 239.05$, $p \leq 0.001$ (Significant)

Table 5.23 shows that there is a significant relationship between pitting on the Radial Notch and lipping on one or more other joint surfaces.

Table 5.23: Radial Notch Pitting and Other Lipping

		Radial	**Notch**	**Pitting**		
		Absent	Slight	Moderate/ Severe	**Total**	
Other	Absent	197	12	0	**209**	
Lipping	Slight	109	8	8	**125**	
	Moderate/ Severe	80	3	7	**90**	
	Total	**386**	**23**	**15**	**424**	

$X^2 = 16.33$, $p \leq 0.01$ (Significant)

Table 5.24 shows that there is a significant relationship between lipping on the Radial Notch and pitting on one or more other joint surfaces.

Table 5.24: Radial Notch Lipping and Other Pitting

		Radial	**Notch**	**Lipping**	
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	271	21	16	**308**
Pitting	Slight	49	12	10	**71**
	Moderate/ Severe	27	16	17	**60**
	Total	**347**	**49**	**43**	**439**

X^2 = 62.08, $p \leq 0.001$ (Significant)

Table 5.25 shows that there is a significant relationship between pitting on the Radial Articulation and lipping on the Radial Articulation.

Table 5.25: Pitting and Lipping on the Radial Articulation

			Pitting		
		Absent	Slight	Moderate/ Severe	**Total**
Lipping	Absent	159	3	2	**164**
	Slight	5	9	15	**29**
	Moderate/ Severe	2	3	15	**20**
	Total	**166**	**15**	**32**	**213**

X^2 = 159.68, $p \leq 0.001$ (Significant)

Table 5.26 shows that no significant relationship exists between pitting on the Radial Articulation and pitting on one or more other joint surfaces.

Table 5.26: Radial Articulation Pitting and Other Pitting

		Radial	**Art.**	**Pitting**	
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	55	11	26	**92**
Pitting	Slight	8	4	2	**14**
	Moderate/ Severe	3	0	3	**6**
	Total	**66**	**15**	**31**	**112**

X^2 = 5.45, $1 \leq p > 0.05$ (Not Significant)

Table 5.27 shows that there is a significant relationship between lipping on the Radial Articulation and lipping on one or more other joint surfaces.

Table 5.27: Radial Articulation Lipping and Other Lipping

		Radial	**Art.**	**Lipping**		
		Absent	Slight	Moderate/ Severe	**Total**	
Other	Absent	138	18	14	**170**	
Lipping	Slight	18	9	3	**30**	
	Moderate/ Severe	7	2	3	**12**	
	Total	**163**	**29**	**20**	**212**	

$X^2 = 12.52$, $p \leq 0.025$ (Significant)

Table 5.28 shows that there is a significant relationship between pitting on the Radial Articulation and lipping on one or more other joint surfaces.

Table 5.28: Radial Articulation Pitting and Other Lipping

		Radial	**Art.**	**Pitting**		
		Absent	Slight	Moderate/ Severe	**Total**	
Other	Absent	139	2	26	**167**	
Lipping	Slight	19	10	3	**32**	
	Moderate/ Severe	7	1	2	**10**	
	Total	**165**	**13**	**31**	**209**	

$X^2 = 42.16$, $p \leq 0.001$ (Significant)

Table 5.29 shows that no significant relationship exists between lipping on the Radial Articulation and pitting on one or more other joint surfaces.

Table 5.29: Radial Articulation Lipping and Other Pitting

		Radial	**Art.**	**Lipping**	
		Absent	Slight	Moderate/ Severe	**Total**
Other	Absent	171	26	16	**213**
Pitting	Slight	10	2	2	**14**
	Moderate/ Severe	3	0	2	**5**
	Total	**184**	**28**	**20**	**232**

X^2 = 10.4, 0.20$\leq$p>0.05 (Not Significant)

Pitting on one joint surface has a significant relationship with pitting on any other joint surface (except pitting on the radial articulation and any other joint surface). Lipping on one joint surface has a significant relationship with lipping on any other joint surface. There are also significant relationships between lipping on one joint surface and pitting on any other joint surface as well as pitting on one joint surface and lipping on any other joint surface (with the exception of lipping on the radial articulation and pitting on any other joint surface). This indicates that if you see deterioration in one place on the ulnae then you would expect to see deterioration on the ulnae in another place as well.

Side

The results from analysis of the ulna in the Poole-Rose ossuary indicate that side does not have a significant relationship with regard to lipping or pitting on the proximal surface or pitting on the distal surface (see

Tables 5.30, 5.31, 5.32). However, side is significant with regard to lipping on the distal joint surface (see Table 5.33). The right ulna is affected twice as much by lipping on the distal joint as the left ulna.

Table 5.30 shows that there is no significant relationship between side and pitting on the proximal ulna.

Table 5.30: Side and Pitting on the Proximal Ulna

	Absent	Slight	Moderate/ Severe	**Total**
Left	161	26	36	**223**
Right	156	40	26	**222**
Total	**317**	**66**	**62**	**445**

X^2 = 4.66, 0.10≤p>0.05 (Not Significant)

Table 5.31 shows that there is no significant relationship between side and pitting on the distal ulna.

Table 5.31: Side and Pitting on the Distal Ulna

	Absent	Slight	Moderate/ Severe	**Total**
Left	70	7	18	**95**
Right	93	7	13	**113**
Total	**163**	**14**	**31**	**208**

X^2 = 2.51, 1≤p>0.05 (Not Significant)

Table 5.32 shows that there is no significant relationship between side and lipping on the proximal ulna.

Table 5.32: Side and Lipping on the Proximal Ulna

	Absent	Slight	Moderate/ Severe	**Total**
Left	127	74	37	**238**
Right	110	67	53	**230**
Total	**237**	**141**	**90**	**468**

X^2 = 4.28, .20≤p>0.05 (Not Significant)

Table 5.33 shows that there is a significant relationship between side and lipping on the distal ulna.

Table 5.33: Side and Lipping on the Distal Ulna

	Absent	Slight	Moderate/ Severe	**Total**
Left	62	18	10	**90**
Right	161	9	10	**180**
Total	**223**	**27**	**20**	**270**

X^2 = 19.07, $p \leq 0.001$ (Significant)

CHAPTER 6: DISCUSSION AND CONCLUSION

Researchers can learn a lot about a prehistoric culture by analyzing cultural alterations, such as cutmarks, that may appear on the bones. Little information has been published on the analysis of cutmarks on the ulna. The cutmarks found on the ulnae of the Poole-Rose ossuary correspond with the muscle attachment and insertion sites on the ulna.

Assuming that the larger a muscle the larger the force required to cut through a muscle, one would expect individuals or regions with more cutmarks to have larger muscles. If this is the case, then the present study indicates that the people of the Poole-Rose ossuary would have large flexor digitorum profundus muscles because of the large number of cutmarks associated with the region of the ulna where this muscle attaches. This muscle attachment area had cutmarks on twenty-two right ulnae and fifteen left ulnae, all of which had multiple cutmarks in this region. This could suggest that the people of the Poole-Rose ossuary were spending a lot of time working with their hands performing duties associated with agriculture, supporting subsistence patterns typical for that time period. The region that includes the flexor digitorum profundus, flexor carpi ulnaris, and extensor carpi ulnaris also had a relatively large number of ulnae with cutmarks. This could also support the assumption that the people in this study used their hands often.

The large number of ulnae with cutmarks in the flexor digitorum profundus area also could be due to mummification. If these individuals were placed on a scaffold and the tissue was allowed to become dry and leathery, then this could have made the tissue harder to remove and require more pressure to cut the tissue away from the bone. Also, time since death may have played a role in the amount of tissue left on the ulnae that needed to be removed. A more recently deceased individual would probably have considerably more tissue than an individual who had been deceased for several years. Another explanation could be length of the muscle. The zone for the attachment of the flexor digitorum profundus covers a large area of the ulnae. This allows for a greater range for cutmarks to be located.

With the exception of the pronator teres muscle, supinator muscle, flexor digitorum profundus muscle and triceps muscle, which had one or no ulna with cutmarks, the other muscle areas had an average of four ulnae with cutmarks in each area. This could possibly indicate that these muscles were smaller, easier to remove, or decomposed more quickly than the flexor digitorum profundus.

Although analysis of cultural alterations is important to understand a culture, from a physical anthropologist’s viewpoint one of the most important analyses that can be preformed on the ulnae is the evaluation of the diseases that affect the bones. The ultimate goal of the interpretation of the results in this study is to make general statements concerning DJD on the ulna and make comparisons with other studies that have been undertaken.

The results of this analysis are consistent with the hypothesis that the people of the Poole-Rose ossuary were subjected to some stress on their joints. Focus will be placed on the elbow joint and radio-ulnar joint, since the DJD occurred primarily on those joint surfaces. Other researchers (Lundin 2000; Parks 2002) have completed the analysis of both the humerus and the radius from the Poole-Rose ossuary.

The findings of the current research project suggest that both pitting and lipping on the ulna occur most frequently together and the ulna has no occurrence of eburnation. When pitting and lipping are found together on a joint surface, then pitting or lipping can also be expected to be found on one or more other joint surfaces.

Pitting found on any of the proximal joint surfaces indicates that pitting is also expected to be seen on one or more other joint surfaces. Additionally, when lipping is found with pitting on any of the proximal joint surfaces, then pitting is again expected to be seen on one or more other joint surfaces. When lipping is present, either proximally or distally, it is expected to be found on another joint surface as well.

DJD affects the proximal surface more often than the distal surface. However, the results of the two-way tables and chi-square that demonstrated a high number of correlations that were statistically significant may likely have been caused by the traits chosen to be compared.

One would expect that the normal wear and tear that causes arthritis would affect the body equally on both sides; such is the case with the Poole-Rose ossuary. Side is not important with regard to pitting, proximally and distally, and to lipping proximally. However, side does appear to be important with regard to lipping distally.

Overall, about 11% of the ulnae showed slight pitting; about 13% of the ulnae showed moderate/severe pitting; about 26% of the ulnae showed slight lipping; and about 15% of the ulnae showed moderate/severe lipping. Forty-nine percent of the ulna showed pitting and/or lipping on one or more of the proximal joint surfaces. Twenty-four percent of the ulna showed pitting and/or lipping on the distal joint surface.

The results of a study on the humerii of the Poole-Rose ossuary reflect 23% overall frequency of DJD or osteoarthritis (OA) on the distal joint, with 21% specifically at the trochlea (Lundin 2000). These frequencies are similar to those of the ulnae in this study. Lundin’s findings on the humerii also correspond well with Ortner’s (1966) findings in his study of the Inuit. Ortner examined the distal joint of the humerus and found that degeneration of the humeral joint corresponds with degeneration of the ulna and radius. However, Anderson (1964) only reported five percent of the distal ends of the humerus had DJD (OA) in the Fairty ossuary.

The study of the radius from the Poole-Rose ossuary also supports the findings of Lundin (2000) and Ortner (1966). Parks (2002) found that overall about 20% of the radii showed moderate/severe pitting but only about six percent showed moderate/severe lipping.

The humerii from the Poole-Rose ossuary show the most DJD at the elbow joint. This may indicate that there was more stress, due to activity or injury, at the elbow than the shoulder. The radii showed the most DJD on the distal surface as opposed to the ulnae which had the most DJD on the proximal surface. This could indicate that the ulna may have absorbed the stress put on the forearm at the elbow joint and the radii absorbed the stress at the wrist.

Anderson (1964) found that in the Fairty ossuary, the ulna had almost twice as much DJD as the radius. The DJD in that group was about even for proximal and distal ends. The Fairty ossuary showed a low incidence of DJD at the elbow, wrist and ankle and a high incidence of DJD at the shoulder, hip and clavicle.

Bridges (1991) also states that the elbow, shoulder, and knee have a high level of DJD in hunter-gather and agriculturist groups from the Southeastern United States. At the elbow joint, Bridges (1991) reports that for individuals over age 30 Archaic females have 57.6% DJD, Archaic males have 48.2% DJD; Mississippian females have 28.6% DJD and Mississippian males have 48.2% DJD. At the elbow, Larsen (1984) reports 9.1% DJD for preagricultural groups and 2.3% DJD for agricultural groups. Goodman (1984) states a frequency of degenerative pathologies (for all sites combined) of 39.7% for Late Woodland groups, 41.8% for Mississippi Acculturated Late Woodland groups, and 65.8% for Mississippian groups.

Pietrusewsky (1997) reports a total of 8.9% of the proximal ulnae of inhabitants of the Mariana Islands, located in the Pacific Ocean between Hawaii and the Philippines, to have advanced DJD. The radial head had less than half of the DJD than that of the proximal ulna, only 3.8%. They state that the articular surfaces with the most arthritic involvement are the knee, ankle and shoulder. However, Merbs (1983) reports the elbow, shoulder, and wrist, followed by the hip and knee, as having the highest incidence of DJD in an Inuit group.

Conclusion

The objective of this study was to provide a complete analysis of the ulna from the Poole-Rose ossuary. Cutmarks and DJD were the main focus of this research. Several hypotheses were presented to explain the possible cause of DJD and presence of cutmarks. The DJD findings in this study complement the analysis of the humerii and the radii from the Poole-Rose ossuary (Lundin 2000; Parks 2002).

The results in this study correspond with the hypothesis that functional and systemic factors affected the distribution of DJD. This suggests that both the subsistence and the lifestyle of the people of the Poole-Rose ossuary may have played a role in the development of DJD. The types of subsistence patterns that this population participated in are very important in terms of DJD. Repetitive movements, such as tending crops, could have led to degeneration of the elbow. However, the current research provides additional insight into DJD and cultural alterations of a region of the skeletal anatomy that has often been ignored in the past.

WORKS CITED

Abrahams PH, Hutchings RT, and Marks Jr, SC (1998) McMinn's Color Atlas of Human Anatomy 4th Ed. Barcelona: Mosby International Limited.

Anderson JE (1964) The People of Fairty: an Osteological Analysis of an Iroquois Ossuary. National Museum of Canada Bulletin *143*: 28-129.

Aufderheide AC, and Rodriguez-Martin (1998) The Cambridge Encyclopedia of Human Paleopathology. Cambridge: Cambridge University Press.

Bass WM (1987) Human Osteology: A Laboratory and Field Manuel, 3rd ed, Special Publication No. 2. Columbia: Missouri Archaeological Society.

Bowden B, and Bowden J (2002) An Illustrated Atlas of the Skeletal Muscles. Englewood: Morton Publishing Company.

Bridges PS (1991) Degenerative Joint Disease in Hunter-Gatherers and Agriculturists from the Southeastern U.S. American Journal of Physical Anthropology *85*: 379-391.

Bridges PS (1992) Prehistoric Arthritis in the Americas. Annual Review of Anthropology *21*: 67-91.

Brothwell D (1961) The Paleopathology of Early British Man: An Essay on the Problems of Diagnosis and Analysis. Journal of the Royal Anthropological Institute of Great Britain and Ireland *91(2)*: 318-344.

Buikstra JE, and Ubelaker DH (1994) Standards for Data Collection from Human Skeletal Remains, Research Series No. 44. Fayetteville: Arkansas Archaeological Survey.

Churcher CS, and Kenyon WA (1960) The Tabor Hill Ossuaries: A Study in Iroquois Demography. Human Biology *32*: 249-273.

Dunne DE (1999) Health in the Poole-Rose Ossuary Population: An Analysis of Vertebral Body Pathology. M.A. thesis, Louisiana State University, Baton Rouge.

Fernandez-Jalvo Y, Diez JC, Caceres I, and Rosell J (1999) Human Cannibalism in the Early Pleistocene of Europe (Gran Dolina, Sierra de Atapuerca, Burgos, Spain). Journal of Human Evolution *37*: 591-622.

Goodman AH, Lallo J, Armelagos GJ, and Rose JC (1984) Health Changes at Dickson Mounds, Illinois (A.D. 950-1300). In *Paleopathology at the Origins of Agriculture*, ed. MN Cohen, GJ Armelagos, pp 271-305. Orlando, Academic Press, Inc.

Harris RI (1994) Osteological Evidence of Disease Amongst the Huron Indians. University of Toronto Medical Journal *27*: 71-75.

Jurmain RD (1977) Stress and the Etiology of Osteoarthritis. American Journal of Physical Anthropology *46*: 353-366.

Jurmain RD (1978) Paleoepidemiology of DJD. Medical College of Virginia Quarterly *14*: 45-56.

Jurmain RD (1990) Paleoepidemeology of a Central California Prehistoric Population from CA-ALA-329:11. Degenerative Disease. American Journal of Physical Anthropology *83*: 83-94.

Jurmain RD (1999) Stories from the Skeleton: Behavorial Reconstruction in Human Osteology. Amsterdam: Gordon and Breach Publishers.

Larsen CS (1982) The Anthropology of St. Catherines Island 3. Prehistoric Human Biological Adaptation. American Museum of Natural History Anthropological Papers *57*: 159-270.

Larsen CS (1984) Health and Disease in Prehistoric Georgia: The Transition to Agriculture. In *Paleopathology at the Origins of Agriculture,* ed. MN Cohen, GJ Armelagos, pp 367-392. Orlando, Academic Press, Inc.

Larsen CS (1995) Biological Changes in Human Populations with Agriculture. Annual Review of Anthropology *24*: 185-213.

Lundin D (2000) Evidence of Osteoarthritic Alterations to the Proximal and Distal Joints of the Humerus: Analysis of Skeletal Remains from the Poole-Rose Ossuary. M.A. thesis, Louisiana State University, Baton Rouge.

McCarthy EF, and Frassica FJ (1998) Pathology of Bone and Joint Disorders with Clinical and Radiographic Correlation. Philadelphia: W. B. Saunders Company.

McKillop H, and Jackson L (1991) Discovery and Excavations at the Poole-Rose Ossuary, Arch Notes *91(1):* 9-13.

Melbye J (1985) Paleopathology of the Ontario Iroquois. Canadian Review of Physical Anthropology *4*: 9-11.

Merbs CF (1983) Patterns of Activity-Induced Pathologies in a Canadian Inuit Population. Archaeological Survey of Canada. *119:*1-199.

Ortner DJ (1966) Description and Classification of Degenerative Bone Chances in the Distal Joint Surfaces of the Humerus. American Journal of Physical Anthropology *28*: 139-156.

Parks MA (2002) Occurrence of Degenerative Joint Disease in the Radius: An Analysis of Skeletal Remains From the Poole-Rose Ossuary. M.A. thesis, Louisiana State University, Baton Rouge.

Pfeiffer S (1985) Paleopathology of Archaic Peoples of the Great Lakes. Canadian Journal of Anthropology *4(2)*: 1-7.

Pietrusewsky, M, Douglas MT and Ikehara-Quebral RM (1997) An Assessment of Health and Disease in the Prehistoric Inhabitants of the Mariana Islands. American Jouranl of Physical Anthropology *104:* 315-342.

Resnick D and Niwayama G (1995) Degenerative Disease of Extraspinal Locations. In Resnick D, editor. Diagnosis of Bone and Joint Disorders, Philadelphia, Pennsylvania: W. B. Saunders Company.

Rogers J and Waldron T (1995) A Field Guide to Joint Disease in Archaeology. Chichester, UK: John Wiley and Sons.

Seidemann EL (1999) Analysis of the Nonmetric Traits of the Skull in the Poole-Rose Ossuary, Ontario, Canada. M.A. thesis, Louisiana State University, Baton Rouge.

Smith HJ (1997) Health in the Poole-Rose Ossuary Population: A Look at Cribra Orbitalia and Porotic Hyperostosis. M.A. thesis, Louisiana State University, Baton Rouge.

Tague RG, Manhein MH, McKillop H (1998) Paleodemography of the Poole-Rose Ossuary. American Journal of Physical Anthropology Supplement 26: 214-215.

Trigger BG (1969) The Huron: Farmers of the North. New York: Holt, Rienhart, and Winston.

Wells C (1964) Bones, Bodies and Disease: Evidence of Disease and Abnormality in Early Man. London: Thames and Hudson.

White TD (1991) Human Osteology. San Diego: Academic Press, Inc.

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