Distribution and Pattern Analysis of Osteoarthritis in an Ancient Tombos Population

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Abstract

Osteoarthritis is the most common type of arthritis, which affects millions of people each year. This degenerative joint disease is associated with many factors, but can be difficult to diagnose in both living and non-living populations. For this study, remains from the ancient Egyptian/Nubian archaeological site of Tombos, Sudan (1400-750 BCE) were observed and analyzed to document the presence of osteoarthritis in discretely buried adult individuals. Data was collected on six joints in seventy-nine individuals for new bone growth, pitting, and eburnation; each joint surface was scored between zero and three based on severity. Individuals who had two or more conditions with a score of two or higher were diagnosed with osteoarthritis. Of the original seventy-nine, nine (11%) were considered osteoarthritic; only three (4%) individuals demonstrated moderate/severe osteoarthritis, with the remaining having a mild severity. Osteoarthritis is a degenerative disease that requires repetitive motion over an extended period for conditions to develop; 89% of individuals presented with mild or absent osteoarthritic conditions. This suggests that most of the population was not engaged in heavy repetitive manual labor. Contextual information, based on demographic data and mortuary practices, indicates that males and females affected by osteoarthritis range from young to old adults and are interred in different tomb types across the site. Variation in osteoarthritis status and mortuary practices provides an opportunity to explore possible socioeconomic and subgroup differences in the community.

Introduction

If osteoarthritis (OA) is considered one of the most prolific joint diseases that most individuals will develop within their lifetime in some capacity, then we should see a higher frequency of osteoarthritis throughout the archaeological record. Underlying conditions and factors, such as weight, sex, and age, as well as environmental factors like burial conditions, must be considered by bioarcheologists when analyzing remains. Unless you have a complete skeletal set, you must consider that osteoarthritis could have been present in the absent joints. Although these factors are considered, it is unclear how they affect the presentation of osteoarthritis compared to degeneration based solely on repetitive motion and labor.

In modern cases, osteoarthritis is first determined by joint pain symptoms and is typically treated with pain management. X-rays and CT scans can show the progression of osteoarthritis, but they only begin to reveal changes once the degeneration has significantly advanced, indicating substantial breakdown of the cartilage and bones nearing contact. The reliance of osteoarthritis research on symptomatic response poses challenges when analyzing non-living populations, as there is no medical comparison for how osteoarthritis progresses. According to a prognosis report from the American Medical Association, individuals suffering from osteoarthritis are thought to follow a similar trajectory regarding increased pain and symptoms, although some may experience fluctuations in pain over several years (Katz, 2021). Regardless of their physiological and environmental factors, no two individuals will express osteoarthritis in the same way.

Looking for osteoarthritis markers in non-living populations can provide both bioarcheologists and modern clinicians with an understanding of how osteoarthritis progresses over time. As stated above, a main cause of osteoarthritis is thought to be repetitive manual labor, so when reconstructing activity patterns, bioarcheologists should be looking for higher rates of severe

osteoarthritis. Osteoarthritis determination can also be applied to other archaeological questions such as economic and political changes on the body (Weiss, 2007). Dr. Sarah Schrader discusses that in between the waves of militarized colonization, ancient Nubians reverted to a pastoral lifeway which is reflected by the higher osteoarthritis values. In comparing different population generations, Dr. Schrader was able to recreate a change in activity patterns throughout times of political unrest and change (Schrader, 2022). This allows bioarcheologists to study how certain environmental stressors affect the body in indirect ways such as increased manual labor, a reduction in balanced diets and access to medical care. There is also the social aspect that can be interpreted in social groups like the division of labor and breakdown of gendered roles. Chryssa Vergidou's 2022 article looked at social history of Roman Macedonia using paleopathological evidence, they found that males were more likely to engage in agricultural and animal husbandry activities than females, but both groups were eating a similar diet. This was interpreted that the division of labor was more likely based on physical strength. For this project, we looked at individuals from across Tombos to determine the prevalence of osteoarthritis throughout the population, from there we can make inferences about social landscapes based on factors such as age, sex, and burial types.

Background

Tombos is located at a critical point of the third Cataract of the Nile River, marking the border between Nubia and Egypt during the New Kingdom Period (c. 1400–1050BCE). It was constructed early on after the second wave of recolonization by the Egyptians (Schrader, 2022). We have evidence of interactions between immigrant Egyptians and recolonized Nubians through their burial types and traditions. Archaeological excavations of Tombos began in 2000 by the University of Southern California, with continued collaboration by Purdue University

beginning in 2010 (Figure 1). Much of the site is covered by the modern town and surrounding agricultural fields, excavations have revealed several walls that have been determined to be structural foundations for large administrative or religious buildings (Whitmore & Buzon, 2019). There are three main cemeteries, two of which contain tombs that are Egyptian in style. In the west, there are pyramid/chapel monuments, and in the east, there are underground chamber tombs, there are also communal and pit tombs scattered about both sites that show continual use throughout the New Kingdom Period. In the third cemetery located in the eastern section of the site are tumuli burials with many having aspects of local practices, although Buzon and Smith argue that even though the burial practices are like those before and after the Egyptian conquest, they do not replicate those found in times of "Nubian revival" (2023).

While the site of Tombos was not built until the New Kingdom Period, the land surrounding the Third Cataract was used by Ancient Nubians as the city of Kerma was located just on the other side of the Nile from the current site of Tombos as it served as the capital for the Kushite Culture. There have been two major waves of colonization of lower Nubia, the first during the Middle Kingdom (2050 to 1650 and the second during the New Kingdom (1550-1070 BCE), CE), but between those two periods, we see a reclamation of Nubia (Schrader, 2022). This back and forth created a hybridization of Nubian and Egyptian culture and explains why some tumuli had a mixture of older and current burial traditions.

Figure 1. Map of Units at Tombos

Materials and Methods

Osteoarthritis is one of the most common degenerative joint diseases found in the human skeleton that affects synovial joints such as the shoulders, hips, and knees. These joints are classified as free moving; therefore, they have a thin layer of cartilage that lines the surface of the bone and synovial fluid which acts as a lubricant for movement. While there are several types of synovial joints, for this project we specifically looked at ball-and-socket joints, which are classified by one bone fitting into another such as the acetabulum, and hinge joints that are named for their hinge like limited movements such as the elbow. Since the synovial fluid lubricates the joint, it provides smooth movements and minimal friction allowing for these joints to be durable (White, 2005).

Just as with most things in life we have normal ‘wear and tear’ on our bodies. Eventually, the protective cartilage will break down, allowing the bones to rub against one another during joint movement. When this breakdown occurs, there is an immediate response by the body to either repair or slow-down joint damage. If the breakdown continues, the response changes to the generation of new bone, this symptom is known as lipping or spur formation (White, 2005), and often creates a jagged look around the edge of the joint (Figure 2 and 3). Along with lipping there is also the presence of small lesions that often represent small holes along the joint surface and according to Jurmain (1999), they are thought to be the after effect of attempts to repair the damaged cartilage tissue. There is much debate on how exactly these small lesions are formed, such as the thinning of the articular plate, or an invasion of calcified cartilage, or a part of the

eburnation process (Jurmain, 1999). Eburnation is the final stage of osteoarthritis and is classified by the polished or 'ivory-like' appearance of joint surfaces as there is no more protective cartilage holding the bones apart (Figure 4). All three of these symptoms occur in their respective order but there is not a point in which new bone growth stops and pitting begins to occur. Since this is a degenerative condition, as the disease progresses it can become extremely painful for the individual and eventually slow down or prevent joint movement all together if the new bone growth becomes severe or possible joint fusion occurs.

In living populations, osteoarthritis is not considered until the complaint around joint pain is first addressed then with x-rays doctors can see the extent of bone damage and regrowth, but this can only be seen once new growth is beginning to develop (Department of Health, 2023). For non-living populations, there are no complaints of joint pain to observe, so osteologists must rely on markers to determine if an individual was suffering from osteoarthritis. Although there are several methods used for determining osteoarthritis, for this project I combined the methods used by Sarah Schrader and the criteria by Tony Waldren when analyzing the individuals. Since osteoarthritis is a degenerative disease several stages and markers are observed to make a diagnosis in non-living populations. An ordinal scale for osteoarthritis severity was adopted (0 = osteoarthritis absent; 1 = mild lipping and porosity, or moderate lipping without porosity; 2 = moderate lipping and moderate porosity; 3 = eburnation present) (Schrader, 2022). For osteoarthritis to be determined, individuals had to have two markers with a score of two or higher present in the same joint. After osteoarthritis was determined to be present, the severity of osteoarthritis needed to be addressed. To determine severity, everyone was ranked based on the number of joints that osteoarthritis was present in (1 to 2 = mild, 2 to 3 = moderate, 4 or more = severe).

Individuals (n=79; male=28, female=41, undetermined=9) from the Tombos collection, housed at Purdue University, were analyzed and only adult remains from the collection were used for this project. Each set of remains had been aged using Transition Analysis created by Boldsen and colleagues (2002) and sexed following the protocols in Buikstra and Ubelaker (1994) prior to this project. Analysis of cranial sutures, public symphyses and iliac auricular surfaces were compared to the references of the program to determine age at time of death. To determine biological sex, morphology of the os coxae and cranium were used based on the categories of female, male and indeterminate. (Buzon and Smith, 2023). **Should add something about identity and expression of physical features? And tables about sexing/ aging concepts** Once all individuals were analyzed, they were added to an excel file along with osteoarthritis marker scoring which was used for comparison.

Figure 2. Severe Lipping and Pitting on Left Patella (36.Shaft1.B12)

Figure 3. Moderate Lipping on Right Scapula. (22.2.2)

Figure 4. Eburnation on Right Distal Femur (6.7)

Results

Osteoarthritis can be tricky to determine due to it is still highly debated about how these morphological changes happen over time as monitoring the initial stages of osteoarthritis is impossible with living populations. If eburnation is present, that individual suffered from an advanced stage of osteoarthritis, so that was the first marker that was looked for, but if not present then two other markers needed to be present with at least a score of 2 to be determined as osteoarthritis.

Table . Frequency of Lipping by Bone, Total

oint	ocation	ide	≠ Observed	≠ Affected (%)	≠ Affected ≥ Level 2
capula	lenoid Fossa	eft	48	22 (46%)	7 (31.8%)

Scapula	Glenoid Fossa	Right	50	29	7
Humerus	Proximal	Left	54	19	1
Humerus	Distal	Left	54	20	2
Humerus	Proximal	Right	51	27	1
Humerus	Distal	Right	59	17	1
Radius	Proximal	Left	56	8	2
Radius	Distal	Left	53	28	3
Radius	Proximal	Right	57	17	0
Radius	Distal	Right	52	30	2
Ulna	Proximal	Left	58	38	5
Ulna	Distal	Left	57	19	3
Ulna	Proximal	Right	54	45	3
Ulna	Distal	Right	55	18	7
Os Coxa	Acetabulum	Left	72	39	11
Os Coxa	Acetabulum	Right	68	37	12
Femur	Proximal	Left	57	26	2
Femur	Distal	Left	55	22	3
Femur	Proximal	Right	58	23	3
Femur	Distal	Right	54	26	5
Patella	Posterior	Left	25	13	3
Patella	Posterior	Right	28	13	0
Tibia	Proximal	Left	55	15	3
Tibia	Distal	Left	50	11	2
Tibia	Proximal	Right	53	18	5
Tibia	Distal	Right	51	12	2

Table . Frequency of Lipping by Bone in Females

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	41	1 (%)	3 (%)
Scapula	Glenoid Fossa	Right	30	5	3
Humerus	Proximal	Left	31	0	1
Humerus	Distal	Left	35	9	0
Humerus	Proximal	Right	34	5	1
Humerus	Distal	Right	34	3	0
Radius	Proximal	Left	34	2	0
Radius	Distal	Left	33	4	2
Radius	Proximal	Right	33	3	0
Radius	Distal	Right	36	7	1
Ulna	Proximal	Left	36	8	2
Ulna	Distal	Left	27	5	0
Ulna	Proximal	Right	34	7	2
Ulna	Distal	Right	31	3	2
Os Coxa	Acetabulum	Left	39	20	7
Os Coxa	Acetabulum	Right	37	9	3
Femur	Proximal	Left	36	2	0
Femur	Distal	Left	34	5	2
Femur	Proximal	Right	36	0	2
Femur	Distal	Right	33	0	1
Patella	Posterior	Left	16	5	2

Patella	Posterior	Right	18	3	0
Tibia	Proximal	Left	29	4	2
Tibia	Distal	Left	31	2	0
Tibia`	Proximal	Right	36	4	0
Tibia	Distal	Right	32	5	2

Table . Frequency of Lipping by Bone in Males

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	30	1 (%)	4 (%)
Scapula	Glenoid Fossa	Right	22	4	7
Humerus	Proximal	Left	23	9	0
Humerus	Distal	Left	28	0	1
Humerus	Proximal	Right	28	1	0
Humerus	Distal	Right	27	3	1
Radius	Proximal	Left	30	4	2
Radius	Distal	Left	28	5	2
Radius	Proximal	Right	27	3	0
Radius	Distal	Right	24	2	1
Ulna	Proximal	Left	29	7	11
Ulna	Distal	Left	24	0	2
Ulna	Proximal	Right	36	27	7
Ulna	Distal	Right	22	9	4

Os Coxa	Acetabulum	Left	31	8	4
Os Coxa	Acetabulum	Right	30	7	5
Femur	Proximal	Left	28	2	1
Femur	Distal	Left	28	4	1
Femur	Proximal	Right	31	2	1
Femur	Distal	Right	29	4	4
Patella	Posterior	Left	3	5	1
Patella	Posterior	Right	3	4	0
Tibia	Proximal	Left	23	9	2
Tibia	Distal	Left	26	9	2
Tibia`	Proximal	Right	24	3	3
Tibia	Distal	Right	26	9	0

Table . Frequency of Lipping by Bone in Indeterminates

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	0	0	0
Scapula	Glenoid Fossa	Right	0	0	0
Humerus	Proximal	Left	0	0	0
Humerus	Distal	Left	1	1	0
Humerus	Proximal	Right	0	0	0
Humerus	Distal	Right	1	0	0
Radius	Proximal	Left	1	1	0

Radius	Distal	Left	0	0	0
Radius	Proximal	Right	1	0	0
Radius	Distal	Right	1	1	0
Ulna	Proximal	Left	3	2	1
Ulna	Distal	Left	1	0	0
Ulna	Proximal	Right	3	3	1
Ulna	Distal	Right	1	0	0
Os Coxa	Acetabulum	Left	1	0	0
Os Coxa	Acetabulum	Right	0	0	0
Femur	Proximal	Left	2	1	1
Femur	Distal	Left	2	2	0
Femur	Proximal	Right	0	0	0
Femur	Distal	Right	1	1	0
Patella	Posterior	Left	0	0	0
Patella	Posterior	Right	1	0	0
Tibia	Proximal	Left	2	0	0
Tibia	Distal	Left	2	0	0
Tibia`	Proximal	Right	2	0	0
Tibia	Distal	Right	2	1	0

Table. Frequency of Lipping by Bone in 15-24 Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2

Scapula	Glenoid Fossa	Left	6	(%)	0 (%)
Scapula	Glenoid Fossa	Right	6		0
Humerus	Proximal	Left	6	0	0
Humerus	Distal	Left	7	0	0
Humerus	Proximal	Right	6	0	0
Humerus	Distal	Right	6	0	0
Radius	Proximal	Left	6	0	0
Radius	Distal	Left	7	0	0
Radius	Proximal	Right	6	0	0
Radius	Distal	Right	7	0	0
Ulna	Proximal	Left	6		0
Ulna	Distal	Left	7		0
Ulna	Proximal	Right	2		0
Ulna	Distal	Right	7	0	0
Os Coxa	Acetabulum	Left	7		0
Os Coxa	Acetabulum	Right	8		0
Femur	Proximal	Left	7		0
Femur	Distal	Left	7	0	0
Femur	Proximal	Right	8		0
Femur	Distal	Right	8		0
Patella	Posterior	Left	2	0	0
Patella	Posterior	Right	2	0	0
Tibia	Proximal	Left	6		
Tibia	Distal	Left	6	0	0

Tibia`	Proximal	Right	5	0	0
Tibia	Distal	Right	5	0	0

Table . Frequency of Lipping by Bone in 25-34 Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	17	5 (%)	2 (%)
Scapula	Glenoid Fossa	Right	20	0	2
Humerus	Proximal	Left	20	7	0
Humerus	Distal	Left	23	3	0
Humerus	Proximal	Right	23	1	0
Humerus	Distal	Right	22	5	0
Radius	Proximal	Left	26	2	0
Radius	Distal	Left	26	4	2
Radius	Proximal	Right	25	3	0
Radius	Distal	Right	20	0	0
Ulna	Proximal	Left	26	4	0
Ulna	Distal	Left	23	7	1
Ulna	Proximal	Right	23	6	1
Ulna	Distal	Right	22	5	2
Os Coxa	Acetabulum	Left	28	4	2
Os Coxa	Acetabulum	Right	26	3	3
Femur	Proximal	Left	24	3	1

Femur	Distal	Left	24	0	2
Femur	Proximal	Right	27	3	2
Femur	Distal	Right	25	0	3
Patella	Posterior	Left	7	3	1
Patella	Posterior	Right	7	3	0
Tibia	Proximal	Left	22	5	1
Tibia	Distal	Left	23	7	2
Tibia`	Proximal	Right	25	0	2
Tibia	Distal	Right	23	3	1

Table . Frequency of Lipping by Bone in 35-49 Age Group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	10	3	3
Scapula	Glenoid Fossa	Right	10	6	1
Humerus	Proximal	Left	10	4	0
Humerus	Distal	Left	12	5	0
Humerus	Proximal	Right	12	5	0
Humerus	Distal	Right	11	5	0
Radius	Proximal	Left	13	2	1
Radius	Distal	Left	11	5	1
Radius	Proximal	Right	14	3	0
Radius	Distal	Right	14	3	2

Ulna	Proximal	Left	13	7	2
Ulna	Distal	Left	11	5	0
Ulna	Proximal	Right	12	0	2
Ulna	Distal	Right	11	7	2
Os Coxa	Acetabulum	Left	14	9	3
Os Coxa	Acetabulum	Right	14	0	4
Femur	Proximal	Left	14	3	0
Femur	Distal	Left	12	5	1
Femur	Proximal	Right	15	7	1
Femur	Distal	Right	11	7	1
Patella	Posterior	Left	4	2	1
Patella	Posterior	Right	5	2	0
Tibia	Proximal	Left	11	4	1
Tibia	Distal	Left	12	3	0
Tibia`	Proximal	Right	13	3	1
Tibia	Distal	Right	13	4	0

Table . Frequency of Lipping by Bone in 50-69 Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	10	4	1
Scapula	Glenoid Fossa	Right	9	4	2

Humerus	Proximal	Left	12	6	1
Humerus	Distal	Left	13	2	1
Humerus	Proximal	Right	3	6	0
Humerus	Distal	Right	2	2	1
Radius	Proximal	Left	4	2	1
Radius	Distal	Left	3	7	1
Radius	Proximal	Right	2	6	0
Radius	Distal	Right	4	0	0
Ulna	Proximal	Left	4	0	1
Ulna	Distal	Left	0	6	1
Ulna	Proximal	Right	2	7	6
Ulna	Distal	Right	0	2	0
Os Coxa	Acetabulum	Left	4	1	4
Os Coxa	Acetabulum	Right	4	0	6
Femur	Proximal	Left	2	6	0
Femur	Distal	Left	2	2	0
Femur	Proximal	Right	1	4	0
Femur	Distal	Right	1	4	0
Patella	Posterior	Left	6	6	1
Patella	Posterior	Right	6	4	0
Tibia	Proximal	Left	1	6	0
Tibia	Distal	Left	4	1	0
Tibia`	Proximal	Right	1	6	1
Tibia	Distal	Right	1	2	1

Table . Frequency of Lipping by Bone in 70+ Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	5	3	1
Scapula	Glenoid Fossa	Right	5	5	2
Humerus	Proximal	Left	5	2	0
Humerus	Distal	Left	3	1	0
Humerus	Proximal	Right	5	1	1
Humerus	Distal	Right	1	1	0
Radius	Proximal	Left	1	0	0
Radius	Distal	Left	5	2	0
Radius	Proximal	Right	3	1	0
Radius	Distal	Right	5	3	0
Ulna	Proximal	Left	5	1	1
Ulna	Distal	Left	1	2	0
Ulna	Proximal	Right	5	5	1
Ulna	Distal	Right	1	3	2
Os Coxa	Acetabulum	Left	5	3	2
Os Coxa	Acetabulum	Right	5	2	1
Femur	Proximal	Left	5	2	0
Femur	Distal	Left	5	2	0
Femur	Proximal	Right	5	2	0
Femur	Distal	Right	5	2	1

Patella	Posterior	Left	5	3	0
Patella	Posterior	Right	4	3	0
Tibia	Proximal	Left	3	0	0
Tibia	Distal	Left	3	0	0
Tibia`	Proximal	Right	5	1	0
Tibia	Distal	Right	5	1	1

Table . Frequency of Porosity by Bone, Total

Joint	Location	Side	# Observed	# Affected %)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	48	0	1
Scapula	Glenoid Fossa	Right	50	1	2
Humerus	Proximal	Left	54	2	0
Humerus	Distal	Left	54	3	0
Humerus	Proximal	Right	51	7	1
Humerus	Distal	Right	59	3	0
Radius	Proximal	Left	56	1	0
Radius	Distal	Left	53	0	1
Radius	Proximal	Right	57	4	0
Radius	Distal	Right	52	3	3
Ulna	Proximal	Left	58	3	1
Ulna	Distal	Left	57	0	0
Ulna	Proximal	Right	54	7	0

Ulna	Distal	Right	55	5	
Os Coxa	Acetabulum	Left	72	5	
Os Coxa	Acetabulum	Right	68	6	
Femur	Proximal	Left	67	9	
Femur	Distal	Left	65	7	
Femur	Proximal	Right	68	9	
Femur	Distal	Right	64	2	2
Patella	Posterior	Left	25	7	
Patella	Posterior	Right	28	4	0
Tibia	Proximal	Left	65	5	
Tibia	Distal	Left	60	3	
Tibia`	Proximal	Right	63	2	2
Tibia	Distal	Right	61	2	0

Table . Frequency of Lipping by Bone in Females

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	41	4	0
Scapula	Glenoid Fossa	Right	30	4	2
Humerus	Proximal	Left	31	7	0
Humerus	Distal	Left	35	3	0
Humerus	Proximal	Right	34	2	
Humerus	Distal	Right	34	3	0

Radius	Proximal	Left	34	0	0
Radius	Distal	Left	33	5	0
Radius	Proximal	Right	33	3	0
Radius	Distal	Right	36	1	1
Ulna	Proximal	Left	36	4	1
Ulna	Distal	Left	27	3	0
Ulna	Proximal	Right	34	3	0
Ulna	Distal	Right	31	2	0
Os Coxa	Acetabulum	Left	39	7	0
Os Coxa	Acetabulum	Right	37	3	0
Femur	Proximal	Left	36	4	0
Femur	Distal	Left	34	3	1
Femur	Proximal	Right	36	5	0
Femur	Distal	Right	33	5	0
Patella	Posterior	Left	16	3	0
Patella	Posterior	Right	18	4	0
Tibia	Proximal	Left	29	10	1
Tibia	Distal	Left	31	2	0
Tibia`	Proximal	Right	36	5	1
Tibia	Distal	Right	32	1	0

Table . Frequency of Porosity by Bone in Males

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2

Scapula	Glenoid Fossa	Left	30	6	1
Scapula	Glenoid Fossa	Right	22	7	0
Humerus	Proximal	Left	23	5	0
Humerus	Distal	Left	28	4	0
Humerus	Proximal	Right	28	5	0
Humerus	Distal	Right	27	1	0
Radius	Proximal	Left	30	0	0
Radius	Distal	Left	28	4	0
Radius	Proximal	Right	27	0	0
Radius	Distal	Right	24	1	0
Ulna	Proximal	Left	29	3	0
Ulna	Distal	Left	24	5	0
Ulna	Proximal	Right	36	2	0
Ulna	Distal	Right	22	4	1
Os Coxa	Acetabulum	Left	31	7	1
Os Coxa	Acetabulum	Right	30	7	1
Femur	Proximal	Left	28	4	1
Femur	Distal	Left	28	4	0
Femur	Proximal	Right	31	4	1
Femur	Distal	Right	29	5	2
Patella	Posterior	Left	3	2	1
Patella	Posterior	Right	3	0	0
Tibia	Proximal	Left	23	4	0
Tibia	Distal	Left	26	1	1

Tibia`	Proximal	Right	24	5	0
Tibia	Distal	Right	26	1	0

Table . Frequency of Lipping by Bone in Indeterminates

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	0	0	0
Scapula	Glenoid Fossa	Right	0	0	0
Humerus	Proximal	Left	0	0	0
Humerus	Distal	Left	1	1	0
Humerus	Proximal	Right	0	0	0
Humerus	Distal	Right	1	0	0
Radius	Proximal	Left	1	1	0
Radius	Distal	Left	0	0	0
Radius	Proximal	Right	1	0	0
Radius	Distal	Right	1	0	0
Ulna	Proximal	Left	3	1	0
Ulna	Distal	Left	1	0	0
Ulna	Proximal	Right	3	0	0
Ulna	Distal	Right	1	0	0
Os Coxa	Acetabulum	Left	1	0	0
Os Coxa	Acetabulum	Right	0	0	0
Femur	Proximal	Left	2	0	0

Femur	Distal	Left	2	0	0
Femur	Proximal	Right	0	0	0
Femur	Distal	Right	1	0	0
Patella	Posterior	Left	0	0	0
Patella	Posterior	Right	1	0	0
Tibia	Proximal	Left	2	0	0
Tibia	Distal	Left	2	0	0
Tibia`	Proximal	Right	2	0	0
Tibia	Distal	Right	2	0	0

Table. Frequency of Porosity by Bone in 15-24 Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	6	0	0
Scapula	Glenoid Fossa	Right	6	0	0
Humerus	Proximal	Left	6	0	0
Humerus	Distal	Left	7	0	0
Humerus	Proximal	Right	5	1	0
Humerus	Distal	Right	7	0	0
Radius	Proximal	Left	7	0	0
Radius	Distal	Left	7	0	0
Radius	Proximal	Right	5	0	0
Radius	Distal	Right	7	0	0

Ulna	Proximal	Left	5	0	0
Ulna	Distal	Left	7	0	0
Ulna	Proximal	Right	2	0	0
Ulna	Distal	Right	7	0	0
Os Coxa	Acetabulum	Left	7	0	0
Os Coxa	Acetabulum	Right	8	0	0
Femur	Proximal	Left	7	0	0
Femur	Distal	Left	7	0	0
Femur	Proximal	Right	8	1	0
Femur	Distal	Right	8	1	0
Patella	Posterior	Left	2	0	0
Patella	Posterior	Right	2	0	0
Tibia	Proximal	Left	5	0	0
Tibia	Distal	Left	5	0	0
Tibia`	Proximal	Right	5	0	0
Tibia	Distal	Right	5	0	0

Table . Frequency of Porosity by Bone in 25-34 Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	17	3	0
Scapula	Glenoid Fossa	Right	20	4	0
Humerus	Proximal	Left	20	2	0

Humerus	Distal	Left	23	2	0
Humerus	Proximal	Right	23	5	0
Humerus	Distal	Right	22	1	0
Radius	Proximal	Left	26	0	0
Radius	Distal	Left	26	4	0
Radius	Proximal	Right	25	1	0
Radius	Distal	Right	20	0	0
Ulna	Proximal	Left	26	3	0
Ulna	Distal	Left	23	5	0
Ulna	Proximal	Right	23	2	0
Ulna	Distal	Right	22	2	1
Os Coxa	Acetabulum	Left	28	4	1
Os Coxa	Acetabulum	Right	26	5	1
Femur	Proximal	Left	24	1	1
Femur	Distal	Left	24	3	0
Femur	Proximal	Right	27	3	1
Femur	Distal	Right	25	3	2
Patella	Posterior	Left	7	0	0
Patella	Posterior	Right	7	1	0
Tibia	Proximal	Left	22	4	0
Tibia	Distal	Left	23	2	1
Tibia`	Proximal	Right	25	4	0
Tibia	Distal	Right	23	1	0

Table . Frequency of Lipping by Bone in 35-49 Age Group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	10	7	1
Scapula	Glenoid Fossa	Right	10	5	2
Humerus	Proximal	Left	10	1	0
Humerus	Distal	Left	12	2	0
Humerus	Proximal	Right	12	5	0
Humerus	Distal	Right	11	1	0
Radius	Proximal	Left	13	0	0
Radius	Distal	Left	11	1	0
Radius	Proximal	Right	14	2	0
Radius	Distal	Right	14	1	1
Ulna	Proximal	Left	13	2	1
Ulna	Distal	Left	11	1	0
Ulna	Proximal	Right	12	3	0
Ulna	Distal	Right	11	2	0
Os Coxa	Acetabulum	Left	14	5	0
Os Coxa	Acetabulum	Right	14	5	0
Femur	Proximal	Left	14	3	0
Femur	Distal	Left	12	3	0
Femur	Proximal	Right	15	3	0
Femur	Distal	Right	11	5	0

Patella	Posterior	Left	4	2	
Patella	Posterior	Right	5	0	0
Tibia	Proximal	Left	11	2	0
Tibia	Distal	Left	12	0	0
Tibia`	Proximal	Right	13	2	0
Tibia	Distal	Right	13	0	0

Table . Frequency of Porosity by Bone in 50-69 Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	10		0
Scapula	Glenoid Fossa	Right	9	2	0
Humerus	Proximal	Left	12	5	0
Humerus	Distal	Left	13		0
Humerus	Proximal	Right	13	2	0
Humerus	Distal	Right	12	0	0
Radius	Proximal	Left	14	0	0
Radius	Distal	Left	13	5	0
Radius	Proximal	Right	12	0	0
Radius	Distal	Right	14		0
Ulna	Proximal	Left	14	2	0
Ulna	Distal	Left	10	2	0
Ulna	Proximal	Right	12	0	0

Ulna	Distal	Right	9	0	0
Os Coxa	Acetabulum	Left	14	5	0
Os Coxa	Acetabulum	Right	14	4	0
Femur	Proximal	Left	12	3	0
Femur	Distal	Left	12	1	1
Femur	Proximal	Right	11	1	0
Femur	Distal	Right	11	0	0
Patella	Posterior	Left	6	3	0
Patella	Posterior	Right	8	2	0
Tibia	Proximal	Left	11	5	0
Tibia	Distal	Left	14	1	0
Tibia`	Proximal	Right	11	2	0
Tibia	Distal	Right	11	0	0

Table . Frequency of Porosity by Bone in 70+ Age group

Joint	Location	Side	# Observed	# Affected (%)	# Affected ≥ Level 2
Scapula	Glenoid Fossa	Left	6	0	0
Scapula	Glenoid Fossa	Right	6	0	0
Humerus	Proximal	Left	6	2	0
Humerus	Distal	Left	8	2	0
Humerus	Proximal	Right	6	1	0
Humerus	Distal	Right	4	1	0

Radius	Proximal	Left	4	0	0
Radius	Distal	Left	5	0	0
Radius	Proximal	Right	3	0	0
Radius	Distal	Right	5	0	0
Ulna	Proximal	Left	5	0	0
Ulna	Distal	Left	4	1	0
Ulna	Proximal	Right	5	1	0
Ulna	Distal	Right	4	1	0
Os Coxa	Acetabulum	Left	5	0	0
Os Coxa	Acetabulum	Right	5	2	0
Femur	Proximal	Left	5	1	0
Femur	Distal	Left	5	0	0
Femur	Proximal	Right	5	1	0
Femur	Distal	Right	5	2	0
Patella	Posterior	Left	5	1	0
Patella	Posterior	Right	4	1	0
Tibia	Proximal	Left	3	2	0
Tibia	Distal	Left	3	0	0
Tibia`	Proximal	Right	5	2	0
Tibia	Distal	Right	5	0	0

Table . Frequency of Lipping by Bone, Total

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	48	0
Scapula	Glenoid Fossa	Right	50	0
Humerus	Proximal	Left	54	0
Humerus	Distal	Left	54	0
Humerus	Proximal	Right	51	0
Humerus	Distal	Right	59	0
Radius	Proximal	Left	56	0
Radius	Distal	Left	53	0
Radius	Proximal	Right	52	0
Radius	Distal	Right	52	1
Ulna	Proximal	Left	58	0
Ulna	Distal	Left	57	1
Ulna	Proximal	Right	54	0
Ulna	Distal	Right	55	1
Os Coxa	Acetabulum	Left	72	0
Os Coxa	Acetabulum	Right	58	0
Femur	Proximal	Left	57	0
Femur	Distal	Left	55	0
Femur	Proximal	Right	58	1
Femur	Distal	Right	54	3

Patella	Posterior	Left	25	0
Patella	Posterior	Right	28	0
Tibia	Proximal	Left	55	0
Tibia	Distal	Left	60	0
Tibia`	Proximal	Right	63	1
Tibia	Distal	Right	61	0

Table . Frequency of Lipping by Bone in Females

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	41	0
Scapula	Glenoid Fossa	Right	30	0
Humerus	Proximal	Left	31	0
Humerus	Distal	Left	35	1
Humerus	Proximal	Right	34	0
Humerus	Distal	Right	34	0
Radius	Proximal	Left	34	0
Radius	Distal	Left	33	0
Radius	Proximal	Right	33	0
Radius	Distal	Right	36	1
Ulna	Proximal	Left	36	0
Ulna	Distal	Left	27	0
Ulna	Proximal	Right	34	0
Ulna	Distal	Right	31	0

Os Coxa	Acetabulum	Left	39	0
Os Coxa	Acetabulum	Right	37	0
Femur	Proximal	Left	36	0
Femur	Distal	Left	34	0
Femur	Proximal	Right	36	1
Femur	Distal	Right	33	1
Patella	Posterior	Left	16	0
Patella	Posterior	Right	18	0
Tibia	Proximal	Left	29	0
Tibia	Distal	Left	31	0
Tibia`	Proximal	Right	36	1
Tibia	Distal	Right	32	0

Table . Frequency of Lipping by Bone in Males

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	30	0
Scapula	Glenoid Fossa	Right	22	0
Humerus	Proximal	Left	23	0
Humerus	Distal	Left	28	0
Humerus	Proximal	Right	28	0
Humerus	Distal	Right	27	0
Radius	Proximal	Left	30	0
Radius	Distal	Left	28	0

Radius	Proximal	Right	27	0
Radius	Distal	Right	24	0
Ulna	Proximal	Left	29	0
Ulna	Distal	Left	24	1
Ulna	Proximal	Right	36	0
Ulna	Distal	Right	22	1
Os Coxa	Acetabulum	Left	31	0
Os Coxa	Acetabulum	Right	30	0
Femur	Proximal	Left	28	0
Femur	Distal	Left	28	0
Femur	Proximal	Right	31	0
Femur	Distal	Right	29	2
Patella	Posterior	Left	3	0
Patella	Posterior	Right	3	0
Tibia	Proximal	Left	23	0
Tibia	Distal	Left	26	0
Tibia`	Proximal	Right	24	1
Tibia	Distal	Right	26	0

Table . Frequency of Lipping by Bone in Indeterminates

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	0	0
Scapula	Glenoid Fossa	Right	0	0

Humerus	Proximal	Left	0	0
Humerus	Distal	Left	1	0
Humerus	Proximal	Right	0	0
Humerus	Distal	Right	1	0
Radius	Proximal	Left	1	0
Radius	Distal	Left	0	0
Radius	Proximal	Right	1	0
Radius	Distal	Right	1	0
Ulna	Proximal	Left	3	0
Ulna	Distal	Left	1	0
Ulna	Proximal	Right	3	0
Ulna	Distal	Right	1	0
Os Coxa	Acetabulum	Left	1	0
Os Coxa	Acetabulum	Right	0	0
Femur	Proximal	Left	2	0
Femur	Distal	Left	2	0
Femur	Proximal	Right	0	0
Femur	Distal	Right	1	0
Patella	Posterior	Left	0	0
Patella	Posterior	Right	1	0
Tibia	Proximal	Left	2	0
Tibia	Distal	Left	2	0
Tibia`	Proximal	Right	2	0
Tibia	Distal	Right	2	0

Table. Frequency of Lipping by Bone in 15-24 Age group

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	6	0
Scapula	Glenoid Fossa	Right	6	0
Humerus	Proximal	Left	6	0
Humerus	Distal	Left	7	0
Humerus	Proximal	Right	6	0
Humerus	Distal	Right	6	0
Radius	Proximal	Left	6	0
Radius	Distal	Left	7	0
Radius	Proximal	Right	6	0
Radius	Distal	Right	7	0
Ulna	Proximal	Left	6	0
Ulna	Distal	Left	7	0
Ulna	Proximal	Right	2	0
Ulna	Distal	Right	7	0
Os Coxa	Acetabulum	Left	7	0
Os Coxa	Acetabulum	Right	8	0
Femur	Proximal	Left	7	0
Femur	Distal	Left	7	0
Femur	Proximal	Right	8	0
Femur	Distal	Right	8	0
Patella	Posterior	Left	2	0

Patella	Posterior	Right	2	0
Tibia	Proximal	Left	5	0
Tibia	Distal	Left	5	0
Tibia`	Proximal	Right	5	0
Tibia	Distal	Right	5	0

Table . Frequency of Lipping by Bone in 25-34 Age group

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	17	0
Scapula	Glenoid Fossa	Right	20	0
Humerus	Proximal	Left	20	0
Humerus	Distal	Left	23	0
Humerus	Proximal	Right	23	0
Humerus	Distal	Right	22	0
Radius	Proximal	Left	26	0
Radius	Distal	Left	26	0
Radius	Proximal	Right	25	0
Radius	Distal	Right	20	
Ulna	Proximal	Left	26	0
Ulna	Distal	Left	23	0
Ulna	Proximal	Right	23	0
Ulna	Distal	Right	22	0
Os Coxa	Acetabulum	Left	28	0

Os Coxa	Acetabulum	Right	26	0
Femur	Proximal	Left	24	0
Femur	Distal	Left	24	0
Femur	Proximal	Right	27	1
Femur	Distal	Right	25	2
Patella	Posterior	Left	7	0
Patella	Posterior	Right	7	0
Tibia	Proximal	Left	22	0
Tibia	Distal	Left	23	0
Tibia`	Proximal	Right	25	1
Tibia	Distal	Right	23	0

Table . Frequency of Lipping by Bone in 35-49 Age Group

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	10	0
Scapula	Glenoid Fossa	Right	10	0
Humerus	Proximal	Left	10	0
Humerus	Distal	Left	12	1
Humerus	Proximal	Right	12	0
Humerus	Distal	Right	11	0
Radius	Proximal	Left	13	0
Radius	Distal	Left	11	0
Radius	Proximal	Right	14	0

Radius	Distal	Right	4	0
Ulna	Proximal	Left	3	0
Ulna	Distal	Left	1	0
Ulna	Proximal	Right	2	0
Ulna	Distal	Right	1	0
Os Coxa	Acetabulum	Left	4	0
Os Coxa	Acetabulum	Right	4	0
Femur	Proximal	Left	4	0
Femur	Distal	Left	2	0
Femur	Proximal	Right	5	0
Femur	Distal	Right	1	0
Patella	Posterior	Left	4	0
Patella	Posterior	Right	5	0
Tibia	Proximal	Left	1	0
Tibia	Distal	Left	2	0
Tibia`	Proximal	Right	3	0
Tibia	Distal	Right	3	0

Table . Frequency of Lipping by Bone in 50-69 Age group

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	10	0
Scapula	Glenoid Fossa	Right	9	0

Humerus	Proximal	Left	12	0
Humerus	Distal	Left	13	0
Humerus	Proximal	Right	13	0
Humerus	Distal	Right	12	0
Radius	Proximal	Left	14	0
Radius	Distal	Left	13	0
Radius	Proximal	Right	12	0
Radius	Distal	Right	14	0
Ulna	Proximal	Left	14	0
Ulna	Distal	Left	10	0
Ulna	Proximal	Right	12	0
Ulna	Distal	Right	0	0
Os Coxa	Acetabulum	Left	14	0
Os Coxa	Acetabulum	Right	14	0
Femur	Proximal	Left	12	0
Femur	Distal	Left	12	0
Femur	Proximal	Right	11	0
Femur	Distal	Right	11	0
Patella	Posterior	Left	5	0
Patella	Posterior	Right	3	0
Tibia	Proximal	Left	11	0
Tibia	Distal	Left	14	0
Tibia`	Proximal	Right	11	0
Tibia	Distal	Right	11	0

Table . Frequency of Lipping by Bone in 70+ Age group

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	5	0
Scapula	Glenoid Fossa	Right	5	0
Humerus	Proximal	Left	5	0
Humerus	Distal	Left	3	0
Humerus	Proximal	Right	5	0
Humerus	Distal	Right	4	0
Radius	Proximal	Left	4	0
Radius	Distal	Left	5	0
Radius	Proximal	Right	3	0
Radius	Distal	Right	5	0
Ulna	Proximal	Left	5	0
Ulna	Distal	Left	4	1
Ulna	Proximal	Right	5	0
Ulna	Distal	Right	4	1
Os Coxa	Acetabulum	Left	5	0
Os Coxa	Acetabulum	Right	5	0
Femur	Proximal	Left	5	0
Femur	Distal	Left	5	0
Femur	Proximal	Right	5	0
Femur	Distal	Right	5	1
Patella	Posterior	Left	5	0
Patella	Posterior	Right	4	0

Tibia	Proximal	Left	3	0
Tibia	Distal	Left	3	0
Tibia`	Proximal	Right	5	1
Tibia	Distal	Right	5	0

Individuals presenting with OA

ID Number	Age	Sex	Joint Affected
5.7	Male	70+	Left distal radius, right distal radius, right distal femur, right proximal tibia
22.2.2	Female	35-49	Right scapula, left proximal ulna
33.2.1	Female	35-49	Right distal radius
9.1A.1	Male	25-34	Right distal femur
20.2.Shaft1	Female	35-49	Left distal tibia
2.2.1	Male	35-49	Left scapula
32.2B.1	Male	25-34	Right distal ulna, left ox coxa, right ox coxa
14.2.1	Female	25-34	Right distal radius, right proximal and distal femur
36.Shaft1.B1.2	Male	35-49	Left Patella

Frequency of OA by Bone

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	48	1

Scapula	Glenoid Fossa	Right	60	0
Humerus	Proximal	Left	64	0
Humerus	Distal	Left	64	1
Humerus	Proximal	Right	61	0
Humerus	Distal	Right	59	0
Radius	Proximal	Left	66	0
Radius	Distal	Left	63	0
Radius	Proximal	Right	67	0
Radius	Distal	Right	62	3
Ulna	Proximal	Left	68	1
Ulna	Distal	Left	67	1
Ulna	Proximal	Right	64	0
Ulna	Distal	Right	65	1
Os Coxa	Acetabulum	Left	72	0
Os Coxa	Acetabulum	Right	68	0
Femur	Proximal	Left	67	0
Femur	Distal	Left	65	0
Femur	Proximal	Right	68	2
Femur	Distal	Right	64	4
Patella	Posterior	Left	25	1
Patella	Posterior	Right	28	0
Tibia	Proximal	Left	65	0
Tibia	Distal	Left	60	1
Tibia`	Proximal	Right	63	1
Tibia	Distal	Right	61	0

Frequency of OA by Bone in Females

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	41	0
Scapula	Glenoid Fossa	Right	30	1
Humerus	Proximal	Left	31	0
Humerus	Distal	Left	35	1
Humerus	Proximal	Right	34	0
Humerus	Distal	Right	34	0
Radius	Proximal	Left	34	0
Radius	Distal	Left	33	0
Radius	Proximal	Right	33	0
Radius	Distal	Right	36	2
Ulna	Proximal	Left	36	1
Ulna	Distal	Left	27	0
Ulna	Proximal	Right	34	0
Ulna	Distal	Right	31	0
Os Coxa	Acetabulum	Left	39	0
Os Coxa	Acetabulum	Right	37	0
Femur	Proximal	Left	36	0
Femur	Distal	Left	34	0
Femur	Proximal	Right	36	1
Femur	Distal	Right	33	1
Patella	Posterior	Left	16	0

Patella	Posterior	Right	18	0
Tibia	Proximal	Left	29	0
Tibia	Distal	Left	31	1
Tibia`	Proximal	Right	36	1
Tibia	Distal	Right	32	0

Frequency of OA by Bone in Males

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	30	1
Scapula	Glenoid Fossa	Right	22	0
Humerus	Proximal	Left	23	0
Humerus	Distal	Left	28	0
Humerus	Proximal	Right	28	0
Humerus	Distal	Right	27	0
Radius	Proximal	Left	30	0
Radius	Distal	Left	28	0
Radius	Proximal	Right	27	0
Radius	Distal	Right	24	1
Ulna	Proximal	Left	29	0
Ulna	Distal	Left	24	1
Ulna	Proximal	Right	36	0
Ulna	Distal	Right	22	1
Os Coxa	Acetabulum	Left	31	0

Os Coxa	Acetabulum	Right	30	0
Femur	Proximal	Left	28	0
Femur	Distal	Left	28	0
Femur	Proximal	Right	31	1
Femur	Distal	Right	29	3
Patella	Posterior	Left	3	1
Patella	Posterior	Right	3	0
Tibia	Proximal	Left	23	0
Tibia	Distal	Left	26	0
Tibia`	Proximal	Right	24	2
Tibia	Distal	Right	26	0

Frequency of OA by Bone in Indeterminates

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	0	0
Scapula	Glenoid Fossa	Right	0	0
Humerus	Proximal	Left	0	0
Humerus	Distal	Left	1	0
Humerus	Proximal	Right	0	0
Humerus	Distal	Right	1	0
Radius	Proximal	Left	1	0
Radius	Distal	Left	0	0
Radius	Proximal	Right	1	0

Radius	Distal	Right		0
Ulna	Proximal	Left	3	0
Ulna	Distal	Left		0
Ulna	Proximal	Right	3	0
Ulna	Distal	Right		0
Os Coxa	Acetabulum	Left		0
Os Coxa	Acetabulum	Right	0	0
Femur	Proximal	Left	2	0
Femur	Distal	Left	2	0
Femur	Proximal	Right	0	0
Femur	Distal	Right		0
Patella	Posterior	Left	0	0
Patella	Posterior	Right		0
Tibia	Proximal	Left	2	0
Tibia	Distal	Left	2	0
Tibia`	Proximal	Right	2	0
Tibia	Distal	Right	2	0

Frequency of OA by Bone in 15-24 Age group

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	3	0
Scapula	Glenoid Fossa	Right	3	0
Humerus	Proximal	Left	3	0

Humerus	Distal	Left	7	0
Humerus	Proximal	Right	5	0
Humerus	Distal	Right	5	0
Radius	Proximal	Left	5	0
Radius	Distal	Left	7	0
Radius	Proximal	Right	5	0
Radius	Distal	Right	7	0
Ulna	Proximal	Left	5	0
Ulna	Distal	Left	7	0
Ulna	Proximal	Right	2	0
Ulna	Distal	Right	7	0
Os Coxa	Acetabulum	Left	7	0
Os Coxa	Acetabulum	Right	8	0
Femur	Proximal	Left	7	0
Femur	Distal	Left	7	0
Femur	Proximal	Right	8	0
Femur	Distal	Right	8	0
Patella	Posterior	Left	2	0
Patella	Posterior	Right	2	0
Tibia	Proximal	Left	5	0
Tibia	Distal	Left	5	0
Tibia`	Proximal	Right	5	0
Tibia	Distal	Right	5	0

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	17	0
Scapula	Glenoid Fossa	Right	20	0
Humerus	Proximal	Left	20	0
Humerus	Distal	Left	23	0
Humerus	Proximal	Right	23	0
Humerus	Distal	Right	22	0
Radius	Proximal	Left	26	0
Radius	Distal	Left	26	0
Radius	Proximal	Right	25	0
Radius	Distal	Right	20	2
Ulna	Proximal	Left	26	0
Ulna	Distal	Left	23	0
Ulna	Proximal	Right	23	0
Ulna	Distal	Right	22	0
Os Coxa	Acetabulum	Left	28	0
Os Coxa	Acetabulum	Right	26	0
Femur	Proximal	Left	24	0
Femur	Distal	Left	24	0
Femur	Proximal	Right	27	2
Femur	Distal	Right	25	3
Patella	Posterior	Left	7	0
Patella	Posterior	Right	7	0
Tibia	Proximal	Left	22	0
Tibia	Distal	Left	23	0

Tibia`	Proximal	Right	25	2
Tibia	Distal	Right	23	0

35-49

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	10	1
Scapula	Glenoid Fossa	Right	10	1
Humerus	Proximal	Left	10	0
Humerus	Distal	Left	12	1
Humerus	Proximal	Right	12	0
Humerus	Distal	Right	11	0
Radius	Proximal	Left	13	0
Radius	Distal	Left	11	0
Radius	Proximal	Right	14	0
Radius	Distal	Right	14	1
Ulna	Proximal	Left	13	1
Ulna	Distal	Left	11	0
Ulna	Proximal	Right	12	0
Ulna	Distal	Right	11	0
Os Coxa	Acetabulum	Left	14	0
Os Coxa	Acetabulum	Right	14	0
Femur	Proximal	Left	14	0
Femur	Distal	Left	12	0
Femur	Proximal	Right	15	0

Femur	Distal	Right	1	0
Patella	Posterior	Left	4	
Patella	Posterior	Right	5	0
Tibia	Proximal	Left	1	0
Tibia	Distal	Left	2	
Tibia`	Proximal	Right	3	0
Tibia	Distal	Right	3	0

50-69

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	10	0
Scapula	Glenoid Fossa	Right	9	0
Humerus	Proximal	Left	12	0
Humerus	Distal	Left	13	0
Humerus	Proximal	Right	3	0
Humerus	Distal	Right	2	0
Radius	Proximal	Left	4	0
Radius	Distal	Left	3	0
Radius	Proximal	Right	2	0
Radius	Distal	Right	4	0
Ulna	Proximal	Left	4	0
Ulna	Distal	Left	0	0
Ulna	Proximal	Right	2	0
Ulna	Distal	Right	0	0

Os Coxa	Acetabulum	Left	4	0
Os Coxa	Acetabulum	Right	4	0
Femur	Proximal	Left	2	0
Femur	Distal	Left	2	0
Femur	Proximal	Right	1	0
Femur	Distal	Right	1	0
Patella	Posterior	Left	5	0
Patella	Posterior	Right	3	0
Tibia	Proximal	Left	1	0
Tibia	Distal	Left	4	0
Tibia`	Proximal	Right	1	0
Tibia	Distal	Right	1	0

70+

Joint	Location	Side	# Observed	# Affected (%)
Scapula	Glenoid Fossa	Left	5	0
Scapula	Glenoid Fossa	Right	5	0
Humerus	Proximal	Left	5	0
Humerus	Distal	Left	3	0
Humerus	Proximal	Right	5	0
Humerus	Distal	Right	4	0
Radius	Proximal	Left	4	0
Radius	Distal	Left	5	0
Radius	Proximal	Right	3	0

Radius	Distal	Right	5	0
Ulna	Proximal	Left	5	0
Ulna	Distal	Left	4	1
Ulna	Proximal	Right	5	0
Ulna	Distal	Right	4	1
Os Coxa	Acetabulum	Left	5	0
Os Coxa	Acetabulum	Right	5	0
Femur	Proximal	Left	5	0
Femur	Distal	Left	5	0
Femur	Proximal	Right	5	0
Femur	Distal	Right	5	1
Patella	Posterior	Left	5	0
Patella	Posterior	Right	4	0
Tibia	Proximal	Left	5	0
Tibia	Distal	Left	5	0
Tibia`	Proximal	Right	5	1
Tibia	Distal	Right	5	0

Overall, 88 percent of the population presented mild or absent osteoarthritic conditions with only 4 percent displaying moderate to severe conditions. We know that a large contributor of osteoarthritis is a repetitive motion for an extended period, so most of the population was not engaged in some type of heavy manual labor, but those that were was not specific to a certain group. When compared, individuals that displayed osteoarthritis were both males and females, ranged from 25 to 70+ in age. These individuals were from various burial types, but most were from tumuli burials. Of the three individuals with severe osteoarthritis, 2 were from chapel burials, both male but from different age groups, 25-34 and 70+. The third individual was a female between the age of 25 to 34 and from a tumuli burial.

We determined that 88 percent of the population was not considered osteoarthritic but that does not mean they did not have osteoarthritis markers present. Most individuals had at least one marker present with a level one or higher in one or more joints, although some did not have any

markers present. Since osteoarthritis becomes more prevalent as individuals age, we expect higher percentages of the beginning stages. Of the joints surveyed, most had a frequency between 30 to 40% of lipping being present (Table 5), which does drop significantly when looking for levels of two or higher. A similar pattern followed for pitting as well but ranged between 10 to 20% (Table 6). Eburnation, the final stage of osteoarthritis, was uncommon in this project as only three individuals had this present at the time of death.

Discussion

From the data, we can tell that most of the population was not engaged in heavy, repetitive manual labor. Of those individuals who were considered to have osteoarthritis, there was not a specific characteristic that tipped the scales in favor of one sex or age over the others. There was almost an even number of males (n=5) and females (n=4) who ranged in age between 25-34 to 70+. Many of individuals (n=79) displayed little to no signs of any degeneration of all joints surveyed, nine presented at least one joint that had 2 markers with scores of two or higher. Of those nine (table 1), three had eburnation present at the time of death. The frequency of osteoarthritis within each joint was calculated, but the average was less than 1.5% (Tables 2, 3, and 4), even though we had osteoarthritis present within the population the number of individuals affected was very low. Most individuals that were affected only had osteoarthritis present in one joint. There is not enough data to speak on a distinct division of labor among the New Kingdom Tombos population, although, from the frequencies of the total population we see that lipping was prevalent throughout. Many of the individuals surveyed were in the 25-34 age range, meaning people were engaging in some type of repetitive motion to set off the beginning stages of osteoarthritis at such a young age. Since osteoarthritis is a degenerative disease, we expect more older individuals to present with severe conditions.

This brings into question why many young individuals presented with osteoarthritis conditions if most of the population was unaffected. This population was living during the second wave of colonization by Egypt. As seen with other colonized groups, some attempted to assimilate and others rebelled. Nubians who ‘Egyptianized’ themselves might have had access to a higher social status and its benefits such as economic stability, political power, and better occupations (Schrader, 2022). While Egyptianized Nubians may still engage in manual labor, it seems to have been less strenuous shown by the mild frequencies of lipping throughout the population. Those who refused Egyptian culture were held to a lower social status and therefore worked the more manual-intensive jobs. Looking at the burial types and grave goods can provide a better insight into the social statuses of these individuals. Seven of the osteoarthritis -affected individuals were from tumuli burials which are associated with Nubian culture. These individuals and most tumuli tombs were excavated in the eastern cemetery. There is a clear line between Egyptians and Nubians when it comes to social status at Tombos, their tomb type and location can provide an insight into the individual’s status. The skeletal analysis can provide supporting evidence for the divisions between social groups based on pathological conditions.

Having a complete or majority of skeletal remains is the goal when excavating, but after two thousand years those chances are small. Commingling, tomb raiding, and environmental conditions exhibited on bones all factor into the survival of skeletal material. This population had a small percentage of individuals present with osteoarthritis conditions, but not all remains surveyed were complete. Some were missing entire bones or only had one-half of a joint. Could it be that osteoarthritis might have been more prevalent if all remains were complete?

Conclusion

The prevalence of osteoarthritis markers can provide insight into the overall health of a population and allow bioarcheologists the supporting evidence for divisions of labor and gendered roles that an individual may have. Osteoarthritis is a degenerative disease, but nine individuals showed moderate/ severe osteoarthritis conditions, three had the presence of eburnation. For those at Tombos, most of the population displayed mild to no markers of osteoarthritis, but that is not to say that none of the individuals were engaging in some type of labor as there were average frequencies of mild lipping. We did expect to see higher osteoarthritis scores in the older populations but this time in New Kingdom Tombos is characterized by the recolonization of Nubia where individuals were aligning themselves with Egyptian culture to secure higher social and political status. These nine individuals are the outliers of the group, but we also must consider the condition of the remains but not all of them were complete skeletons so there higher osteoarthritis scores could be possible but without a joint to examine we can only speculate based on other joint conditions.

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