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The Effects of Orthopedic Pathologies on the Prevalence of Hip Osteoarthritis

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Introduction

Osteoarthritis (OA) is a degenerative joint disease that is a leading cause of disability among aging adults. In the U.S., over 2.5 million individuals live with total hip arthroplasties (Kremers et al., 2015), of which 70% attribute OA as the cause (AJRR, 2016). Because the majority of anthropological OA research excludes pathological individuals, little is known about how prostheses and pathologies impact OA. The current understanding of OA is as a disease of the entire joint organ rather than just an isolated disease of articular cartilage (Felson, 2004; Felson and Neogi, 2004). The multifactorial etiology of OA suggests that different populations may exhibit different patterns of the disease to a certain degree (Jurmain, 1990). Age is one of the primary influences in the likelihood of an individual to develop OA (Domett et al., 2017; Eng, 2016; Jurmain, 1980; Weiss and Jurmain, 2007; Winburn, 2017). However, other influences such as weight (BMI), sex, disease, trauma, bone mineral density (BMD), and physical activity may also influence its onset and severity (Weiss and Jurmain, 2007; Winburn 2017). The relationship between systemic diseases and OA is an important consideration in modern human skeletal biology research as it investigates modern disease processes and the effects these common diseases may have on individuals.

This study investigates the effects of orthopedic pathologies on the prevalence of hip OA in modern African- and European-American individuals from the Edmonds Orthopedic Pathology Collection at the National Museum of Health and Medicine in Silver Spring, Maryland. It is hypothesized that osteoarthritic changes of the hip are positively correlated with age and prosthesis implants compared to individuals lacking prostheses, and that the prevalence of OA is positively correlated with other systemic diseases.

Materials and Methods

The first author examined the proximal femora of 186 individuals of European-American (n=144) and African-American (n=42) ancestry, 21-95 years old (Table 1). Of the 186 individuals, 93 are in the previous injury/prosthesis cohort, 24 in the non-disease cohort, and 69 in the disease cohort. Of the 69 individuals in the disease cohort, 49 (71%) were diagnosed with cancer.

Table 1. Demographic composition (ancestry and sex) of the sample for each cohort.

Cohort	European-American (n=144)		African-American (n=42)	
	Males	Females	Males	Females
Disease	19	23	9	18
Non-Disease	7	10	3	3
Previous Injury/ Prostheses	26	59	2	7

The degree of OA was observed and scored on the proximal femur following Jurmain (1990), using an ordinal scoring system: none/slight (0), moderate (1), severe/eburnation (2), and ankyloses (3) (Figure 1). A subset of 17 individuals studied were re-scored to examine inter- and intraobserver error. Statistical analyses included Spearman's rank correlations, Chi-square analyses, exploratory data analysis, logistic regression, and Cohen's kappa (Table 2).

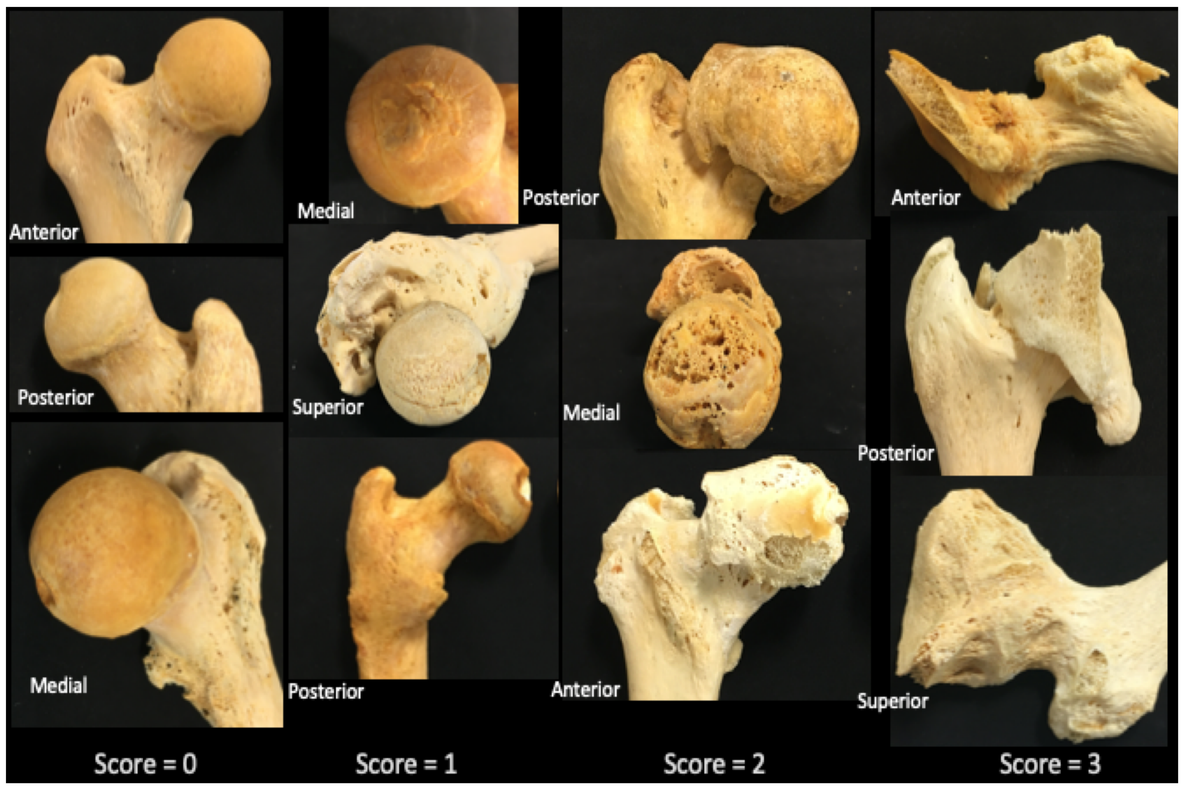

Figure 1. Visual representation of the ordinal scoring system of proximal femur OA.

Table 2. Description of statistical tests conducted for the current research.

Statistical Test	Description
Spearman's rank correlation	Detect variation in femur score between left and right femora within each individual (Field, 2009)
Chi-square	Test of independence (relationship between femur score and cohort) (Field, 2009)
Exploratory data analysis	Investigate group differences (average femur scores in different cohorts) (Field, 2009)
Ordinal logistic regression	Predict the probability of an individual having OA (Field, 2009)
Cohen's kappa	Intra- and interobserver error (Landis and Koch, 1977)

Results

Results show that osteoarthritic hip changes are positively correlated with age and presence of a prosthesis, and that systemic diseases, such as cancer, increase the likelihood of OA in an individual (Figure 2). The multifactorial etiology of OA suggests that different populations exhibit variable patterns of OA. Results from Chi-square tests, exploratory data analysis, and ordinal logistic regression show that there is a statistically significant relationship ($p<0.000$) between degree of OA, age, recorded disease, and evidence of previous injury or prostheses, but no differences in sex or ancestry (Figures 3 and 4) .

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Results

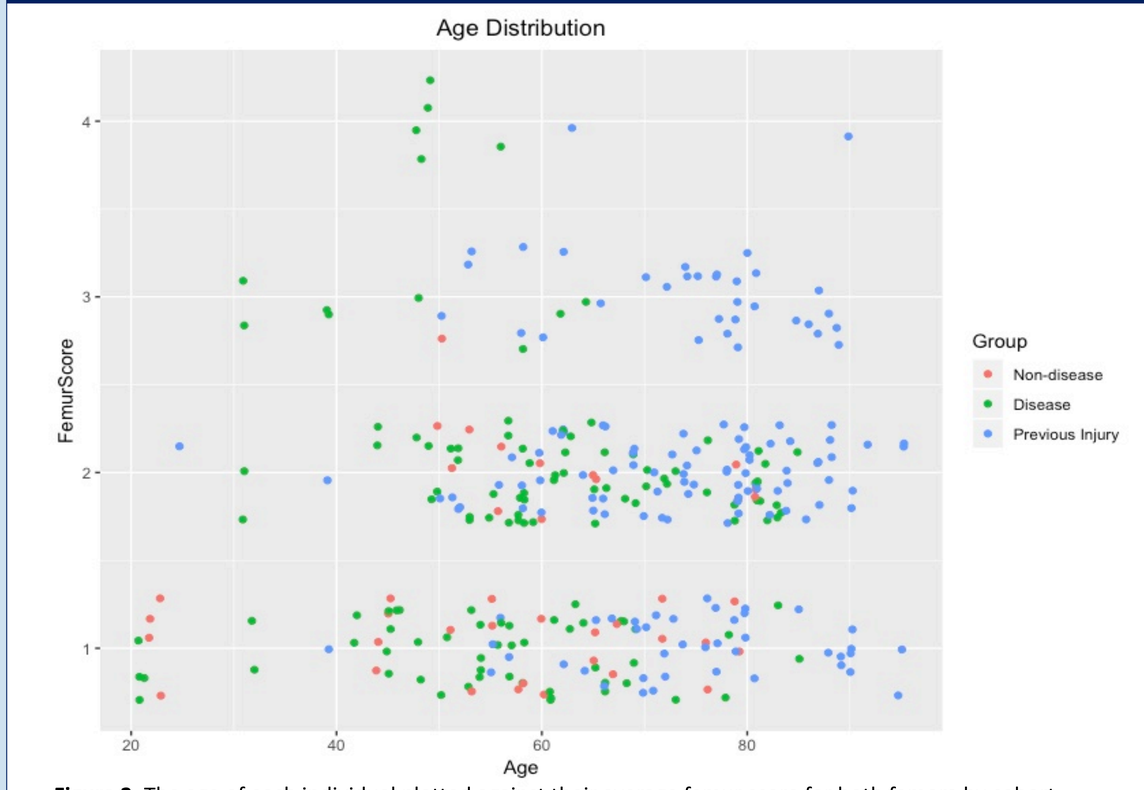

Figure 2. The age of each individual plotted against their average femur score for both femora by cohort.

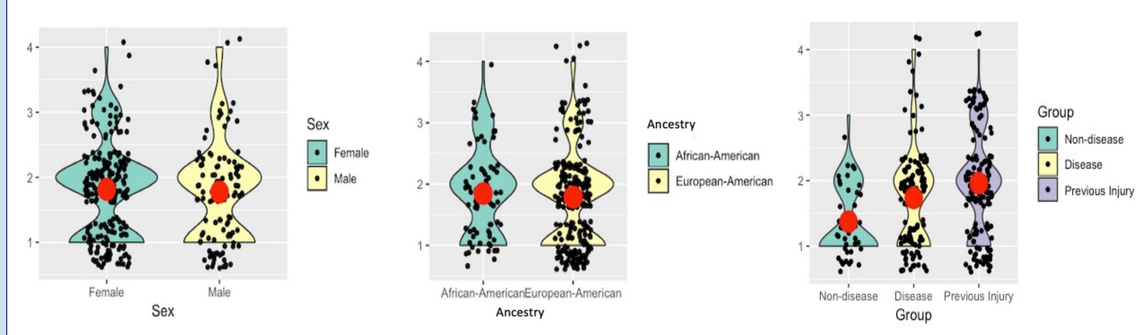

Figure 3. Violin plots illustrating differences in the average femur score (red dots) by sex, ancestry, and group.

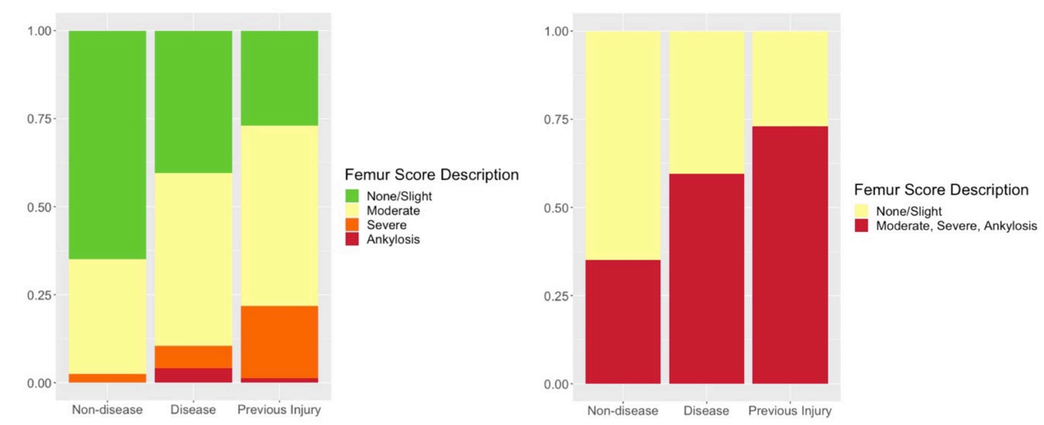

Figure 4. Frequency of individuals in each cohort plotted against OA femur score descriptions.

Further, inter- and intraobserver error rates were calculated using Cohen's kappa. The inter-rater reliability was found to be Kappa = 0.452 ($p<0.001$), 95% CI (0.159, 0.746). The results indicate moderate agreement between the two individuals, following Landis and Koch (1977). For intraobserver error, Kappa = 1.000 ($p<0.001$), 95% CI (1.000) indicating perfect agreement between the two separate scoring events, following Landis and Koch (1977).

Discussion and Conclusions

This research considers the intersection of OA and disease, examining the effects of orthopedic pathology on the prevalence of hip OA and leading to a more complete view of the variation in the expression of OA and its multifactorial etiology. These results will help researchers better understand the etiology and contemporary risk factors of OA, as well as contribute data to OA research on an underrepresented sample.

The results of this study are of value to clinicians when considering the necessity for and outcome of total hip arthroplasties and hip prostheses. This study, combined with recent research (Calce, 2012; Calce and Rogers, 2011; Calce et al., 2017; Calce et al., 2018a,b; Rissech et al., 2006; Rissech et al., 2007; San-Millán et al., 2016; San-Millán et al., 2017; San-Millán et al., 2019; Winburn, 2017; Winburn, 2018), provides evidence in support of further research investigating progressive changes of the hip joint. This investigation could lead to both a better understanding of how OA and aging are related, and could eventually lead to more refined techniques for estimating age-at-death in a forensic context—perhaps using not only the acetabulum (*sensu* Calce, 2012; Rissech et al., 2006; San-Millán et al., 2017) but also the femoral head. The current results contradict the expectation of population variation in OA expression, indicating that future research should utilize diverse skeletal samples to elucidate the role played by sex and ancestry in OA prevalence and patterning—including how, if at all, BMD affects the progression and expression of OA. The findings that OA progression and expression magnify in individuals with pre-existing systemic diseases, injuries, and surgical interventions also suggest further avenues for research into the prevalence of OA in pathological populations (i.e., whether OA presents as bone formation or degeneration and how it is affected by disease). Researchers of OA must continue to consider pathological populations, or else their results will be of limited relevance for the nearly 20% of individuals in the U.S. living with musculoskeletal diseases (Lawrence et al., 1998).

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