H77 Where Are the Missing Bones? Structural and Material Properties of Bone and Differential Survivability

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After attending this presentation, attendees will be able to understand how various bone properties can affect bone preservation and skeletal element representation, which is essential in order to make a more robust and thorough assessment of commingled assemblages.

This presentation will impact the forensic science community by providing baseline data regarding human bone structural density and survivability in forensic contexts. Of the most useful contexts are those that are common in forensic settings – that of commingled remains.

While many intrinsic properties of bone affect its potential for preservation, the property that has received the greatest amount of attention in taphonomic studies has been bone density. The definition of "bone density" has been the source of significant confusion among anthropologists and archaeologists. This confusion is warranted, given that this term has been used to refer to different properties or other similar terms (e.g., "bone mineral content," "bone mineral density," "structural density," "bulk density," "true density," "apparent density") have been used in the same context, and that "bone density" has been measured using several different methods that vary in accuracy. What one may typically think of as "bone density," the (dry) mass of a bone divided by its volume, is also known as its apparent density (Martin et al.) or structural density (Lyman).[1,2]

Bone density data have been collected for a number of animal species and for humans, and density has become, by far, the most commonly used proxy value for a bone's potential to survive destructive processes. Bone density studies with a zooarchaeological focus have far outnumbered those conducted with a forensic objective on human material. This reflects the comparatively high frequency in which zooarchaeologists encounter large bone assemblages that include commingled remains of multiple individuals often representing multiple species. However, bone density data for human are of particular relevance to forensic studies by providing guidance as to how to most accurately determine the number of skeletal elements (and individuals) present in the assemblage. Although previous studies have documented bone mineral density in humans (Galloway et al., Willey et al.), these data have not been widely used to explain the actual skeletal element representation. This study offers a larger sample size (MNI=432) discovered from various macro-environments, such as South East Asia, Korea, the Pacific Islands, and Northern Europe.[3,4]

In forensic and archaeological cases, in which the remains of large numbers of individuals are commingled, the determination of the number of individuals is a common research objective. Archaeologists seek to determine the minimum number of individuals (MNI), with the tacit assumption that an accurate determination of MNI provides a plausible estimate for the actual number of individuals represented. Ubelaker noted the relevance of zooarchaeological methodology to the study of commingled human remains.[5] In particular, he cited the observation that, when long bones are consumed by carnivores, the shaft fragments are more likely to survive than the epiphyses and would therefore provide the highest counts for long bone elements. In fact, reconstruction of shaft fragments has allowed a more accurate understanding of prehistoric diet and procurement activities (Bunn; Bunn and Kroll).[6,7] In forensic cases, the use of DNA analysis can be an important tool in determining the number of individuals represented in a commingled assemblage. Where DNA analysis is constrained by financial limitations or poor preservation, the determination of MNI rests largely on the morphological assessment. Under these circumstances, an understanding of the patterns of bone density and their effect on bone preservation is essential.

Skeletal remains recovered by the Joint POW/MIA Accounting Command (JPAC) provide multiple assemblages to test the relationship between bone structural density and survivability in human bones; specifically, this study tests the hypothesis that more dense bone will display increased survivability regardless of contextual background. In most cases, bone structural density and survivability show statistically significant correlation, which indicate the presence/absence of certain skeletal elements can probably be best explained by the natural process of bone degradation. Particular case studies originate from the Democratic People's Republic of Korea (DPRK; aka "North Korea"), related to human remains originating from the Korean War, between 1950 and 1953. One specific commingled case originates from a secondary, fluvial deposit from a POW holding area. The structural density and bone survivability showed significant correlation, and the MNI count of nine was based on the femoral shaft. The DNA data then confirmed that there were nine individuals. This example shows the importance of correctly identifying the most dense long bone shafts to calculate the most accurate MNI. Other examples come from a large commingled assemblage of remains that were turned over by the DPRK to the United States government, collectively referred to as the K208.

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Taphonomy, Bone Density, Commingling

