H10 A Re-Examination of Age-at-Death Estimation From the Human Sacrum

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After attending this presentation, attendees will have a more comprehensive understanding of the human sacrum as an age indicator and statistical techniques used to assess age.

This presentation will impact the forensic science community by providing further investigation into traits and statistical techniques for estimating age-at-death from the human sacrum.

The goal of this presentation is to inform attendees about the performance of seven traits previously proposed as significant markers in the assessment of age at death from the human sacrum.[1]

Accurate age-at-death estimation from human skeletal remains is critical for establishing a comprehensive biological profile of an unknown individual, in order to facilitate the victim identification process. While many regions of the human skeleton have methods available to assess age at death, the sacrum has only recently been investigated.[1] The study builds on that previous work.

The primary aim of this study was to assess the performance of seven sacral traits, previously proposed to have utility in the assessment of age-at-death from human skeletal remains. These traits were: fusion of S1/S2, fusion of S2/S3, surface change, apical change, fusion of annular ring of S1, microporosity, and macroporosity. The study sample consisted of n=633 sacra from the Hamann-Todd (n=386) and Bass (n=247) collections. Individuals from the Hamann-Todd collection consisted of males and females, mainly of African and European ancestry, ranging in age-at-death from 10 to 96 years, and individuals from the Bass collection consisted of males and females of European ancestry, ranging in age-at-death from 16 to 97 years. Previous research found no significant sex or ancestry differences in regard to age changes in the sacrum.[1]

These traits develop over a continuum and each morphological character was scored according to multiple trait variants as described in Passalacqua (2009). In order to limit observer error; however, these traits were re-scored on a presence/absence or an unfused/fused scale. Age ranges were arbitrarily assigned into three broad age categories: young adult (<31 years), middle-aged adult (31 – 50 years), and old adult (51+ years). Each of these age ranges were treated as "populations" and subjected to multinomial regression analysis, random forest modeling, a naïve Bayesian model, and linear discriminant function analysis. Lastly, frequencies for each trait within each age group were tabulated and used to calculate Principal Component (PC) scores. The PCs were plotted against themselves to investigate the interplay of each trait in the estimation of age.

Each of these statistical methods for group membership had a similar correct classification rate, ranging from 69.8% correct using a naïve Bayesian analysis to 67.1% correct using discriminate function analysis. This trend, however, did not hold true for classifications of particular age ranges. By far, the most mis-aged age range was the middle-aged adults (31 – 50 years), with three of the four analyses correctly classifying 3.4% or less of this age range. Discriminate function analysis showed a much better ability to correctly classify middle-aged adults, with 38.1% of this group correctly classified.

Principal component analysis showed that the frequency distribution of these traits varied by age. Two principal components were derived from these data. The first PC showed the greatest loadings in the fusion of the S1 annular ring and then by the depression/resorption of the S1 annular ring, while PC2 demonstrated the greatest loading was macroporosity followed by surface changes. When plotted against themselves, the principal components showed a clear separation of each of the age ranges. On PC1, the decades moved in gradual order from youngest to oldest, while PC2 showed the <31-year group and 51+ years in a gradual order while 31 – 50-year group was separated.

Results demonstrated that treating age groups as populations yielded total correct classifications greater than pure chance. In each analysis, middle-aged adults misclassified most frequently. Conversely, the oldest age group (51+ years) demonstrated the highest classification accuracies. The principal components indicated that fusion of the S1 annular ring, depression/resorption of the S1 annular ring, macroporosity, and surface change accounted for the majority of variation present in the sample. Similar to other degenerative aging techniques, the sacrum predictably changes throughout life with younger and older individuals classifying correctly more often than middle-aged individuals.

Reference:

1. Passalacqua NV. Forensic age-at-death estimation from the human sacrum. *J Forensic Sci* 2010;54(2):255-262.

Forensic Anthropology, Age-at-Death Estimation, Sacrum

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