A26 A New Method for Adult Skeletal Age Estimation Using Transition Analysis: TA3

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Learning Overview: After attending this presentation, attendees will better understand a new system for adult age estimation from the skeleton. The system comprises new trait definitions and scoring procedures, new analytical methods for age estimation, and new software that facilitates the entire process.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by addressing a significant gap in best practices in the forensic anthropological approaches to adult age estimation. This method is based on more than 1,600 skeletons from around the world, exhibits little bias in estimating age in individuals approximately 20 to 100 years old, and can use numerous traits from throughout the skeleton.

Accurate and precise age estimates are crucial for identifying skeletal remains. Age intervals assigned to skeletons can rarely provide support for individual identifications. Current age estimation methods for adults are characterized by biased point estimates of age accompanied by prediction intervals that usually span several decades to include virtually all of adulthood. Moreover, open-ended categories such as "50+" are often used because the currently used traits provide no further information after 50 years of age. Clearly, new skeletal traits are needed to better estimate age.

Creating a new system involved defining and refining the new skeletal traits, assessing inter-observer differences, establishing trait age distributions, employing new statistical and machine learning analytical procedures, and developing user-friendly software for scoring traits and estimating age.

Observations were collected from 136 traits, 39 of which are bilateral, from more than 1,600 known-age adult skeletons from four continents to accommodate regional and ancestry-related variation in the aging process. The new system, TA^3, is an improvement on Transition Analysis, which has focused solely on the pelvic joints and cranial sutures. TA^3 uses many newly defined traits distributed throughout the skeleton. Most traits were scored as binary, either present or absent, usually reflecting additional bone formed over time, such as lipping near joints; judging bones as "light" is an example of scoring bone loss; weights and lengths of certain bones were recorded to quantify bone density; other traits were scored as ordinal traits, depending on the attainment of certain thresholds. Subjective stages defined by numerous features were avoided. The traits that undergo a fast transition from one state to the next during adulthood are especially valuable. Several statistical and machine learning methods were used to combine information from multiple traits to yield valid age estimates and prediction intervals.

The most important general result of this research is that there are numerous traits throughout the skeleton that show changes throughout the human lifespan, enabling more accurate estimates without large open-ended age intervals such as "50+." The mean correlation for all traits with age is 0.46, and some are far more useful than others. The ordinal traits are often expressed in general age distribution categories of "young" (20 to 40), "middle aged" (40 to 60), or "older" (at least 60). As a result, TA^3 yields far better age estimates throughout adulthood than any other currently used method. For example, a single trait from the femur (fovea margin smooth vs. lipping) shows a more rapid transition and provides a much better age estimate than Suchey-Brooks stage 5 vs. stage 6. The latter finding illustrates the value of defining simple traits from any skeletal area rather than through divining complicated stages by observing many trait states in a few areas.

Other important results include: the cranium appears to have little age-relevant information; subjective "lightness" of bones is valuable in estimating older ages; vertebral and humeral traits are very informative; many traits show high intercorrelations, and bilateral traits are, for the most part, very highly correlated; marked asymmetry seems restricted to one trait from the ulna.

The analytical methods are still being refined but results so far show age estimates with 95% prediction intervals of as small as +/-10 years, and most importantly, with little to no bias in age estimation between 20 and 100 and no plateau in age estimates. Using more traits from different bones provides more accurate estimates. Also, because TA^3 can use bony features distributed throughout the body, meaningful age estimates are possible for incomplete skeletons, which often is essential in forensic investigations.

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Biological Profile, Skeletal Age Estimation, Transition Analysis