A32 An Age-at-Death Estimation in a Contemporary Australian Population Using Femoral Histomorphometry

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Learning Overview: After attending this presentation, attendees will: (1) understand how bone remodeling is reflected in bone microstructure and can be used for histomorphometric age-at-death estimation; (2) appreciate the importance of population-specific standards for age-at-death estimation; and (3) appreciate the importance of sample size in relation to error and accuracy rates.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating the need for population-specific standards derived from larger reference samples. Increased understanding of the relationship between sample size and standard error will serve to improve the accuracy of histological aging methods.

Histology is an alternative approach for forensic age-at-death assessment, particularly in fragmentary remains. Bone remodeling can be assessed based on the premise that the rate of bone turnover increases as an individual ages. Histomorphometric studies use measurements of secondary osteons and their respective features to formulate age-at-death regression models. To further understand potential applications and inherent limitations of histomorphometric approaches in a forensic context, the present study examines existing histomorphometric age-at-death methods as applied to a modern Australian population.

Microradiographs from 215 femoral mid-shaft cross-sections (117♂; 98♀) were obtained from the Melbourne Femur Research Collection (MFRC) at the Melbourne Dental School; recorded chronological age at death is 18–97 years of age (pooled $\bar{x}$=56.1, SD=22.8; ♂ $\bar{x}$=56.2, SD=21.8; ♀ $\bar{x}$= 56.0, SD= 24.0). Twelve variables are measured across six anterior 1mm^2 fields of view using ImageJ. Technical Error of Measurement (TEM) and Intra-Class Correlation (ICC) are calculated to test intra-observer repeatability. The age-at-death estimation formulae of: (1) Singh and Gunberg, (2) Goliath et al.; and (3) Keough et al. are applied; stepwise linear regression is used to develop population-specific formulae.[1-3] The relationship between estimated and actual age at death is statistically quantified using the Standard Error of the Estimate (SEE).

The TEM values were within acceptable limits (rTEM<5%, R>0.8) and ICC values were considered "excellent" (>0.9). Pooled standard error values for the existing methods were all in excess of ±20 years (range: ±22.3–22.6 years) and generally more accurate for males (SEE ♂±21.6–24.3 vs. ♀22.6–25.0 years). Population-specific modeling resulted in increased accuracy (pooled: ±19.8–22.0 years; ♂20.4–21.4 years; ♀19.4–23.0 years). When the study sample was split by age group, all methods demonstrated increased accuracy for the 35–50 year and 51–74 year age groups, with SEE values of ±10.9–21.6 and ±8.9–14.2 years for the existing age estimation methods, and ±11.2–12.6 and ±10.3–12.4 years (for the 35–50 years and 51–74 year age groups, respectively). Further examination is needed to determine the exact cause of the inaccuracies for the two remaining age groups (18–34 years and 75+ years) and any differences in bone remodeling in younger and older individuals that may be the cause. These results clearly demonstrate the importance of critical validation of existing formulae. Given the large SEE values from regression-based formulae for histomorphometric age at death, further validation of existing standards on foreign populations is necessary. Future work will include the production of population-specific standards for histomorphometric age-at-death estimation using novel variables or ratios.

Reference(s):

1. Singh, I.J., and D.L. Gunberg. Estimation of Age at Death in Human Males from Quantitative Histology of Bone Fragments. *American Journal of Physical Anthropology* 33, no. 3 (1970): 373-81.
2. Goliath, J.R., M.C. Stewart, and S.D. Stout. Variation in Osteon Histomorphometrics and Their Impact on Age-at-Death Estimation in Older Individuals. *Forensic Science International* 262 (2016): 282.e1-82.e6.
3. Keough, N., E.N. L'Abbé, and M. Steyn. The Evaluation of Age-Related Histomorphometric Variables in a Cadaver Sample of Lower Socioeconomic Status: Implications for Estimating Age at Death. *Forensic Science International* 191, no. 1–3 (10/30/ 2009): 114.e1-14.e6.

Histomorphometry, Age-at-Death Estimation, Forensic Anthropology

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