H72 A Bayesian Approach to Multifactorial A g e - a t - D e a t h Estimation: A Validation Study

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After attending this presentation, attendees will be able to assess the efficacy of a Bayesian multifactorial age-at-death estimation method. The goal of this presentation is to inform attendees about the performance of a Bayesian multifactorial approach to age-at-death estimation.

This presentation will impact the forensic science community by presenting a validation study of a statistically sound yet simple way to combine multiple estimates of age-at-death.

Accurate age-at-death estimation is often crucial to successful identification of unknown skeletal remains in a forensic setting. Garvin and Passalacqua showed that forensic anthropologists have a preference for age-at-death methods based on the pubic symphyses, sternal ends of the fourth ribs, and auricular surfaces, but that there is little consensus when combining estimates from multiple methods.[1] Practitioners often use their experience to combine methods and many previous techniques for multifactorial age estimation use linear combinations or simple averages of the separate age estimates and have little utility or statistical validity.

This research contributes to the validation of a Bayesian multifactorial approach first presented at the 2011 American Academy of Forensic Sciences Annual Scientific Meeting. Uhl *et al*. designed "look-up tables" for easy use by forensic anthropologists for combining age-at-death estimates from different skeletal elements, including the pubic symphysis, auricular surface, and sternal rib ends.[2] This validation study tests the efficacy of this approach in identified cases analyzed by anthropologists at the New York City Office of Chief Medical Examiner Office. Review of case files provided data (Suchey-Brooks phases, İşcan sternal rib end phases, and Lovejoy auricular surface phases) to generate age estimates from the look-up tables. Those age estimates were compared with the actual age of the decedents for accuracy and precision.

Case files for 78 positively identified cases from the New York City Office of Chief Medical Examiner provided phase scores for pubic symphyses, sternal ends of the fourth ribs, and the auricular surfaces, as available. These scores were recorded upon initial anthropological assessment and only later were the individuals positively identified. Look-up tables first presented by Uhl *et al*. and published in Uhl provide mean log ages for each phase.[2,3] To combine the estimates, the precisions (the inverse of the mean age variance) for each indicator were summed. The inverse of the summed precisions is the within-indicator variance. The between-indicator variance is the variance of the mean log ages for the indicators, and the total variance is the sum of the within- and between-indicator variance. The standard deviation is the square root of the total variance; to obtain a 95% Confidence Interval (CI) for normally distributed data, multiply the standard deviation by 1.96 (a standard scaling variable for how wide a curve will be when normally distributed) and add and subtract that from the overall mean log age. Narrower confidence intervals were also constructed (90%, 75%, and 50%). The final step is to exponentiate (convert from log numbers to regular numbers) the endpoints of the interval and the mean log age to convert it from log years to actual years.

Overall accuracy of the point estimates is 6.45 years, while the overall precision is -4.62 years. Coverage (the percent of individuals falling within the confidence intervals) is very good. The 95% CI contained 77 of 78 individuals (99%), the 90% CI contained 75 of 78 individuals (96%), the 75% CI contained 71 of 78 individuals (91%), and the 50% CI contained 57 of 78 individuals (73%).

This Bayesian method of combining age estimates is advantageous for forensic anthropologists for many reasons. First, it is easy to use because the scoring methods are familiar. The look-up tables simplify the process of combining estimates from different age indicators, even if they are disparate. Second, it is a statistically sound means for combining separate age estimates—a method that could be demonstrated in case reports and testimony. Finally, the results of this validation indicate this method provides relatively accurate and precise age estimates. All analyses were done in R, a free statistical software program, so anthropologists can construct more population specific look-up tables for their own purposes.

References:

1. Garvin H, Passalacqua N. Current practices by forensic anthropologists in adult skeletal age estimation. J Forensic Sci 2011;57(2):427-33.
2. Uhl NM, Passalacqua NV, Konigsberg LW. A Bayesian approach to multifactorial age-at-death estimation. *Proceedings of the American Academy of Forensic Sciences*; 63rd Annual Scientific Meeting. Chicago, IL; 2011;17:339.
3. Uhl N. Age-at-death estimation from the human skeleton. In: Moore M, DiGangi E, editors. Research methods in human skeletal biology. New York: Elsevier, in press.

Age-at-Death, Bayesian, Multifactorial

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