



Physical Anthropology Section – 2005

H64 Evaluation of Regression Equations to Estimate Age at Death Using Cranial Suture Closure

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The goal of this presentation is to present to the forensic anthropological community the utility of regression formulae to estimate age at death using cranial suture closure.

This presentation will impact the forensic community and/or humanity by demonstrating that cranial suture closure can be a useful tool to estimate age.

Age at death is one of the primary components of the biological profile constructed by forensic anthropologist during a skeletal analysis. There are several indicators used to estimate age at death for adults, however, some are employed more frequently than others. The study of cranial suture closure and its relationship with age dates back to the 16th century. However, since that time and continuing into the present, there have been doubts about the applicability of suture closure to age estimation. Even with this skepticism, researchers continue to examine suture closure as an indicator of age at death. Most recently Nawrocki (1998) introduced 14 regression equations to estimate age using cranial suture closure. Testing of the performance of these equations as well as their applicability as an age estimator has been limited. This study examines 6 of the regression equations (Equations 1, 2, 3, 4, 7, and 8) created by Nawrocki using recently deceased individuals. The test sample contains 356 individuals (111 females, 255 males) of European ancestry. The majority of the test sample is derived from documented skeletal collections curated by the University of Tennessee and the Maxwell Museum at the University of New Mexico. A small percentage of individuals were forensic cases processed by the University of Indianapolis Archeology and Forensics Laboratory.

In total, 31 landmarks were scored on each specimen: 18 ectocranial (external) surface, 7 endocranial (internal) surface, 2 facial, and 4 from the palate. Following Meindl and Lovejoy (1985), one-centimeter segments along the cranial sutures were scored from 0 to 3, where 0 is no closure, 1 is 1-50% closure, 2 is 51-99% closure, and 3 is complete obliteration. The endocranial and palatal sutures were scored following Nawrocki's (1998) guidelines. Age was estimated for each individual using up to 4 different equations: 2 general equations (EQ 1 and 2) and 2 group-specific equations (i.e. all females, European females). Inaccuracy and bias were calculated for each equation to assess its performance. The percentage of individuals whose estimated age falls within each equations \pm 2SE prediction interval was also calculated. An analysis of covariance (ANCOVA) was used to determine if suture closure is influenced by an individual's sex.

Inaccuracy is the average absolute error of the estimate. For Equation 1, inaccuracy was 12.81yrs (M + F). Inaccuracy for Equation 2 was 13.44yrs (M + F). The 2 male-specific equations (EQ 4 and EQ 8) had inaccuracies of 12.58 and 15.64 years respectively. The inaccuracy for the 2 female-specific equations (EQ 3 and EQ 7) was 22.18 and 18.84 years respectively. Bias is a measure of the overall underor over-estimation. Bias for EQ 1 was -5.61 yrs (M + F). Bias for EQ 2 was -7.61 yrs (M + F). Bias for the 2 male-specific equations (EQ 4 and EQ 8) was 2.21 – and 8.25 – years respectively. For the 2 female-specific equations (EQ 3 and EQ 7), bias was -19.13 and -4.21 years respectively. The percentage of individuals falling within \pm 2SE for the general equations ranged from 73.6 to 93.5. For the male-specific equations (EQ 4 and EQ 8), 84.4% and 74.7% respectively fell within \pm 2SE. The percentage for the female-specific equations (EQ 3 and EQ 7) was 52.6% and 59.5% respectively. The ANCOVA results suggest that summed suture score is influenced by sex. This study found that the general equations performed well and in general had better results than the group-specific equations. The male-specific equations performed better than the female-specific equations. The poorer performance for the females may be due to a larger number of older individuals in that subgroup compared to the males. Cranial suture closure does correlate with age, however, sex influences that relationship and needs to be accounted for when using sutures to estimate age. In conclusion, cranial suture closure can be a useful tool to estimate age and the longstanding skepticism should be reconsidered.

Cranial Suture Closure, Age at Death Estimation, Forensic Anthropology