



## A27 Why Cranial Sutures Should be Included in Adult Age-At-Death Estimates

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**Learning Overview:** After attending this presentation, attendees will better understand how cranial suture fusion counterbalances the age-at-death estimate when combined with more reliable and commonly used adult age-at-death indicators.

**Impact on the Forensic Science Community:** This presentation will impact the forensic sciences community's ability to estimate age at death more accurately and precisely by minimizing overall mean error with the application of non-destructive and familiar macroscopic methods.

Cranial sutures are perhaps the least popular macroscopic age indicator for the human skeleton. With very few advocates, most scholars and practitioners only use cranial suture fusion when there are limited options to estimate age at death, and it is normally advised to use suture fusion with at minimum a second, more reliable indicator. Regardless of their vilification, cranial sutures do provide age-related information. They also persevere in research and practice because they are necessary in the event that other age indicators are absent or too damaged to provide reliable age estimates.

Research on the cranial sutures to date has focused on testing established methods or on evaluating which suture sites provide the most reliable information. However, most prior publications fail to place cranial sutures within the broader framework of age estimation or investigate how they perform when used with other well-known and relatively accurate and precise methods. The primary objective of the current research, therefore, is to determine how the inclusion of cranial sutures with other age-estimation methods can influence the final composite age-at-death estimate. Since there are multiple statistical strategies for combining multiple age-estimation methods, this research also tests whether the mode of statistical combination alters the outcome of the primary objective.

Data were collected from the Bass Donated Collection in Tennessee ( $n=120$ ) and the University of Pretoria Bone Collection in South Africa ( $n=132$ ), for a total sample size of  $n=252$  females and males of White and Black ancestries. Nawrocki's cranial suture fusion method, which scores ectocranial, endocranial, lateral, and palatal sutures was used to score all crania. The Suchey-Brooks Pubic Symphysis (PS), Osborne et al. Auricular Surface (AS), and İşcan et al. sternal rib end (Ribs) methods were selected because they are non-destructive and regularly used to estimate age. Each skeleton was scored blind using all four methods. Target age estimates and 95% prediction intervals were obtained for all individuals using published tables and equations; a summary age was calculated by averaging the target age estimates to allow comparisons. Mean measures of error (including bias and inaccuracy) were used to evaluate whether there was improvement in the age-at-death estimation when cranial sutures were incorporated. The final step evaluated alternate statistical strategies for consolidating individual target ages into a single summary age.

Mean absolute error (inaccuracy) was lowest when the cranial sutures were combined with the pubic symphysis, auricular surface, and sternal rib ends. When all four methods were averaged together, the mean absolute error was 12.1 years and the bias dropped to a low of -5.4 years. When the cranial sutures were excluded, mean absolute error increased to 14.4 years, with a bias of -11.2 years. The inclusion of cranial sutures in the consolidated age estimate was statistically significant for both inaccuracy and bias. These results were consistent when the data were grouped by binary sex and when the data were combined using alternate statistical strategies.

The positive influence cranial suture fusion had on the PS, AS, and Ribs can be explained by the fact that the sutures were the only independent indicator to return a positive bias in the total sample. In addition, the sutures returned the lowest inaccuracy and bias in the older decades of all the methods used in this study. These results indicate the cranial sutures act as a counterweight to help balance the expected tendency of the PS, AS, and Ribs to regress to the mean. To illustrate the implications of this finding, a bias level set to within  $\pm 10$  years allowed age to be predicted from approximately 42–70 years when sutures were included, as opposed to approximately 25–59 years when sutures were excluded.

As a result of this study, it is recommended that cranial suture fusion be included with the PS, AS, and Ribs when estimating the age of individuals that may be older than 40 years.

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### Cranial Sutures, Age-At-Death, Multifactorial