A5 Plaque and Projections: Assessing the Utility of Morphological Variants of the Sternal Fourth Rib for the Estimation of Sex and Age-at-Death

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After attending this presentation, attendees will better understand the statistical associations between biological sex, age-at-death, and the presence of bony plaque and/or central projections within the sternal pit of the fourth rib.

This presentation will impact the forensic science community by providing data suggesting that osseous anomalies of the sternal end of the fourth rib may profitably be employed in the estimation of sex and age-at-death from isolated ribs deriving from unidentified decedents, thereby allowing construction of a biological profile where more commonly used skeletal elements (e.g., cranium and os pubis) are unavailable.

This research was conducted using the Hartnett-Fulginiti collection housed at the Forensic Science Center in Maricopa County, AZ. This collection is comprised of more than 600 specimens of pubic symphyses and associated sternal ends of the fourth ribs from decedents of known sex, age-at-death, and ancestry. A total of 557 individuals (375 males and 182 females) ranging in age from 18 to 99 years were evaluated for the presence of bony plaque and central projections in the sternal pit of the fourth rib. Rib ends were independently assessed by two experts and consensus opinions on the presence or absence of plaque and projections were recorded. In addition, the presence of bony plaque was subdivided into three distinct morphological categories (Grades 1, 2, and 3) and, where sample sizes permitted, each category was independently assessed for associations with sex and age-at-death.

Results suggest that neither the presence of central projections nor that of plaque are independent of biological sex (projections: $\chi2$=37.5257, df=1, p-value=9.022e-10; plaque: $\chi2$=80.9211, df=1, p-value<2.2e-16). Based on the sample proportions, the probability that an individual exhibiting central projections is female is 0.775 with an associated 95% Confidence Interval (CI) of 0.623 to 0.879. Likewise, the probability that an individual exhibiting bony plaque is female is 0.717 with an associated 95% CI of 0.621 to 0.797. A more complex association is apparent when the occurrence of plaque is subdivided morphologically. All individuals in this sample exhibiting Grade 1 plaque are female (n=7), but sample size is too small to permit statistical validation. There is a 60.4% chance that an individual exhibiting Grade 2 plaque is female, but the associated 95% CI (0.463 to 0.730) suggests that this form of plaque is equally likely to be found in both males and females. However, there does appear to be age discrepancies between males and females exhibiting this plaque morphology such that Grade 2 individuals who are older are more likely to be female (95% CI: 0.562 to 0.962). The probability that an individual exhibiting Grade 3 plaque is female is 0.791 with a 95% CI of 0.646 to 0.888.

Similarly, the age distributions of individuals exhibiting central projections or bony plaque are statistically different. The mean age of individuals with projections (74.68, n=40) is higher than that of unaffected individuals (52.14, n=463) (Mann-Whitney: U=3428.5, p-value=3.78e-11). While the mean age of individuals exhibiting any form of bony plaque (54.41, n=404) is not statistically different from that of unaffected individuals (51.81, n=98) (Mann-Whitney: U= 21998.5, p-value=0.08735), investigation of the association of specific plaque morphologies with age-at-death suggests more useful patterning. Results of a Kruskal-Wallis test indicate that the age distributions for each morphological grade of plaque and for unaffected individuals are not the same (H=34.944, v=3, P=2.2e-16). Post-hoc tests using Dunn's non-parametric comparisons indicate that the mean age of individuals with Grade 2 plaque (35.02, n=47) is significantly lower than that of unaffected individuals (54.41, n=404) and that the mean ages of individuals exhibiting Grade 1 (36.86, n=7) and Grade 2 morphologies is significantly lower than that of Grade 3 individuals (72.84, n=43).

These results suggest that, although far from ubiquitous, the presence of central projections and the formation of bony plaque within the pit of the sternal ends of fourth ribs may be useful in estimating both age and sex in unidentified remains for which more commonly used skeletal elements are missing or damaged. Further research is both required and encouraged to see if the associations identified here are present in other known-age skeletal collections and to assess the accuracy of using these morphological features of sternal rib ends for the estimation of sex and age-at-death.

Sternal Fourth Rib, Age-at-Death, Sex Estimation

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