A166 Resolving Commingling Via Osteometric and Isotopic Data

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Learning Overview: The goal of this presentation is to inform attendees of the utility of combined osteometric and isotopic data to resolve commingling.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a framework for incorporating independent lines of evidence into a single cohesive model for predicting correct element matches from commingled assemblages of human remains.

Resolving commingling is an integral part of skeletal analysis, allowing for more complete sets of remains for further analysis. While multiple methods exist for the analysis of commingled assemblages, these methods are employed in isolation, with no obvious or intuitive way to incorporate the results of various methods into a single decision-making criterion. A Bayesian methodology can provide a means for incorporating multiple lines of evidence in one cohesive model. Previous research has shown the utility of such an approach to osteometric reassociation.[1] This study extends a Bayesian approach through the incorporation of limb bone measurements and simulated intra-and inter-individual isotopic data in predicting correct matches from small-scale (n=10) commingled assemblages.

To associate elements, simulated bone collagen carbon and nitrogen isotope values (δ^{13}C and δ^{15}N, respectively) were combined with linear limb measurements. Isotope values were simulated as random draws from a normal distribution based on the inter-individual and population-level distributional properties of collagen δ^{13}C and δ^{15}N values from a Northeast Asian population.[2,3] Osteometric data came from 883 individuals curated at the Bass Donated Skeletal Collection at the University of Tennessee, Knoxville. These data were applied to the reassociation model described by McCormick, using a commingled assemblage size of 10 individuals and 1,000 simulated commingled assemblages.[1] It was expected that the incorporation of isotopic data would have a significant impact on resolving commingling in non-paired element comparisons (articulating and "other" [non-articulating and non-paired element] comparison types), as these comparisons typically show the lowest correct classification rates from osteometric data alone.[1]

The inclusion of isotopic data increased correct classification across all comparisons (17 comparisons or 17,000 simulated commingled assemblages), for an overall correct classification rate of 92.0%. "Other" element comparisons showed the highest increase in correct classification over limb bone measurements alone, with a correct classification rate of 88.8% using both osteometric and isotopic data as compared to 31.0% for osteometric data alone. Articulating comparisons also showed a dramatic increase in correct classification with the inclusion of isotopic data, with a correct classification rate of 89.9% using both types of data and 43.4% correct classification using only limb bone measurements. Paired elements had the lowest increase in correct classification with the inclusion of isotopic data (97.6% overall; 85.2% osteometric data alone); this is likely due to the already-high correct classification rate of paired elements via limb bone measurements. Overall, isotopic data alone provided a correct classification rate of 84.8%.

Independent lines of evidence (i.e., osteometric and isotopic data) are of obvious importance in forensic science. Such evidence provides convergence and increases confidence in results. This study provides an important early step in objectively combining multiple lines of evidence into a single model, which reduces uncertainty and subjectivity otherwise present when an analyst uses multiple techniques in conjunction to arrive at a decision. These results illustrate the strength of this approach to resolving commingling. When utilizing two independent lines of highly informative evidence, such as with paired element comparisons, this model is both powerful and accurate. Perhaps the most impactful result of this study is the ability to resolve commingling beyond paired elements, an underrepresented aspect of research on the resolution of commingled human remains. These results also confirm the conclusions of Berg et al. as to the value of isotopic data in resolving commingling and highlight the strength of isotope testing in the analysis of human skeletal remains.[2]

Reference(s):

1. McCormick K. 2019 A novel method for osteometric reassociation using Hamiltonian Markov Chain Monte Carlo (MCMC) simulation. *Forensic Anthropology*. 2(2):1–15.
2. Berg G.E., Bartelink E.J., Yuryang J., Shin Y., and L.A. Chesson. 2019. A large-scale evaluation of intraperson isotopic variation within human bone collagen and bioapatite. *Proceedings of the American Academy of Forensic Sciences*, 71st Annual Scientific Meeting, Baltimore, MD. 2019. 122
3. Isolocate© 2017 Berg and Kenyhercz 2017. Underlying data used with the permission of the authors. https://anthropologyapps.shinyapps.io/IsoLocate/.

Commingling, Isotopes, Bayesian Modeling

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