

OSAC RESEARCH NEEDS ASSESSMENT FORM



Title of research need:

Validation of Skeletal Trauma Analysis Methods

Describe the need:

Forensic skeletal trauma analysis has become one of the primary consult requests for forensic anthropology practitioners (Fleischman et al. 2023). It typically involves interpretation of trauma mechanisms and other information (e.g., direction, sequence, number and timing of trauma events) from observation of skeletal defects. These interpretations are currently derived from comparisons of defect characteristics with those documented from retrospective case studies or produced through experimental research designs. While controlled experimental studies (particularly those from Michigan State and Ohio State) have provided a foundation for skeletal trauma research (Boyd, 2025), it has been observed (Dempsey and Blau, 2020; Harden et al., 2023; Love, 2019) that there is currently no reliable method(s) that provides for accuracy of these interpretations. This is primarily due to the dearth of validated methodology in forensic skeletal trauma analysis. Method validation has been defined by NIST (<https://www.nist.gov/video/analytical-method-validation>) as the “suitability of an analytical method for an intended purpose.” Validated methods for skeletal trauma analysis, including those that support accurate interpretations of aspects of blunt, sharp, projectile, and thermal trauma represent a critical need for practitioners. This includes documentation of accuracy, precision, repeatability, reliability, and bias associated with trauma methods utilizing large samples with known trauma mechanisms.

Keyword(s):

Skeletal Trauma Analysis, Forensic Anthropology, Method Validation

Submitting subcommittee(s):

Anthropology

Date Approved:

9/19/2025

Background Information:

1. Does this research need address a gap(s) in a current or planned standard? (ex.: Field identification system for on scene opioid detection and confirmation)

Yes.

ASB Standard 147 (Standard for Analyzing Skeletal Trauma in Forensic Anthropology) establishes minimum requirements for skeletal trauma analysis for forensic anthropology practitioners. It stresses that trauma analysis “shall be...analyzed using available peer-reviewed, published methods, standards, or best practices” and cautions that trauma analysis shall be limited to descriptions (rather than interpretations) when evidence is lacking (thus, reducing its utility in court testimony). Although there are many published peer-reviewed publications on forensic trauma analysis, few incorporate validated methods for interpreting skeletal trauma. The dearth of validated interpretive methods for trauma analysis also largely precludes development of a more detailed best practices document.

Although there has been limited validation of methods for sharp force trauma analysis, including methods for analyzing cut marks (Crowder et al. 2011, 2013; Love et al. 2012; Puentes and Cardoso 2013; Symes et al. 2010), saw marks (Greathouse et al. 2021; Love et al. 2015; Symes et al. 2010) and hacking/chopping marks (McGehee and

Schultz 2024; McGehee et al. 2024), Love et al. (2019) note that this validation has been specific to the individual study conditions that generated it and cannot be extrapolated to a broader validation of sharp force trauma methodology. Method validation for blunt, projectile, and thermal trauma has been rare to non-existent. This is likely because skeletal defects from these mechanisms do not readily lend themselves to quantitative documentation. This restricts trauma casework reports to descriptive observations of skeletal defects. Development of validated methodology for transforming qualitative and quantitative observations of fracture patterns into interpretive statements about skeletal trauma, particularly that derived from blunt and projectile impacts and thermal alteration, is greatly needed.

2. Are you aware of any ongoing research that may address this research need that has not yet been published (e.g., research presented in conference proceedings, studies that you or a colleague have participated in but have yet to be published)?

Boyd, D.C. 2025 The scientific foundation for skeletal trauma analysis. In: Boyd, D. C., Sochor, M.. (eds): Forensic Skeletal Trauma: Scientific Foundation and Guide to Professional Practice. Sussex, UK: Wiley Publishers, in association with the American Academy of Forensic Sciences Forensic Science in Focus series.

3. Key bibliographic references relating to this research need: (ex.: Toll, L., Standifer, K. M., Massotte, D., eds. (2019). Current Topics in Opioid Research. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-88963-180-3)

American Academy of Forensic Sciences Academy Standards Board Std 147 Standard for Analyzing Skeletal Trauma in Forensic Anthropology

Butler, J., Iyer, H., Press, R., Taylor, M., Vallone, P., Willis, S. (2020), NIST Scientific Foundation Reviews, NIST Interagency/Internal Report (NISTIR), National Institute of Standards and Technology, Gaithersburg, MD, [online], <https://doi.org/10.6028/NIST.IR.8225> (Accessed November 26, 2024).

Crowder, C. C., Rainwater, C. W., Fridie, J. S. 2011. Microscopic analysis of sharp force trauma in bone and cartilage: A validation study. Technical Report. Washington, D. C.: National Institute of Justice.

Crowder, C. C., Rainwater, C. W., Fridie, J. S. 2013. Microscopic analysis of sharp force trauma in bone and cartilage: a validation study. Journal of Forensic Sciences, 58, 1119-1126.

Dempsey, N., Blau, S. 2020. Evaluating the evidentiary value of the analysis of skeletal trauma in forensic research: a review of research and practice. Forensic Science International, 307, 110140.

Fleischman, J. M., Vollner, J., Adams, B., Crowder, C. M., Pinto, D., Soto Martinez, M., Rainwater, C., Vogelsberg, C., Wiersema, J. 2023. The evolving role of forensic anthropologists in medical examiner's offices. Forensic Anthropology DOI: 10.5744/fa.2023.0013.

Greathouse, H., Chapman, E., Maxwell, A., Klales, A.R. 2021. Identifying handsaw tooth shape based on the micro- and macroscopic analysis of the kerf floor contour. Forensic Anthropology, 4, 20-29.

Harden, A. L., Stull, K.E., Bolte, J.H., Kang, Y-S., Agnew, A.M. 2023. Blunt force skeletal trauma research methods: a multidisciplinary perspective. Forensic Anthropology, 6, 79-91.

Lesciotto K.M. 2015. The impact of Daubert on the admissibility of forensic anthropology expert testimony. *Journal of Forensic Sciences* 60(5), 549-555. <https://doi.org/10.1111/1556-4029.12740>).

Love, J. C., Derrick, S. M., Wiersema, J. M., Peters, C. 2012. Validation of tool mark analysis of cut costal cartilage. *Journal of Forensic Sciences*, 57, 306-311.

Love, J. C. 2019. Sharp force trauma analysis in bone and cartilage: a literature review. *Forensic Science International*, 299, 119-127.

McGehee, K.C., Schultz, J.J., Friedline, S.E. 2024. Analyzing cut mark characteristics on bone from chopping/hacking tools. *Forensic Anthropology*, 6, 138-156.

McGehee, K.C., Schultz, J.J. 2024. Microscopic analysis of cut mark characteristics from chopping/hacking tools. *For Sci International* 363, 112197.

National Commission on Forensic Science (2016) Recommendation to the Attorney General: Technical Merit Evaluation of Forensic Science Method and Practices. Available at <https://www.justice.gov/archives/ncfs/page/file/905541/download>.

NIST 2018 Procedure for method validation. <https://www.nist.gov/system/files/documents/2018/01/12/procedure-for-method-validation-20180101.pdf>
Accessed November 27, 2024

Puentes K., Cardoso, H. V. F. 2013. Reliability of cut mark analysis in human costal cartilage: the effects of blade penetration angle and intra- and inter-individual differences. *Forensic Science International*, 231, 244-248.

Symes, S. A., Chapman, E. N., Rainwater, C. W., Cabo, L. L., Myster, S. T. 2010. Knife and saw toolmark analysis in bone: a manual designed for the examination of criminal mutilation and dismemberment. In: JUSTICE, N. I. O. (ed.). Washington, D. C.: National Institute of Justice.

4. Review the annual operational/research needs published by the National Institute of Justice (NIJ) at <https://nij.ojp.gov/topics/articles/forensic-science-research-and-development-technology-working-group-operational#latest>? Is your research need identified by NIJ?

Partially. Forensic pathology lists a research need for “further research needs on force measurement, fracture mechanics, modeling of injuries (to include hard tissue and soft tissue), and/or utilization of advanced imaging technologies to improve accuracy of trauma analysis and quantify error rates associated with trauma interpretation.” This research need addresses the broader issue of validating interpretive methods for trauma analysis in forensic anthropology.

5. In what ways would the research results improve current laboratory capabilities?

A large portion of casework for many forensic anthropology practitioners is focused on trauma consults (Fleischman et al. 2023), yet validated methods for skeletal trauma analysis methodology is lacking. Developing validated methods will greatly improve the accuracy, precision, repeatability, and reproducibility of skeletal trauma analyses conducted in professional laboratories and will allow identification of bias and error in current methods and procedures.

6. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

Following recommendations from the National Commission on Forensic Science (2016) for evaluating scientific research, NIST's Scientific Foundation Reviews (Butler et al. 2020) delineate criteria for the scientific validity of forensic disciplines. This includes methodology that is clear and based on reproducible (e.g., controlled experimental) procedures that are appropriate to the question or problem and that have been or have the capacity to be fully and rigorously validated. Validated methods are those that are based on accurate, precise, repeatable (consistent results over time and by different operators), and reproducible (e.g., consistent results from other laboratories) procedures, including methods that measure and document measurement uncertainty and bias. Validation studies will investigate and document the scientific validity of skeletal trauma analysis methods and lead to the development of more accurate, precise, reproducible, and repeatable ones while minimizing bias and error.

7. In what ways would the research results improve services to the criminal justice system?

Forensic anthropologists testify about trauma analysis more frequently than any other analysis or activity. Knowledge of accuracy, precision, reliability, and bias associated with the skeletal trauma methods of analysis used to make interpretive statements in trauma cases will strengthen the scientific accuracy of results for these cases and address standards for admissibility of evidence established in Daubert (Lesciotto 2015).

8. Status assessment (I, II, III, or IV):

I		Major gap in current knowledge	Minor gap in current knowledge
	No or limited current research is being conducted	I	III
	Existing current research is being conducted	II	IV

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.