



A40 A Reevaluation of the (hu)MANid Classification Software Using Virtually Collected Mandibulometer Measurements

Heather M. Garvin, PhD*, Des Moines University, Des Moines, IA 50312-4198; Kelsey A. Carpenter, MS, Mercyhurst University, Erie, PA 16546; Gregory E. Berg, PhD, DPAA Identification Laboratory, Joint Base Pearl Harbor-Hickam, HI 96853-5530; Michael W. Kenyhercz, PhD, Department of Defense POW/MIA Accounting Agency, Joint Base Pearl Harbor-Hickam, HI 96816

Learning Overview: After attending this presentation, attendees will understand how inaccurate mandibulometer measurements can impact sex and ancestry classifications and how the (hu)MANid classification software performs using validated virtually collected mandibulometer data.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting an accurate method of collecting mandibulometer measurements from 3D models and a test of the (hu)MANid software on a virtual sample.

At a previous American Academy of Forensic Sciences (AAFS) meeting, Carpenter and Garvin presented a test of the (hu)MANid classification software that had been developed by Berg and Kenyhercz for sex and ancestry classification from mandibular metric and morphoscopic variables.^{1,2} Carpenter and Garvin reported a strong bias toward the classification of White individuals into Black reference groups.¹ Following the AAFS meeting, discussions with the program developers and comparisons of group mean measurements with the (hu)MANid reference groups indicated that the tested mandibular length and maximum ramus height measurements were erroneous. The first goal of this study was thus to develop and test a method to accurately collect mandibulometer measurements (mandibular length, maximum ramus height, and mandibular/gonial angle) from 3D mandibular models. The second goal was to re-run the analyses on the same samples presented by Carpenter and Garvin to assess the impact of the erroneous mandibulometer measurements on group classification, as well as to test the (hu)MANid software program using accurate measurements.¹

Geomagic Wrap® and Microsoft® 3D Builder were used to orient 3D mandibular models in lateral view as though they were resting on a flat surface. Screenshots of the lateral view (orthogonal projection) were extracted and opened in ImageJ for data collection. Horizontal and vertical guidelines were placed so a mandibular angle consistent with that measured with a mandibulometer could be measured and drawn, with subsequent mandibular lengths and ramus heights collected using the guidelines and lengths from the drawn angle. A sample of 89 mandibles, in which both 3D scans and mandibulometer measurements were available, was used to test the accuracy of the virtual data collection method. Relative Technical Error of Measurements (rTEM) were within acceptable levels, with 1.69% for angle measurements, 1.65% for length measurements, and 3.41% for ramus height measurements. The higher ramus height errors may be related to difficulties in observing the superior extent of the condyles in the 3D scans given that the mandibles had been originally scanned in articulation with the associated cranium. Intra-observer analyses performed on 20 mandibular scans returned rTEM values of 0.61% for angle, 0.75% for length, and 1.20% for ramus measurements.

When the revised mandibular length and ramus height measurements and the additional mandibular angle measurements were utilized to re-run the Carpenter and Garvin analyses on the same sample of 230 United States White and Black mandibles, classifications improved.¹ Using Linear Discriminant Analysis (LDA), correct sex classifications up to 83.12% were obtained for the pooled sample, and the previously reported sex biases were not observed. Correct group classifications (sex+ancestry) were similar to those reported by Berg and Kenyhercz.² Group classifications as high as 78.7% were obtained when the sample was run against only White and Black reference groups, although some ancestry bias was observed with higher classifications for White males and females (WM=78.68%, WF=70.68%, BM=56.14%, BF=29.62%). Mixture Discriminant Analysis (MDA) was also used and typically outperformed the LDA in total correct classification, but the upward bias in classification of Whites remained. The lower classifications of the Black females may represent smaller reference group sample sizes and may improve as additional samples are added to (hu)MANid. In addition to providing a test of the (hu)MANid program, this study highlights the diligence required when overcoming research challenges, as well as the need to transform traditional methods as data and methods advance with increased accessibility to 3D data.

Reference(s):

1. Carpenter K.A., Garvin H.M. A Test of the (hu)MANid Classification Software on a Sample of United States White and Black Mandibles. *Proceedings of the American Academy of Forensic Sciences, 70th Annual Scientific Meeting, Seattle, WA. 2018. A56.*
2. Berg G.E., Kenyhercz M.W. Introducing Human Mandible Identification [(hu)MANid]: A Free, Web-Based GUI to Classify Human Mandibles. *J Forensic Sci.* 2017; 62:1592-1598.

Mandible, Sex Estimation, Ancestry Estimation