H26 Sexual Dimorphism of Joint Surface Area through 3-D Digital Data Modeling

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After attending this presentation, attendees will gain insight into the sexual dimorphism of the surface area of four skeletal articular elements, learn of the feasibility of using this method to determine sex of an unknown skeleton, and gain a better understanding of the research potentials of 3-D modeling and digital data acquisition.

This presentation will impact the forensic community by elucidating the variation of an easily observed variable that is rarely used in osteological research and by fostering interdisciplinary research approaches in physical anthropology by incorporating 3-D technologies.

The surface area of skeletal features is easily observed but because its quantification is difficult to capture by traditional approaches, it is rarely included in osteological research. As a result, variation in the surface area of human skeletal features has never been thoroughly investigated. This study investigated the relationship of joint surface area with sex by applying three-dimensional modeling and digital data collection techniques normally used in engineering and computer science applications. In physical anthropology, research designs that have employed 3-D techniques (mostly in the analyses of primates and fossils) are limited. In addition, many studies that have included observations of surface area have quantified it through indirect expressions. Here, laser-assisted stereo modeling was utilized to reverse engineer skeletal features that allowed for accurate and reliable digital quantification of joint surface area.

A total of 810 virtual models of joints were stereologically created with an optical laser scanner from 211 adult skeletons drawn from the Robert J. Terry Anatomical Collection. Four surfaces from three joints (femoral head, humeral head, glenoid fossa of the scapula, and auricular surface of the ilium) from each skeleton were modeled with a Cyberware Inc., Model 15 scanner. A watershed-based segmentation software was used to isolate the articular surface of each joint, and a region editor program was used to measure the isolated joint surface.

All four surfaces were found to be sexually dimorphic. Univariate discriminant function analyses on each variable produced cross- validation accuracies between 69.4% using the auricular surface area and 87.2% using the humeral head area. Only the area of the humeral head and the glenoid fossa were selected for determining sex with a multivariate linear discriminant function analysis. Correct classification using this function was found to be 90.0%. Surface area was found to be a better indicator of size and sexual dimorphism than linear long bone dimensions.

This project has significant ramifications. First, its focus on surface area addressed research questions of an easily observable, yet largely ignored biological feature. The high accuracy percentage found in determining sex with a multivariate discriminant function with the area of the humeral head and glenoid fossa indicates that these are highly useful criteria. In contrast, the exclusion of the area of the femoral head from the function suggests that perhaps further research into its human variation is warranted given its highly-used linear variables in determining sex. Second, this project made effective use, on a large scale, of a relatively new method of 3-D digital data acquisition that has only begun to demonstrate its vast applications. While time consuming, the virtual methods used here may serve as a springboard for other studies to incorporate 3-D quantification of surface area into their research designs. This technology presents physical anthropologists with much-needed innovation to conduct research. Finally, 3-D digital modeling can produce such an accurate virtual model of a bone that a quasi-permanent replica can be made available to students and researchers instead of the actual specimen. The ramifications are substantial as 3-D digital modeling can create a virtual library for future generations that can help preserve priceless skeletal collections, such as the Terry Collection. While a virtual model may not always be a perfect replacement for the real thing, this research project demonstrates that, in some cases, a virtual model is arguably *better* than the real thing.

Surface Area, Sexual Dimorphism, 3-D Imaging

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