



## Physical Anthropology Section - 2012

### H12 Cranial Sexual Dimorphism and Anthropological Standards: Preliminary Investigations in a Western Australian Population

Daniel Franklin, PhD\*, University of West Australia, Centre for Forensic Science, MBDP M420, 35 Stirling Highway, Crawley, Western Australia 6009, AUSTRALIA; Ambika Flavel, MSc, Algis Kuliukas, MSc, and Charles E. Oxnard, PhD, The University of Western Australia, Centre for Forensic Science, Crawley, 6009, AUSTRALIA; and Murray K. Marks, PhD, University of Tennessee, Department of Pathology, 1924 Alcoa Highway, Box 108, Knoxville, TN 37920

After attending this presentation, attendees will gain awareness of: (1) the relationship between contemporary population specific standards and the expected accuracy of sex estimation in adults; and, (2) the value of 3D medical databases as potential sources of contemporary morphometric data for creating forensic anthropological standards.

This presentation will impact the forensic science community by quantifying population specific standards in forensic anthropology. Further, it will demonstrate how 3D medical databases provide abundant sources of contemporary research data that are complementary to traditional approaches based on direct examination of physical remains.

The formulation of a biological profile (osteobiography) is a crucial tool when unidentified skeletal remains are investigated. Accurate sex estimation ensures that the most appropriate and accurate statistics and standards for analyzing the remaining aspects of the biological profile are applied, e.g., sex-specific age, ancestry, and stature. Also, the most accurate biological profile is achieved using contemporary population-specific standards.

Australian forensic anthropology is constrained by a paucity of population specific standards as repositories of documented skeletons, traditionally the main source of population-specific data, do not exist. Today, if a morphometric approach is required for sex estimation, then a standard formulated from a non-Australian reference sample is the only option. The general effect of applying non-population standards creates an accuracy reduction in classification, the magnitude of which is proportionately related to the degree of dissimilarity (increasing biological distance) between the original reference sample and the individual to which those standards are being applied.

This research provides preliminary results of sexual dimorphism in Western Australian crania. The primary purpose is to formulate a series of morphometric standards for the estimation of sex and to demonstrate the effect on classification accuracy when non-population specific vs. population-specific standards are applied. The sample comprises cranial multi-slice computed tomography (MSCT) scans at a maximum thickness of one millimeter on 100 adult females (mean age of 36 years) and 100 adult males (mean age of 40.33 years). The 3D coordinates, using 3D volume rendering of 48 landmarks were acquired (by AF) using *OsiriX*<sup>®</sup> (v.3.9). A total of 55 linear measurements were calculated using *Morph Db* (an in-house developed database application). Measurements were analyzed using basic descriptive statistics and discriminant function analyzes using *SPSS 19.0*. The degree of correct sex classification in the Western Australian (WA) sample was also explored using the Giles and Elliot and Steyn and Iscan standards.<sup>1,2</sup>

Results reveal strong dimorphism in the WA population with bizygomatic breadth, mastoid height and maximum cranial length contributing significantly to sex discrimination. Maximum cross-validated classification accuracy using a step-wise analysis of five variables is 93% with a 4% sex bias. When classifying the WA sample using Giles and Elliot (Function #16 – American Caucasians) and Steyn and Iscan (Function #1 – South African Caucasians), sex was estimated correctly in 83% and 80% of cases respectively. However, the sex-bias is 31% and 36% respectively. Using the same variables required by the aforementioned foreign functions to formulate specific WA standards, results had an expected classification accuracy of 89% (sex bias 1%) for Giles and Elliot and 88% (sex bias 2%) for Steyn and Iscan. While the overall sex classification accuracy is still relatively high, using foreign standards for the WA sample results in an unacceptably large bias. These non-Western Australian standards will thus frequently misclassify females. These results highlight the importance and necessity for developing population-specific standards for Western Australians.

#### References:

1. Giles E, Elliot O. Sex determination by discriminant function analysis. *Am. J. Phys. Anthropol* 1963;21:53-68.
2. Steyn M, Iscan MY. Sexual dimorphism in the crania and mandibles of South African whites. *Forensic Sci. Int.* 1998;98:9-16.

#### Sex Estimation, Cranium, Western Australia