H99 Estimation of Cartilaginous and Soft Tissue Components for Estimating Adult Stature Using the Anatomical Method

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The goal of this presentation is to present an improved method, by using a digitizer, for estimating skeletal height using the standing anatomical position. Once accurate individual skeletal heights are obtained, regression formulas that account for the Cartilaginous and Soft Tissue (CCST) height components are used to estimate biological statures.

This presentation will impact the forensic science community by demonstrating how the CCST is related to age and individual variation. This presentation will discuss how to improve the accuracy of the anatomical method of stature estimation and how to create multiple stature-estimation formulas for skeletons where age-at-death is known but antemortem stature records are lacking.

Thirty-eight European American males from the William M. Bass Donated Skeletal Collection at the University of Tennessee Knoxville were used for this study. The individuals were born between 1929 and 1940, and died between 1987 and 2009. The range of age-at-death is 19 to 74 years with a mean of 46.7 years. Using the digitizer, measurements of the heights of the cranium, vertebral columns from C2 to L5 (TVH), the vertical space height between the anterior margin of the sacral promontory to the level that connects the superior margins of the left and the right acetabulae (AP-SMLRACE), articulated talus and calcaneus, and the physiological length of the tibia (Martin 2) were recorded. The physiological length of the femora was measured using an osteometric board because of the limited arm length of the digitizer. The interlandmark distances were calculated by Euclidian distances, in two or three dimensions, and trigonometry.

The use of five different locations on individual vertebrae (anterior, left, right, posterior, and the average of the left and the right sides), allows alternative means of calculating TVH in the event that individual vertebrae columns are incomplete. The spinal curve corrections were adapted from the Intermediate Index (DI) of Delmas as normal for all ages as well as under 42 years of age. Delmas' Dynamic Index (DDI) was used for individuals 43 years of age and older. These indices were used to evaluate additional curve reductions to determine if they should be applied to older ages. The CCST heights were obtained by subtracting the Total Skeletal Heights (TSHs) from the Adjusted Cadaver Stature (ACS)

The relationships among CCSTs, TSHs, and age were investigated using the Pearson correlation coefficients. The results showed the CCSTs had negative correlations (r=-0.206 to -0.409) to age whereas the TSHs had almost no correlation (r=0.012 to 0.1) to the CCSTs. Next, the test on residuals of Partial correlation was examined and confirmed that there are no influences after controlling on the TSHs. These results indicated that the individuals who have tall TSHs do not necessarily have thicker CCSTs. Therefore, the ten regression formulae for estimating CCST heights from all five locations, DI, and DDI were constructed from only age (e.g., Anterior CCST (mm) =-0.853*age + 179.58, 95% PI (Point Estimate ± $54.13\sqrt{1.026 + ((Age - 46.74)^2 / 7107.69)}$). ACS to Estimated Biological Statures (EBS = TSH + CCST) were tested by Paired *t*-tests on the ten models which ranged from -0.006mm to 0.0197mm with 95% lower CI between -8.269mm to -8.970mm and upper CI between 8.309mm to 8.947mm (p>0.996). Lastly, four independent samples of war casualties (European ancestry) from Joint POW/MIA Accounting Command-Central Identification Laboratory (JPAC-CIL) were examined for accuracy and bias from antemortem stature records. The results showed Accuracy: 10.76 to 13.09mm, Bias: -0.71 to 17.13mm.

More accurate individual total skeletal heights TSHs were obtained using the digitizer, specifically when the S1 height was replaced with AP-SMLRACE and the physiological length of the tibia (Martin 2) from Fully was used. This methodology will be useful for skeletons that lack records of biological stature to create stature estimation equations from single and multiple elements in order to increase group-specific and generic stature estimates.

Standing Anatomical Position, CCST Components, Digitizer

 ** Presenting Author*