



Physical Anthropology Section – 2010

H103 Error and Uncertainty in Pelvic Age Estimation Part I: Younger vs. Older Adult Males

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After attending the presentation, attendees will understand how the error rates of four commonly-used pelvic age estimation methods differ among different age groups and how to quantify uncertainty in forensic anthropological analysis.

This presentation will impact the forensic science community by responding to Recommendation #3 of the National Academy of Sciences publication, *Strengthening Forensic Science in the United States: A Path Forward*, which calls for research determining causes of bias and work toward quantification of method error in forensic investigations.

It is often stated that adult skeletal age estimation methods have lower error rates when applied to young adults than to older adults. Additionally, age estimation methods are widely understood to overage the young and underage the old. This paper supports these assertions by offering quantified measurements of error for four frequently-used pelvic age estimation methods, as applied to a large male sample of individuals between the ages of 19 and 94. The methods include auricular surface and pubic symphyseal techniques: Lovejoy *et al.* (1985); Suchey-Brooks (1990); Buckberry and Chamberlain (2002); and Osborne *et al.* (2004).

The sample for this study was compiled from two sources: male individuals sampled from modern known-age Iberian skeletal collections housed at the Universidad de Valladolid and the Universidad Autònoma de Barcelona; and male individuals identified at the JPAC-CIL between 1972 and 31 July 2008 whose case documentation included known age- at-death and estimated age based on specific pelvic age estimation methods. The entire sample was divided into ten-year age groups (e.g., 20-29) with a final age group of 60+. These divisions were distilled into two broad categories based on age ("young" individuals ≤ 39 years and "older" individuals ≥ 40 years). Error with respect to the methods' assigned means was analyzed in terms of bias (directionality of error) and inaccuracy (absolute mean error in years). Percent of correct age classifications (i.e., the method's predicted age range included the individual's actual age) was also calculated.

The Suchey-Brooks (1990) and Lovejoy *et al.* (1985b) methods show low mean positive biases for the group of individuals between the ages of 20 and 39. The Osborne *et al.* (2004) method shows a low mean negative bias for this age group. The Buckberry and Chamberlain (2002) method shows a substantial positive bias for individuals between 20 and 39. All four methods have substantial negative biases for individuals 40 years of age and older. In all four methods, the differences between mean bias in individuals under 40 and individuals 40 years and older are significant at the $p \leq 0.001$ significance level (Student's *t*-test).

For the Suchey-Brooks, Lovejoy *et al.*, and Osborne *et al.* methods, mean inaccuracy approximates four years in individuals between the ages of 20 and 39. For the Buckberry and Chamberlain method, mean inaccuracy is greater than 13 years. In all four methods, mean inaccuracy is never less than 11 years for individuals 40 years and older. In all four methods, all differences between inaccuracy in the younger and older age groups are statistically significant at the $p \leq 0.001$ significance level (Student's *t*-test).

For the Suchey-Brooks and Osborne *et al.* methods, percent of correctly classified individuals is approximately 95% for individuals ≤ 39 and 85% for individuals ≥ 40 . For the Buckberry and Chamberlain method, percent of correctly classified individuals is approximately 94% for individuals ≤ 39 and 95% for individuals ≥ 40 . For the Lovejoy *et al.* method, percent of correctly classified individuals is approximately 63% for individuals ≤ 39 and 31% for individuals ≥ 40 .

Full ranges of error (in years) for each method for individuals ≤ 39 are as follows: Suchey-Brooks (-8.3 to 28.2); Lovejoy *et al.* (-6.5 to 16); Buckberry and Chamberlain (-1.7 to 35.7); Osborne *et al.* (-10.9 to 18.8). For individuals ≥ 40 , full ranges of error (in years) are as follows: Suchey-Brooks (42.4 to 20.2); Lovejoy *et al.* (-44 to 22); Buckberry and Chamberlain (-22.6 to 29.3); Osborne *et al.* (-40.2 to 15.9).

This study indicates that pelvic aging techniques estimate age in young adults (≤ 39) with lower error than older adults (≥ 40). The error of the Suchey-Brooks method increases with age, suggesting modifications of upper phases are warranted. However, auricular surface methods are problematic regardless of age group. Narrow age intervals in the Lovejoy *et al.* method result in low percentages of correctly classified individuals. The Buckberry and Chamberlain method frequently results in extreme overaging of the young and has the highest error for every age class under fifty. Of the three auricular surface methods, the Osborne *et al.* method has the broadest applicability.

There will always be error associated with age estimation; the focus now should be on understanding and quantifying error so as not to overstate method performance.

Adult Male Age Estimation, Pelvis, Error