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Technical Note: Revised Fully Stature Estimation Technique

Michelle H. Raxter,[1]* Christopher B. Ruff,[2] and Benjamin M. Auerbach[2]

[1]*Department of Anthropology, University of South Florida, Tampa, FL 33620*
[2]*Center for Functional Anatomy and Evolution, School of Medicine, Johns Hopkins University, Baltimore, MD 21205*

In a previous paper (Raxter et al., 2006), we devised new formulae and clarified measurement procedures for estimating living stature from skeletal height using Fully's (1956) anatomical technique on Terry Collection samples. Like previous researchers (Lundy, 1983; Lundy and Feldesman, 1987; Sciulli et al., 1990; Sciulli and Giesen, 1993; Bidmos, 2005; Petersen, 2005), we found that it was necessary to adjust living statures for age, i.e., the known decline of stature with aging (Trotter and Gleser, 1951; Friedlaender et al., 1977; Galloway, 1988; Cline et al., 1989; Chandler and Bock, 1991; Giles, 1991). Thus, our preferred formula for converting skeletal height (the sum of skeletal element heights used in the Fully technique) to living stature incorporated an age term. However, because precise ages may be difficult to estimate in many archaeological and forensic cases, we also devised an equation without an age correction term. This formula inherently incorporated average age effects in our sample. However, because the mean age of our Terry Collection sample was 54 years, and since the great majority of archaeological individuals and samples will be younger on average than this, application of this formula to typical archaeological remains may result in systematic underestimation of living stature. Thus, in this situation it may be advisable to use even broad age approximations in the formula with an age term, rather than the formula without an age term.

To illustrate this potential problem, we constructed a sample composed of only individuals under 50 years of age from our original Terry sample (Raxter et al., 2006). This sample consisted of 48 adults (18 black females, 5 white females, 18 black males, 7 white males) of known age, ranging from 21–49 years, with a mean age of 38 years. This adult age distribution may not be too unrepresentative of "typical" archaeological samples (e.g., Ubelaker, 1974). Because we found no effect of sex or ancestry on stature estimation (Raxter et al., 2006), a pooled sample was used for all analyses here. Skeletal height was calculated as previously described (Raxter et al., 2006). Three estimates of living stature (FES, Fully estimated stature) were then calculated from skeletal height and compared with "true living stature" (LS), the cadaveric statures available from the Terry Collection, adjusted as recommended by Trotter and Gleser (1952). The first estimate used the known available ages from the Terry Collection's records and our formula including an age term. We refer to this as "age-adjusted FES." The second estimate also used our formula with an age term, but utilized the mid-value of decadal age ranges for each known age. That is, those individuals between the ages of 20–29.9 years were estimated as 25 years, 30–39.9 as 35 years, and 40–49.9 as 45 years. This simulates more typical archaeological or forensic situations where age estimation is only approximate. We refer to this as "mean age-adjusted FES." The third estimate used our formula without an age term.

Differences between estimated and true living statures were assessed using paired *t*-tests. We also compared prediction errors (i.e., differences from true living stature) using the three estimated stature techniques directly, again with paired *t*-tests. All statistics were carried out using Microsoft Excel XP and SYSTAT 11.

Paired *t*-test results in Table 1 show no significant difference between LS and age-adjusted FES, or between LS and mean age-adjusted FES ($P > 0.60$), while FES calculated without the age term significantly underestimates LS, as predicted, by an average of almost a centimeter ($P < 0.02$). Prediction errors are nonsignificantly different between the age-adjusted and mean age-adjusted estimates, but errors using the FES formula without the age term are significantly greater (Table 2).

Thus, when using the new Fully stature estimation technique (Raxter et al., 2006), we recommend that the

TABLE 1. Comparison of Fully estimated statures (FES) and true living stature (LS) (cm)

	Mean differences	
	FES-LS (cm)	P[a]
FES, age-adjusted[b]	−0.131	0.694
FES, mean age-adjusted[c]	−0.150	0.652
FES, no age term[d]	−0.868	0.013

[a] Paired *t*-tests between estimates, FES-LS.
[b] Stature = 1.009 (skeletal height) − 0.0426 (age) + 12.1. Age in years, other dimensions in cm.
[c] Same formula as above, but using decadal mean ages (see text).
[d] Stature = .996 (skeletal height) + 11.7.

*Correspondence to: Michelle H. Raxter, Department of Anthropology, University of South Florida, 4202 East Fowler Avenue, SOC107, Tampa, FL 33620, USA. E-mail: mraxter@mail.usf.edu

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TABLE 2. Comparison of estimation errors (cm), age-adjusted FES with mean age-adjusted FES and FES without age term

	Mean difference	
	FES – LS (cm)	P^a
Mean age-adjusted FES–LS	−0.020	0.257
No age term FES – LS	−0.737	<0.001

[a] Paired *t*-tests between errors.

formula including an age term be used whenever possible. This is true even if decadal or similarly broad age estimates must be employed. If the formula without an age term is used, statures will be systematically underestimated if the age of the individual or mean age of the sample is likely well under 50 years of age, and (more rarely) overestimated if the likely age is well over 50 years.

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