Age Estimation with Bone Histomorphometry from the Human Iliac

Annie Billings[1]; Ashley C. Smith, M.Sc.[1]
[1]Department of Anthropology
UNIVERSITY OF TORONTO

INTRODUCTION

- During forensic assessments of skeletal material, anthropologist often **estimate age** of unknown individuals.
- **Majority** of histological methods for age estimation rely primarily on **long bones.**
- In **recent** years, **alternative bones** have been used for histological age estimation.
- The **current project** investigated the validity of using **iliac crests** as an age marker for histological analysis.

METHODS

- 12 individual iliac crest biopsy samples. The samples were fixed, pre-cut, pre-sectioned at 10-15µm thick, pre-mounted, and unstained.
- Samples were viewed under polarized reflected light with a 4x/0.10. magnification. A total of 6 pictures were taken of each sample: top, middle, and bottom of both the outer and inner table of cortical bone.
- From the images, histological traits such as osteon count, relative cortical area (RCA), and osteon population density (OPD) were examined.
- Histological analysis was conducted with Adobe™ Photoshop®.
- Age was estimated using previously published equations (Table 1).

Original Study	Formulae	R^2
Stout and Paine (2)	Age = 0.07028 * OPD + 2.216	0.69
Stout et al (3)	Age = 0.085 * OPD + 2.033	0.85
Lee et al (4)	Age = 1.412–0.282 * RCA + 2.519 * OPD	0.63

Table 1. Age estimation formulae from the original studies and R^2 values reported original study

RESULTS

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	105.080	1	105.080	1.710	.220[b]
	Residual	614.587	10	61.459		
	Total	719.667	11			

a. Dependent Variable: Sample
b. Predictors: (Constant), Stout_and_Paine

Figure 1. ANOVA table results from regression analysis of actual age of individuals and age estimations from Stout and Paine. Table includes the statistical significance (Sig.) of the regression model.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90.355	1	90.355	1.436	.258[b]
	Residual	629.312	10	62.931		
	Total	719.667	11			

a. Dependent Variable: Sample
b. Predictors: (Constant), Stout_et_al

Figure 2. ANOVA table results from regression analysis of actual age of individuals and age estimations from Stout et al. Table includes the statistical significance (Sig.) of the regression model.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90.340	1	90.340	1.435	.258[b]
	Residual	629.327	10	62.933		
	Total	719.667	11			

a. Dependent Variable: Sample
b. Predictors: (Constant), Lee_et_al

Figure 3. ANOVA table results from regression analysis of actual age of individuals and age estimations from Lee et al. Table includes the statistical significance (Sig.) of the regression model.

Human age can be estimated using **bone histomorphometry** from the **iliac**, but further research is needed for better accuracy

Figure 7. Histological image of an iliac crest biopsy. This image is of the left side middle quadrant of a sample used in study. Squares are used to visualize the osteons.

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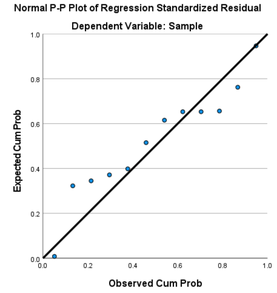

Figure 4. P-P plot (normal probability plot) of actual age of samples and age estimated from Stout and Paine's age estimation formula. Plot compares the observed cumulative distribution function (CDF) of the standardized residual to the expected CDF of the normal distribution.

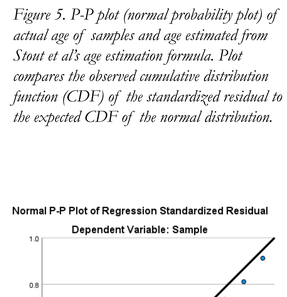

Figure 5. P-P plot (normal probability plot) of actual age of samples and age estimated from Stout et al's age estimation formula. Plot compares the observed cumulative distribution function (CDF) of the standardized residual to the expected CDF of the normal distribution.

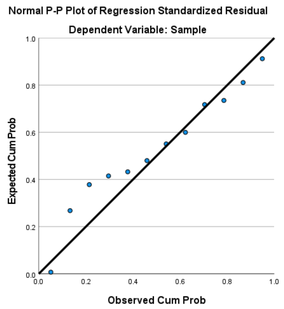

Figure 6. P-P plot (normal probability plot) of actual age of samples and age estimated from Lee et al's age estimation formula. Plot compares the observed cumulative distribution function (CDF) of the standardized residual to the expected CDF of the normal distribution.

DISCUSSION

- Linear regression analysis determined there was a low positive linear relationship between the actual age of individuals and estimated ages.
- The low correlation could be due to the fact that each tested formula was created with specific ethnicities in mind, whereas this experiment was only provided with age
- Chi-square analysis determined there were no statistical difference between the regression analysis of both studies. The expected R^2 values from the original study are as followed: Stout and Paine (R^2 =0.69), Stout et al (R^2 =0.85), and Lee et al (R^2 = 0.63). In comparison, the current study yielded: Stout and Paine (R^2 =0.146), Stout et al (R^2 =0.126), and Lee et al (R^2 = 0.126).
- As there were no statistical differences between R^2 values, it was concluded that replacing the clavicle bones with iliac bones did not change the accuracy of age estimation formulas to a significant degree.
- Experiment was limited to sample size; further research is required to determine a more accurate level of success.

CONCLUSION

- It is foreseeable for the ilium to have a place in histological age estimation in forensic applications, however new age estimation equations specific to the bone will need to be formulated.

CITATIONS

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3. Stout S, Porro M, Perotti B. Brief communication: A test and correction of the clavicle method of Stout and Paine for histological age estimation of skeletal remains. American Journal of Physical Anthropology 1996;100(1):139-42. Doi: https://doi.org/10.1002/(SICI)1096-8644(199605)100:1<139::AID-AJPA12>3.0.CO;2-1