Inter/Intra Observer Error Rates for Metric and Morphological Measures to Identify Sex in Unidentified Human Remains.

Wyatt Schiefelbein and Zachary Rintoul

Introduction

Forensic anthropological expertise will ultimately be used is in the courtroom, it is therefore necessary to adhere to such court rulings as *Daubert v. Merrell Dow Pharmaceuticals* when conducting research or applying techniques as these rulings act as guides informing admissibility of scientific testimony in the court of law.

Daubert ruling states that:

Scientific theory and techniques should:

1) Be subject to testing.
2) Have known or potential error rates.
3) Be appropriately standardized.
4) Be subject to peer review / Publication.
5) Is widely accepted in the scientific community.

Our study addresses these guidelines by providing a set of error rates for measures used in the estimation of sex for human skeletal remains. In so doing, the current study also tests the accuracy of these measures, while also testing the degree of standardization in these measures.

Hypothesis

1. Inter-observer agreement rates among morphological measurements will be low.

2. Intra-observer agreement rates among morphological will be high.

3. Few inter- and intra-observer error rates will exceed 9.9% for the metric measures.

References:

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- Cowal, Lynne S., and Robert F. Pastor. 2008. Dimensional variation in the proximal ulna: Evaluation of a metric method for sex assessment. American Journal of Physical Anthropology 135: 469-478.
- Orish, C. N., Didia, B. C., and Fawehinmi, H. B. 2014. Sex determination using inion-opistocranium-asterion triangle in Nigerians' skulls. Anatomy Research International 2014(1): 1-5.
- Robling, Alexander G., and Douglas H. Ubeaker. 1997. Sex estimation from the metatarsals. Journal of Forensic Science 42(6): 1062-1069.
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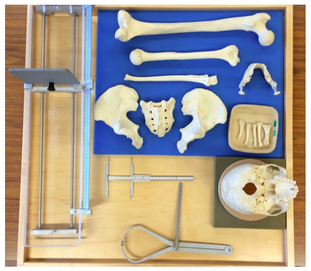
Materials

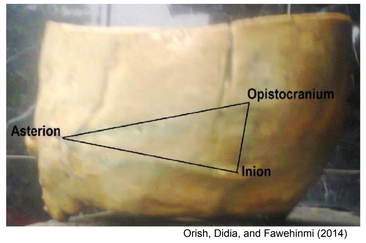
A skull, humerus, femur, innominate, ulna, and five metatarsals were obtained from the University of Victoria's collection of human skeletal remains. Measurements were taken using a sliding calipre.



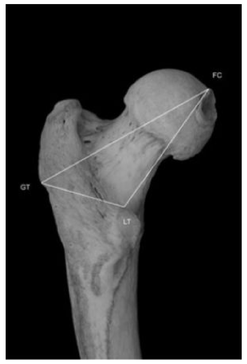
Methods

A total of 61 features shown to express sexual dimorphism in humans were tested in this study - each feature was measured/observed twice by one researcher, and then twice again by the other. Forty nine features were measured using metric methods and 12 features were observed using morphological methods.

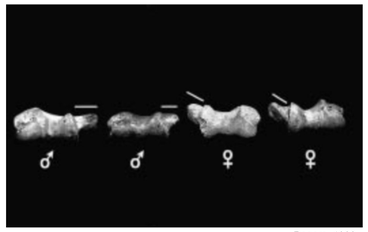
Measures and estimates were then compared within and between observers to obtain intra-/inter observer error rates.



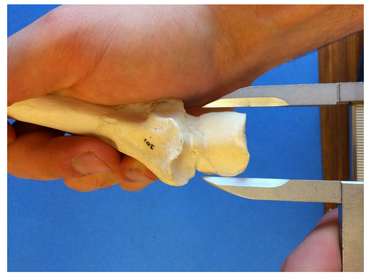
Orish, Didia, and Fawehinmi (2014)

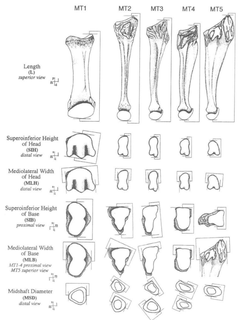


Albanese, Ecklics, & Tuck 2008



Rogers, 1999





Robling & Ubelaker, 1997

Findings

Our hypotheses 1 and 2 were largely supported by our findings; the inter-observer agreement rate was substantially less (60% for skull measures, 50% for humerus) than the intra-observer agreement rates (100% and 71.4% for skull measures, and 60% and 60% for measures of the humerus).

Our third hypothesis was somewhat supported by our findings. There was a greater number of measures reaching significance for error than we were expecting (16/180), but not so much as to consider metric methods unreliable.

Overall, the metric methods represented in this study have a high degree of reliability both between and within observer measures. This high degree of reliability is possibly due to the fact most features are clearly defined and thus relatively easy to pinpoint and measure. The morphological agreement rates were not particularly high, but this may reflect our level of experience as opposed to the accuracy of the measures themselves.

Table 1. Intra and Inter Observer Percent Error for Metatarsal bones (Robling and Ubelaker 1997)

Feature	Observer 1 Intra %Error	Observer 2 Intra %Error	Inter-Observer % Error
Metatarsal 1			
L	7.9	4.8	2.1
SIH	0.0	0.0	2.7
MLH	0.0	2.6	1.3
SIB	0.0	0.0	1.8
MLB	5.6	2.2	1.1
MSD	4.2	2.5	0.9
Metatarsal 2			
L	0.0	1.4	0.0
SIH	0.0	6.9	0.4
MLH	0.0	1.1	2.9
SIB	2.6	0.0	1.3
MLB	0.0	6.7	3.6
MSD	14.3	14.3	0.0
Metatarsal 3			
L	0.0	0.0	1.5
SIH	40.0	0.0	20.0
MLH	5.9	0.0	3.0
SIB	0.0	2.8	1.4
MLB	4.0	9.1	9.8
MSD	7.1	7.1	6.9
Metatarsal 4			
L	0.8	0.0	1.2
SIH	4.3	0.9	6.0
MLH	6.3	1.3	2.6
SIB	0.0	2.9	1.5
MLB	0.0	0.0	0.0
MSD	23.1	5.9	13.8
Metatarsal 5			
L	6.8	0.0	2.5
SIH	4.3	0.0	2.2
MLH	0.0	0.0	0.0
SIB	0.0	8.8	31.5
MLB	2.9	2.9	2.8
MSD	28.6	0.0	12.5

Table 2. Intra and Inter Observer Percent Error for Various Bones Organized by Method Used

Features	Observer 1 Intra %Error	Observer 2 Intra %Error	Inter-Observer % Error
Inominate and Proximal Femur (Albanese 2003)			
AIL	3.7	11.6	5.8
Ischium Length	7.7	0.7	2.0
Hipbone Height	1.3	0.0	1.6
Iliac Breadth	0.0	0.3	0.2
SPRL	9.4	7.3	6.9
Max Femur Head Diameter	0.0	3.0	13.1
Epicondylar Breadth of Femur	0.6	1.3	1.6
Proximal Femur (Albanese, Eklics, and Tuck 2008)			
GT - FC	0.5	3.0	0.8
GT - LT	6.4	5.4	9.0
LT - FC	1.5	5.0	0.3
Angle GT	0.6	0.6	5.0
Angle FC	8.1	12.1	15.9
Angle LT	2.1	3.5	6.1
Cranium (Orish, Didia, and Fawehinmi 2014)			
Inion to Opistocranium	2.8	14.7	0.0
Inion to Asterion	0.9	15.6	7.8
IOA Index	1.8	35.9	6.0
Ulna (Cowal and Pastor 2008)			
Ulna Notch Length	4.1	4.7	14.5
Width of Olecranon	0.0	1.9	1.0
Height of Coronoid	4.4	1.4	4.5

Table 3. Percent Agreement of Morphological Methods Organized by Bone

Feature	Intraobserver 1 % of Agreement	Intraobserver 2 % of Agreement Total	Interobserver % Agreement
Skull	100%	71.40%	20%
Distal Humerus	60%	60%	50%

Contact: Wyatt Schiefelbein - wschiefe@uvic.ca
Zachary Rintoul - zrintoul@uvic.ca