Sexual Dimorphism of the Iliac Crest: A Quantitative Approach

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Abstract. This study examines indicators of male-female differences in the os Coxa, specifically in the shape of the iliac crest for the purpose of skeletal sex estimation. The iliac crest is a curved, or "S-shaped", epiphysis which extends along the cranial margin of the ilium, posteriorly from the anterior superior iliac spine to the posterior superior iliac spine of the os Coxae. Forty two metric variables characterizing the shape of the os Coxa and iliac crest are derived from a digital data-base of 150 adult White human os Coxae, including 75 males and 75 females, from the Hamann-Todd osteological collection at the Cleveland Museum of Natural History. The os Coxae are all digitized using a MicroScribe-3DX digitizer, and the data is stored in an excel spread-sheet, facilitating further mathematical analysis to define and calculate all variables. A single point of origin defined as the most superior point in the midline of the pubic symphysis, is common to each variable. This study hypothesizes that these variables will better define variation in form, and that they will better characterize sexual dimorphism in the iliac crest. Statistical analyses will be used to test the potential application of the findings of this study to human identification in osteological investigation.

1. Introduction

Documentation of morphological variation, particular to the estimation of sex, has proven fundamental to the estimation of biological profiles derived from undocumented skeletal remains. Thus better achieve complete inventory assessments and positive identifications [1]. This study addresses the issue of variation in adult White os Coxae, more specifically, the iliac crest. The iliac crest is an epiphysis along the cranial margin of the ilium, extending posteriorly from the anterior superior iliac spine to the posterior superior iliac spine of the os Coxa.

The research presented here quantifies the shape of the iliac crest and documents the presence and nature of male-female variation in the shape of the crest. Such differences will lend themselves to improved osteological assessment of sexual dimorphism in skeletal materials of prehistoric, historic archaeological, modern forensic complete and fragmentary os coxae.
Overall, adult male skeletons are larger and more robust than female specimens. Certain bones and areas throughout the skeleton are widely known to be better indicators of sex than others and that the most reliable area for sex estimation is the os coxae [1, 2, 3, 4, 5, 6]. Current studies of pelvic morphology describe the female os coxa as less robust, exhibiting a relative absence or lesser expression of muscle markings. The female pelvis has also been characterized as both broader and lower; whereas the male os coxa is larger in size with more extensive muscle markings, displaying a taller and relatively narrow appearance [7, 5, 1, 6].

Although there are several metric and non-metric studies that focus certain features of the os coxae in determining sex, only one study could be found that focused on iliac crest [8] and one study that briefly discussed the dimorphic condition of the crest [9]. With the lack of studies on the iliac crest, it is apparent that further research needs to be conducted in this area of sexual dimorphic features.

2. Materials and Methods

To quantify the shape of the iliac crest, 150 adult Caucasian os Coxae (75 males and 75 females) from the Hamann-Todd osteological collection at the Cleveland Museum of Natural History in Cleveland, Ohio were digitized by a MicroScribe-3DX digitizer. Once the os Coxae were digitized, the data was entered into an excel spread sheet where mathematical analysis was conducted to establish 42 nontraditional variables. The nontraditional variables included seventeen chords, sixteen angles, a total triangular area, an anterior triangular area, a posterior triangular area, a posterior chord, an anterior chord, the subtense at ninety degrees, the anterior breadth, the posterior breadth and the iliac breadth. The origin point for all variables is the most superior point in the midline of the pubic symphysis. In addition to digitizing the iliac crest, the sciatic notch was scored qualitatively from hyperfeminine (-2) to hypermasculine (+2). Preliminary analytical methods for quantifying sexual dimorphism in the iliac crest and os Coxa include descriptive statistics, independent samples t-tests and a correct classification on all 42 variables. Statistical significance was determined using an α-level of .01 for the independent t-tests, where

$p<.01$. The calibration sample was subsequently compared to an independent test sample comprised of 17 males and 17 females.

3. Results and Discussion

The preliminary results from the analytical methods highlights shape differences between the male and female form. The descriptive statistics show a difference in means in all variables, with female means smaller than the male means. Additionally, in 19 of the observations, females exhibit more variability. The independent t-tests show statistically significant male and female means for five chords (chords 7-11), six angles (angles 10-12 and 15-17), iliac breadth, subtense, anterior chord, posterior chord, and all triangular areas.

Correct classification for these 18 variables based on univariate sectioning points calculated from male and female means, are consistently greater in variables also significant when tested for difference of means using a t-test. These variables have a female, male, or pooled correct classification percentage of 60-76%. The subtense measurement proved to have the best classification percentage, with 76% in female, male and pooled results.

To test the reported calibration results, the analytical methods were applied to an independent test sample of 34 males and females. The independent test sample descriptive statistics showed a difference in means, with only 8 variables having larger means in females rather than males, and females proved to be more variable in 15 of the 42 measurements. The independent t-tests show statistically significant male and female means for the subtense, anterior chord, total triangular area, anterior triangular area, and angles 11 and 12.

In the correct classification percentage of the independent test sample, 18 variables had a female, male, or pooled percentage of 64.7-94.12%. As in the calibration sample, the subtense had the best classification percentage, with 70.59% for females, 94.12% for males and 82.35% overall.

The independent female test sample results of the independent t-tests and correct classification percentage supports the findings of the calibration sample. The subtense, anterior chord, total triangular area, anterior triangular area, and angles 11 and 12 proved to be statistically significant and have a relatively high associated correct classification percentage for both samples.

4. Conclusions

From the results outlined above, it is clear that there are slight indications of sexual dimorphism in the shape of the iliac crest and the overall os Coxa among White males and females. In this study, the best discriminators between females and males are the height of the iliac blade (subtense), the shape of the iliac blade (anterior and posterior chords and the three triangular areas), and the shape of the middle portion of the iliac crest (chords 7-11 and the associated angles). Such findings are relatively contrary to the hypothesized results. Thus further research of the observed variation is necessary to better address these findings. The new approach to quantifying the os Coxae and the iliac crest as presented here, does cast further light on the complexity of the question of sexual dimorphism in the human pelvis and it provides a new basis for its continued investigation.

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