Determining Sex using the Human Sacrum

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Objective

The objective of this research is to determine a more efficient way to sex the human sacrum by revisiting previously conducted measurements.

Introduction

In the past century, identification of diagnostic features between the sexes are in the in the literature. One of the features previously described is the curvature of the sacrum . It is said that the normal female sacrum tends to be flat while the normal male sacrum tends to be more curved. Female sacra are said to be flat because of the female biological ability for childbirth. In regards to dimensions, female sacra should have a wider total breath than males as well as a smaller first sacral vertebra articulation width (S1)(Trotter 1926:450). The maximum anterior height is a measurement taken into consideration to sex the sacrum (Flanders 1978:104). Researcher Kunihiko Kimura measured the length of a single ala (wing) along with the S1 breadth to develop an index that had provided a relatively high accuracy in sexing the sacrum. In an archaeological or forensic setting being able to determine the sex of an unknown individual is important. Although the pelvis is the best source to determine sex difference, the sacrum (as part of the pelvic girdle) should also hold some significant difference to help determine sex when the pelvis is broken or absent. The present research will explore these methods previously identified to determine their efficacy and evaluate metric data by statistical analysis.

Materials and Methods

Three hundred and twenty four (325) individuals from the Robert J. Terry Anatomical Skeletal Collection were measured for this study. The selection was done blindly to avoid influences by knowing the demographic information of the specimen. The sample size was broken into four groups of 81 each - Black Females, Black Males, White Females, and White Males. We also included individuals that had more severe arthritic changes to the S1 and sacro-iliac articuation to provide a more realistic sense of the variation found in the human sacrum. We limited some variations from our sample size, excluding individuals that had more than 6 sacral vertebral segments and anyone showing severe pathological or morphological anomalies. Using coordinate and sliding calipers, the following four measurements were taken from each sacrum:

S1 Width

Maximum Height and Midpoint Curve

Total Breadth

Results

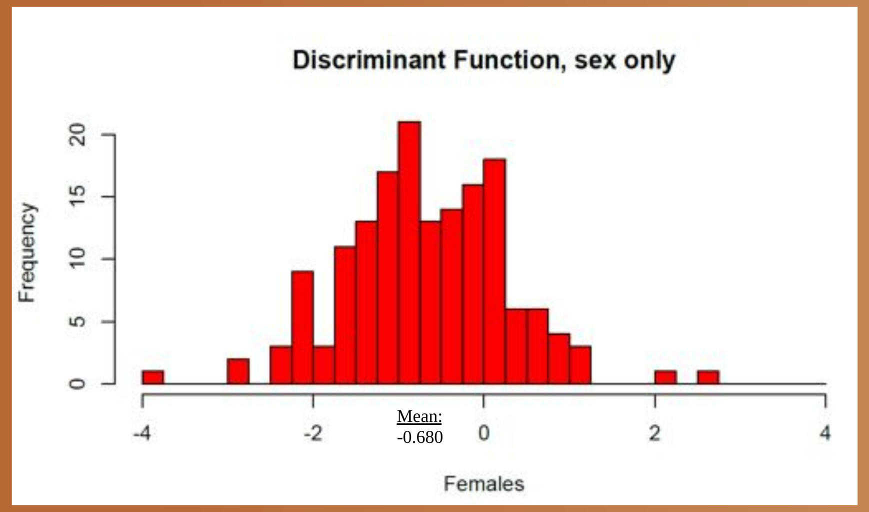

Figure 1

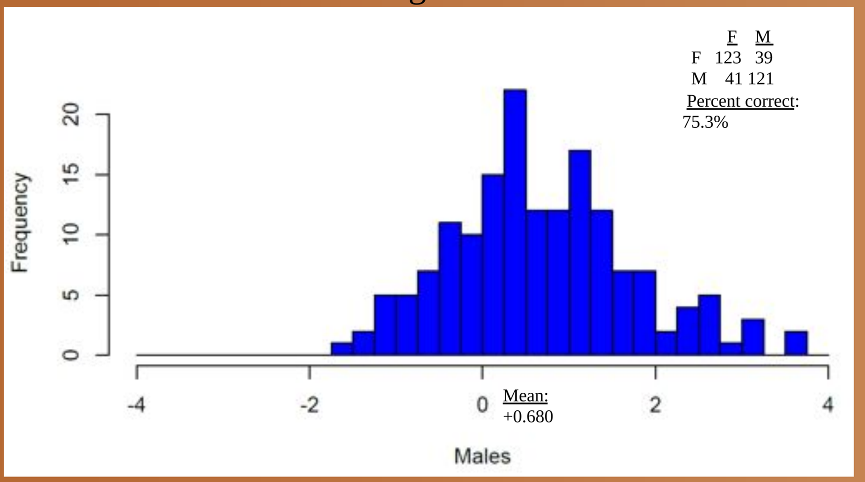

Figure 2

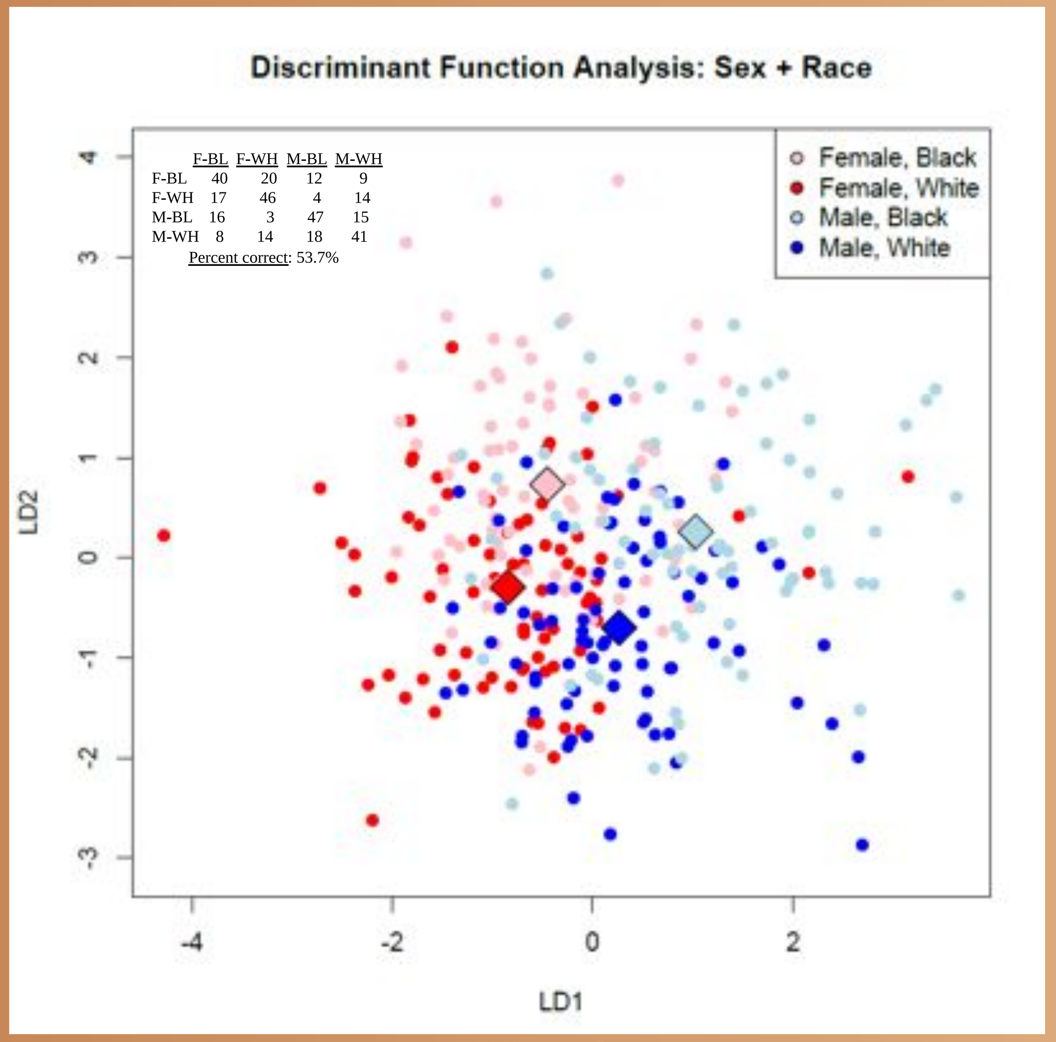

Figure 3

Figure 1 and Figure 2 illustrates the differences between sexes. Figure 3 scatterplot shows the values of the different groups along with group centroids (identified by the diamonds). Males and females separate along the LD1 axis while LD2 separates Blacks from Whites. Correct classification is only 54% with the four group analysis and 75% correct classification with only the two sexes (races combined).

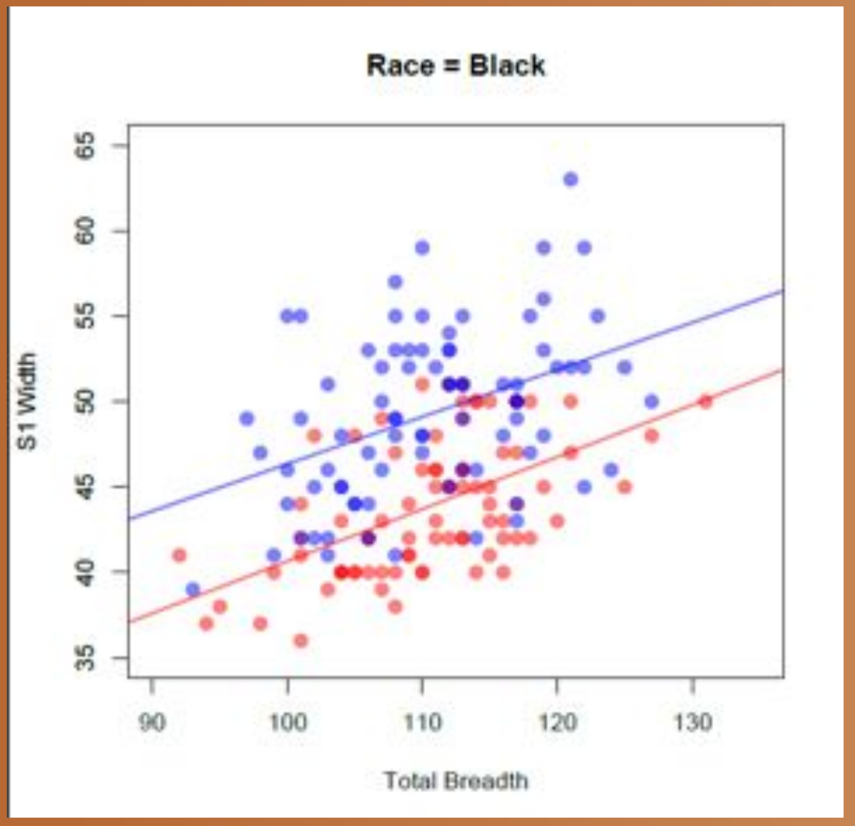

Figure 4

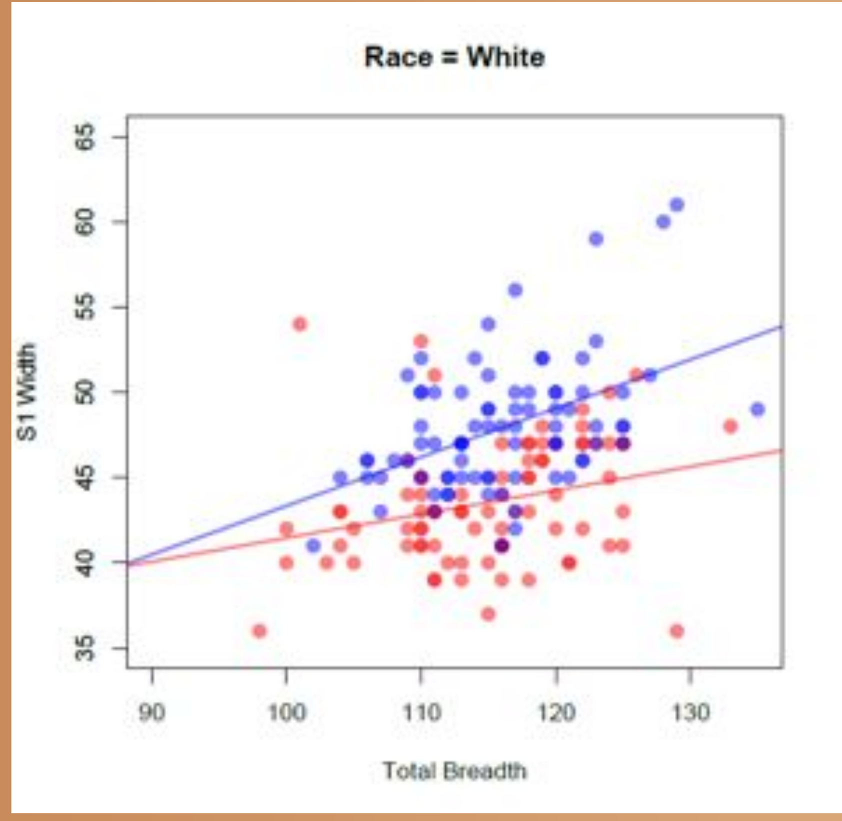

Figure 5

In Figure 4, the least squares lines demonstrate a positive relationship where increase in total breadth and S1 breadth are equitable, and there is sufficient separation between Black males and females by these metric values. Alternatively, Figure 5 illustrates that White females increase in overall size at a slower rate than White males, obscuring adequate separation of sexes.

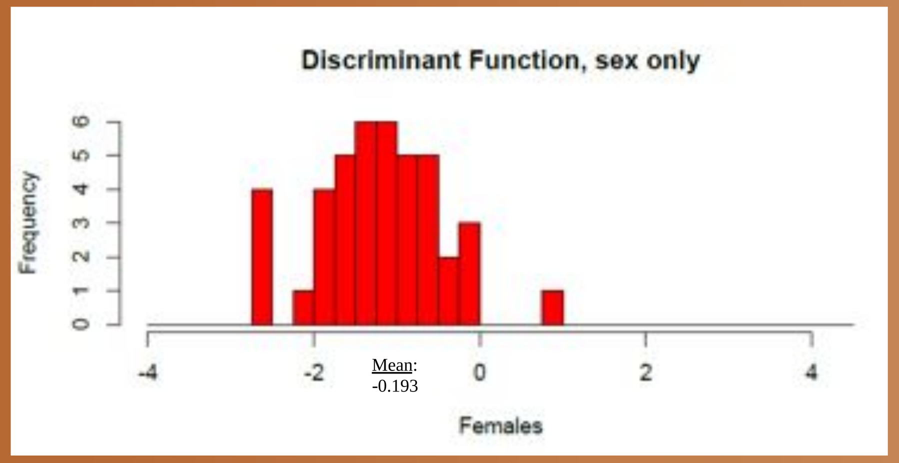

Figure 6

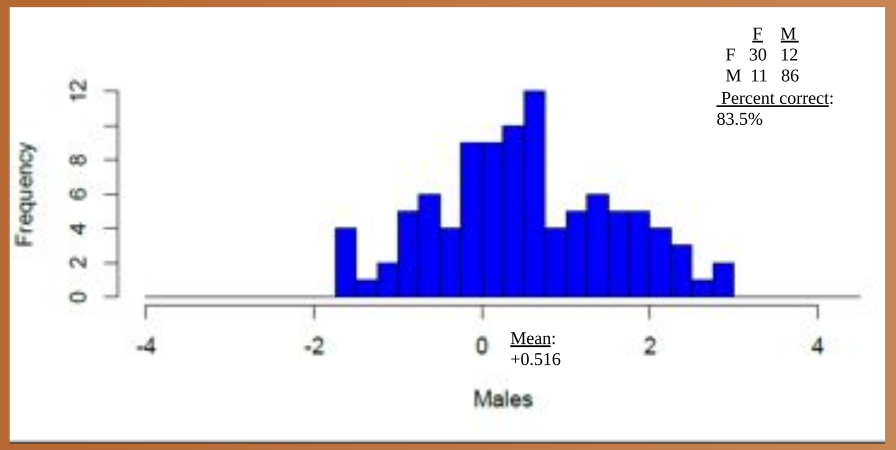

Figure 7

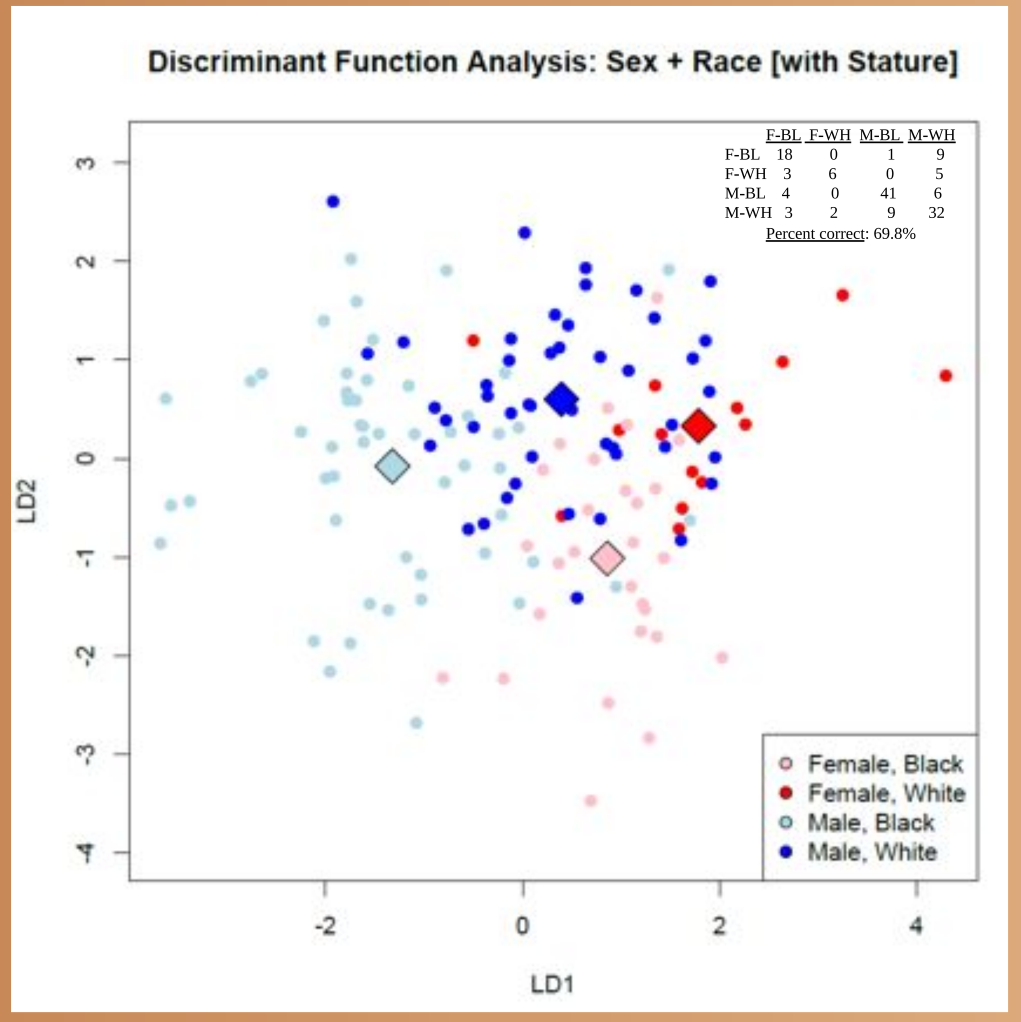

Figure 8

With the previous results indicating differential change in size, stature was used as controlling value for size. Of the study sample, 139 individuals had recorded cadaver stature. Re-application of discriminant analysis resulted in an increase in accuracy in the classification into the correct group (increased from 53.7% to 69.8% in the four group and 75.3% to 83.5% in the sexes only.

Discussion

The overall statistical analysis of the data showed significant differences in the ANOVA and t-test results, but at a low level of correct classification due to the high level of overlapping values between males and females. Some of this 'noise; may be due to the arthritic lipping that was present in the majority of the specimen. The S1 measurement was the most consistent at showing strong statistically significant results, while interestingly, maximum breadth demonstrated significant t-test in races rather than in sex. However, there was still a statistically significant separation of the four groups when as shown in the scatterplot. Using stature for size control, males and females separated more clearly and increased the correct identification percentage greatly (8.5 %). During the data collection, it was found that many specimens demonstrated the complete opposite of what has been said to be diagnostically male and female. The pelvis of these individuals were examined to determine if there were anomalies which would explain their inconsistent morphology. In only one case was there sufficient proof of congenital anomaly to indicate reason for unexpected variation. The conclusion from these observations clearly shows the substantial variation found in the human sacrum. Without being aware of this variation will lead to incorrect classification of sex of the specimen (see illustrations below).

Flat Male

Highly Curved Female

Spina Bifida Occulta is a neural tube defect identified when at least 3 sacral segments are unfused, or clefted (Barnes, 1994:44-45). While collecting data, observations for this anomaly were made and out of the total 324 sacra, 13 displayed this developmental anomaly. There were 3 Black males, 8 White males, 2 White females and 0 Black females. The higher prevalence in Whites is noted by Barnes, however, in this study, there were more affected males than females, the reverse frequency cited by Barnes (1994:41).

Full Spina Bifida Occulta

Spina Bifida Occulta with 3 Segments

Superior view of Full Spina Bifida Occulta

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