H35 Sexual Dimorphism in Vertebral Dimensions at the T12/L1 Junction

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The objective of this presentation is to demonstrate new methods of accurate sex assessment from the axial skeleton based on dimensional variation of the lower thoracic and upper lumbar vertebral column, specifically the twelfth thoracic (T12) and first lumbar (L1) vertebrae.

This presentation will impact the forensic community and/or humanity by demonstrating that the lower thoracic and upper lumbar vertebrae are highly dimorphic. Measurements for centrum diameters, length of the spinous and transverse processes, and articular facet width were found to provide reasonably accurate sex classification in the range of, or higher than, other postcranial elements such as the lower limbs or pelvis. Both vertebrae should be considered for metric sex determination with complete skeletons and especially in fragmentary forensic assemblages from aircraft and other mass disasters.

The dimensions of many skeletal elements, such as the long bones and pelvis, have been shown by numerous workers to vary systematically with sex. Evidence also exists from several previous studies for sex-based metrical variation in parts of the axial skeleton, such as the atlas and axis, basocranium, sacral elements, and there is preliminary evidence for metric sex and age differences in the lower thoracic and lumbar centra. Reliable metric methods are still in need of development, especially because of the taphonomic problems with buried or otherwise degraded forensic cases and archaeological remains where preservation of the skeleton is often poor. This is especially true for fragile bones of the skull, hands and feet, and pelvis. Due to their weight-bearing function and relative density, the lower thoracic and lumbar vertebrae are often preserved well in archaeological skeletal assemblages and forensic contexts. Even when bone preservation is problematic for the axial skeleton, the unique morphology of the twelfth thoracic (T12) and first lumbar (L1) vertebrae means these can be readily distinguished even when fragmentary. It has also been widely acknowledged that population variation in skeletal element size differences needs to be considered when producing specific standards for accurate determination of sex.

All measurements were collected to the nearest 0.1 millimeter using a Mitutoyo digital sliding caliper. One variable, the AP diameter of the foramen, required measurement with a Mitutoyo vernier sliding caliper with elongated points. Only mature (adult) vertebrae free of pathological insult were measured. All specimens were selected 'blind' to avoid measurement bias for known sex.

A pilot study revealed significant sex differences for several vertebral metric traits (centra diameters) measured in the Hickelton and Raunds historical British archaeological samples (Biological Anthropology Research Centre, Bradford). However, undocumented archaeological samples are limited by the inherent and uncertain variation in sexual dimorphism. Therefore, two documented skeletal collections were used for testing and refining the method and developing discriminant functions for sex determination, because such series provide samples where factors of sex and age can be tested and controlled for statistically. Variation associated with population differences was also investigated. An expanded suite of metric characters consisting of twelve diameters and dimensions were examined, including the height of the anterior centrum at midline (CENAN), antero-posterior and medio-lateral diameters of the centrum (CENAP and CENLAT, respectively) and vertebral foramen, maximum medial-lateral width across the transverse processes (TRANPRO), maximum spinous process length (SPINPRO), maximum distance between the inferior articular facets (INTFAC), and the maximum height and width of the articular facets (ARFACVER, ARFACWID, respectively). The first phase of this study was conducted on the 18th/19th century Spitalfields documented collection comprising a White immigrant population (French Huguenots) housed at the British Museum of Natural History, London. A total of 53 vertebral pairs from a split-sex sample consisting of 23 males and 30 females were analyzed. The ages of this group ranged from 18-89 years. Significant sex differences were determined for 7 of 12 traits and 8 of 12 traits for the T12 and L1 vertebrae, respectively (Student's t-tests, $p < 0.05$ to 0.001).

Subsequently, a larger study was conducted to investigate the degree of sexual dimorphism and potential population variation for these traits in a second documented sample, the Smithsonian's Terry Collection (Washington, DC), with the aim of developing discriminant functions useful for sex determination. The Terry sample consisted of T12/L1 vertebral pairs (n=124) from 27 White males, 26 White females, 41 Black males, and 30 Black females with ages ranging from 19-63 years. Two additional variables (n=14) were added to the suite of metric traits: the maximum diameter in the sagittal and transverse (medio-lateral) planes between the limits of the superior annular epiphyses (rings) of the centra (CENAPA and CENLATA, respectively).

Separate discriminant function analyses were conducted on the datasets to control for differences by

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skeletal element and race. The results showed significant sex differences for both vertebrae in the Spitalfields and Terry samples. Using T12, White males and females in the Terry Collection were correctly sexed on average 88.9% of the time using two of the fourteen measurements (CENAP, SPINPRO). Using L1, Terry White males and females were correctly sexed on average 91.8% of the time with the variables CENAPA and INTFAC. For Terry Black males and females, two variables (CENAP, CENLAT) yielded an average correct sexing of 86.6% for T12 and 85.1% for L1. Discriminant function analyses of the Spitalfields male and female sample yielded widely different results for the two vertebral elements. For T12, the highest average correct sexing was 76.7% using the single measurement CENLAT, but for L1 a high of 100% average correct sexing was provided predominantly by the variable TRANPRO, with smaller contributions from the variables ARFACWID, CENAP, and CENAN. The more disparate results for the Spitalfields sample may be due to greater occupational or other sex differences, to secular differences between this and the more contemporary Terry sample, or as a result of the overall younger age range in the Terry sample.

The results of this study demonstrate that the lower thoracic and upper lumbar vertebrae are highly dimorphic. Of the 12-14 metric variables examined, a small subset of measurements for centrum diameters, length of the spinous and transverse processes, and articular facet width were found to provide reasonably accurate sex classification in the range of, or higher than, other postcranial elements such as the lower limbs or pelvis. This is especially true for the first lumbar vertebra of the two White samples. Both vertebrae should be considered for metric sex determination with complete skeletons and especially in fragmentary forensic assemblages from aircraft and other mass disasters.

Sex Determination, Thoracic-Lumbar Vertebrae, Discriminant Functions

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