A90 Sex Estimation From the Vertebral Foramen of the Seven Cervical Vertebrae: An Analysis of Greek and Portuguese Skeletal Populations

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After attending this presentation, attendees will recognize the potential value in utilizing the vertebral foramen of the seven cervical vertebrae to estimate sex of unknown individuals. Skeletal remains are commonly exposed to a variety of taphonomic processes, including destructive environmental factors, disarticulation, and scattering due to animal scavenging, which hinder skeletal sex estimation methods. The cervical vertebrae exhibit strong architectural structural integrity resulting in good postmortem preservation that increases the likelihood for successful adult sex estimation when other sexually diagnostic elements of the skeleton are absent or badly preserved.

This presentation will impact the forensic science community by providing alternative means of correctly identifying the sex of unknown individuals from the cervical vertebrae and will be useful in cases such as mass disasters when only fragmented remains are available for examination.

The purpose of this study was to understand the relationship between sex and the cervical vertebral foramen in two White skeletal populations. A total of 295 individuals (157 males and 138 females) were selected from two cadaveric collections: (1) the University of Athens Human Skeletal Reference Collection, Greece (N=135); and, (2) the Luis Lopes Skeletal Collection, National Museum of Natural History, Lisbon, Portugal (N=160). Inclusion criteria consisted of individuals from 20 to 99 years of age, the presence of at least five complete cervical vertebrae, and vertebrae free of skeletal pathologies. The maximum vertebral body height (CHT) and anterior-posterior (CAP) and transverse diameters (CTR) of the vertebral foramen were recorded for each of the seven cervical vertebrae (excluding CHT for C1). Measurements were taken from the superior aspect of the vertebral foramen using a digital Vernier caliper accurate to 0.01mm.

The data were then subjected to statistical analyses; the mean, range, and standard deviation were calculated for each vertebra. Pearson's correlation coefficients were calculated to measure the correlation between CHT, CAP, and CTR measurements and stature. Two-sample *t*-tests were used to test the presence or absence of sexual dimorphism in the Athens and Lopes collections. Two-sample *t*-tests were also used to test whether the mean vertebral measurements for males and females exhibited statistical differences between the two White populations. Canonical discriminant function coefficients were used to develop formulas to estimate sex from the vertebrae that exhibited sexual dimorphism.

The results of this investigation showed that sexual dimorphism is exhibited in the CHT and CTR measurements between males and females with means greater in the male population in all cervical vertebral segments. No statistically significant differences were observed in the CAP measurement between males and females. There were no statistically significant population differences between vertebral measurements in the Athens population compared to the Lopes populations; therefore, males and females from both populations were grouped into one large sample population.

When examining the classification results to assess which vertebrae more accurately estimated sex, a combination of all three measurements (CHT, CAP, CTR) from all seven vertebrae (C1-C7) performed best with 84.9% correct male estimation and 83.3% correct female estimation. Excluding the irregular C1 and C2 vertebrae, classification results correctly estimated males (82.9%) and females (81.7%). When removing the irregular vertebrae and the transitional C7 vertebra, C3-C6 correctly estimated males (80.2%) and females (78.2%). The strongest sexually dimorphic indictor was the CHT measurement followed by CTR in all seven vertebrae with CAP exhibiting minimal statistically significant dimorphism. Utilizing CHT and CTR measurements for vertebrae C3-C7, males and females are correctly classified with accuracies of 84.8% and 80.6%, respectively. Classification using the two measurements of the vertebral foramen (CAP, CTR) results in low accuracies for vertebrae C3-C7 with 71.3% correct male and 67% correct female estimations. The most dimorphic measurements were C1AP, C2HT, C2TR, C3HT, C5HT, C5TR, and C7TR with 79.4% correct male estimation and 84.9% correct female estimation using these seven features. Sex estimation could not be performed on individual vertebrae due to poor male and female classification accuracies that ranged from 58.9% to 74.4%.

This research has shown that sexual dimorphism is present in the vertebral foramen of the seven cervical vertebrae; however, the discriminant functions equations derived from the two vertebral foramen dimensions (CAP, CTR) are of limited use because of the low correct sex estimation accuracies. The CHT measurement must be included in the equations to achieve higher accuracies for sex estimation. Also, including all seven vertebrae in the discriminant functions will result in higher accuracies for sex estimation.

Forensic Anthropology, Sex Estimation, Cervical Vertebrae