H107 The Effect of Axial Developmental Defects on Forensic Stature Estimates

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The goal of this presentation is to explore how the presence of axial developmental defects affects living stature estimates.

This presentation will impact the forensic science community by helping to establish methodological standards when calculating living stature estimates from human skeletal remains that evidence vertebral developmental defects.

The accurate estimation of stature is vital to the establishment of an individual's identity in medicolegal investigations involving human skeletal remains. In forensic anthropological analyses, stature is commonly estimated by: (1) combining the measurements of those bones responsible for living stature (i.e., anatomical method); or, (2) using regression equations based on intact long bone measurements (i.e., mathematical method). The use of Fully's anatomical method to estimate living stature, for example, involves the measurement of cranial height, maximum anterior height of the vertebrae C2 through S1, bicondylar length of the femur, physiological length of the tibia, and the maximum height of the articulated calcaneus and talus. Conversely, stature estimates derived solely from long bone measurements, with the occasional addition of sacral height, do not consider the entire vertebral column.

Congenital anomalies or malformations are produced by pathological changes in the normal development during intrauterine life. Specifically, axial developmental defects affect the skull, vertebral column, ribs and sternum. Because a major component of skeletal height is the combined length of C2 through S1, vertebral agenesis, supernumerary vertebrae and irregular vertebral segmentation such as those seen in axial developmental defects may influence stature. It is hypothesized that using stature estimations based solely upon long bone measurements may under or overestimate stature, depending on the type of axial developmental defect present. Very little research has been conducted on how these anomalies, especially those involving the vertebral column, affect the estimation of living stature. To this end, stature was estimated using both anatomical and mathematical methods for skeletal remains with and without the presence of axial developmental defects in order to determine the variance, if any, between the two methods.

Study materials for this research came from skeletal cases under the jurisdiction of Florida medical examiner districts 4, 17, and 20. The sample consisted of 32 adult individuals, of which 23 were male and nine were female. At least 50% of each individual was present, including the elements necessary to ensure accurate sex, age, ancestry, and both anatomical and mathematical stature estimates. Each case was inventoried, a biological profile was determined, and the remains were analyzed for vertebral developmental defects. The presence or absence of vertebral anomalies such as irregular vertebral segmentation (e.g., block vertebrae), vertebral border shifting (e.g., lumbarization, sacralization, etc.), supernumerary vertebrae and vertebral agenesis was recorded. Interobserver error was minimized by having three investigators estimate the stature on all individuals. Stature was determined using both anatomical (i.e., revised Fully method) and mathematical (i.e. regression equations from long bone measurements using FORDISC 3.0) methods. Data using chi square analysis of variance.

Upon analysis, eight of the 32 individuals presented with at least one axial developmental defect. Most individuals exhibited only one type of developmental defect; however, two individuals had defects in multiple vertebral regions. Overall, there were three instances of irregular vertebral segmentation, four instances of general vertebral border shifting, one instance of supernumerary vertebrae and two instances of vertebral agenesis. The chi square analysis of variance revealed a significant difference in mean stature, as well as standard deviation within each stature estimate for those sets of remains with axial developmental defects ($df = 7$, $p = 0.005$). The difference in mean stature for the remains without axial defects was not significant ($df = 23$, $p = 0.619$). In individuals with vertebral agenesis and block vertebrae, the mathematical method tended to overestimate stature, thereby emphasizing the vertebral column's impact on living stature.

Forensic Anthropology, Stature Estimation, Axial Developmental Defects