A83 Virtual Anthropology: The Interchangeability of Morphological Sex Estimation Methods on 3D Models of the Pelvis and Their Dry Skeletal Counterpart

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Learning Overview: The goal of this presentation is to inform attendees as to whether commonly used pelvic morphological methods (e.g., those incorporated in the Klales and the 1980 Workshop of European Anthropologists (WEA) morphological sex estimation methods) can be accurately scored on reconstructed virtual 3D pelvic bone elements.[1,2]

Impact on the Forensic Science Community: This presentation will impact the forensic science community by informing attendees on the interchangeability of morphological sex estimation methods from virtual bone models to dry skeletal elements. This is a pivotal prerequisite for the use of Computed Tomography (CT) scans as a reference for forensic anthropological case work.

Background: For forensic anthropological sex estimation methods to be admissible in the court of law, they need to agree with the *Daubert* standards, and thus derived from or tested on large and representative skeletal populations. However, most European countries lack representative collections and are thus unable to develop or test sex estimation methods. The large amount of clinical CT data in hospitals could serve as a basis for a 3D virtual skeletal database and thus provide a solution, but it is uncertain if the often-subtle features associated with morphological sex estimation can be scored accurately from virtual 3D skeletal elements.

The current study aims to determine whether commonly used pelvic morphological methods (e.g., those incorporated in the Klales and WEA morphological sex estimation methods) that utilize ordinal scales can be accurately scored on reconstructed virtual 3D pelvic bone elements.[1,2]

Materials and Methods: Twenty-seven (13 males, 14 females) randomly selected and fully intact cadavers from the body donation program of the Amsterdam UMC, University of Amsterdam, Department of Medical Biology, section Clinical Anatomy and Embryology were CT scanned using a standard patient scanning protocol. The scan data were used to produce 3D virtual pelvic elements, and the os coxae were segmented with an in-house research software. Following CT scanning, the bodies were processed to obtain the corresponding dry skeletal elements.

Three Phenice traits expanded to an ordinal scale by Klales and five selected WEA traits were scored on both the virtual bone models and the dry bone counterparts.[1,2] Intra- and inter-observer agreement, and the agreement between the virtual bone models and their dry skeletal counterpart, was calculated using Cohen's weighted Kappa (K).

Results: For all Klales traits investigated, Kappa values showed substantial to almost perfect agreement for intra- and inter-observer agreement, respectively, on both the virtual bone models (K=0.78-0.84 and 0.62-0.72) and the dry bones (K=0.78-0.89 and 0.61-0.77), when scored in isolation.[1] When comparing corresponding virtual- to dry bone pelvic elements, all three traits show substantial to almost perfect agreement (K=0.74-0.82).

Only two of the five WEA traits (pre-auricular sulcus and pubic angle) showed substantial to almost perfect agreement for intra- and inter-observer agreement, respectively, on both the virtual bone models (K=0.71-0.80 and 0.65-0.82) and the dry bones (K=0.80-0.93 and 0.76-0.88), when scored in isolation.[2] The remaining three traits showed poorer results for inter-observer agreement, with the Greater sciatic notch and the Arc compose resulting in fair to moderate agreement (K=0.51 and K=0.54, respectively), while the Ischial body showed less than chance to fair agreement (K=0.054-0.33).

When comparing corresponding virtual to dry bone pelvic elements, only the Greater sciatic notch, sub-pubic angle, and Arc compose show substantial to almost perfect agreement (K=0.68-0.85).

Discussion and Conclusion: These results suggest that the Klales morphological sex estimation technique can be used interchangeably between virtual bone models and dry skeletal elements.[1] However, the same cannot be said for the five selected WEA pelvic traits addressed in this study.[2] Despite the scores for the Greater sciatic notch, sub-pubic angle, and Arc compose accurately corresponding on both the virtual bone models and the dry skeletal elements, due to the lack of inter-observer agreement, only the sub-pubic angle can be used interchangeably. This study shows the importance of testing the differences between the virtual bone models and the dry skeletal elements before methods are applied interchangeably.

Reference(s):

1. Klales, A.R., Ousley, S.D., and Vollner, J.M. (2012). A Revised Method of Sexing the Human Innominate Using Phenice's Nonmetric Traits and Statistical Methods. *American Journal of Physical Anthropology.* 149, 104–114.
2. Workshop of European Anthropologists. 1980. Recommendation for Age And Sex Diagnosis Of Skeletons. *Journal of Human Evolution.* 9: 517-549.

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