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Recommended citation(APA):

Lottering, N., Swart, T., Blau, S., & Alston-Knox, C. (2023). *Multi-indicator Age Standards for Epiphyseal Union of Australian Children derived from Post-mortem Computed Tomography*. 1-1. Abstract from 23rd Triennial Meeting of the International Association of Forensic Sciences - 2023, Sydney, New South Wales, Australia. <https://iafs2023-c10000.eorganiser.com.au/index.php?r=programWebService/newIndex#!/event>

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Multi-indicator Age Standards for Epiphyseal Union of Australian Children derived from Post-mortem Computed Tomography

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After attending this presentation, attendees will gain an awareness of the temporal characterization of secondary ossification of the post-cranial skeleton in Australian subadults; and be informed of the possibilities associated with the development of a new Bayesian multi-indicator model for age estimation.

The integrity of current techniques employed in forensic and clinical practice for estimating subadult age has been questioned due to complexities of reference collections, socio-environmental variation, and use of conservative statistical approaches. Developmental data collected from living Australian children under the Trauma Protocol at metropolitan Childrens Hospitals has led to the dissemination of re-calibrated single-variable age standards for the cranium, cervical spine and iliac crest using morphological approaches¹. Updated, modality-specific developmental data has yet to be collected for epiphyses of the appendicular skeleton.

In this study, PMCT scans conducted for triaging of forensic casework at the Victorian Institute of Forensic Medicine were acquired for 401 subadults (males: n=206, females: n=195) aged 2-25 years. DICOM datasets were viewed as multi-planar reconstructions, and 21 secondary ossification centers of the extremities scored using five-stage ordinal classification. Transition analysis was applied to elucidate age at transition between union states for each centre, and uni-indicator posterior distributions of age established for all sites. This study complements Scheuer and Black², providing the first exclusive set of CT-specific age intervals for union and temporal maturity of each secondary ossification centre; and demarcates significantly earlier onset of ossification and attainment of final form compared to key literature. For example, the oldest Australian male to exhibit 'non-union' of the composite epiphysis of the proximal humerus is 12.4 years, compared to 18 years in Lisbon individuals³. Complete fusion of the distal humerus occurs as young as 12 years in males and all upper limb centres (except the clavicle) are fused by 20 years. In females, complete fusion of the femoral head occurs between 13-16 years, greater and lesser trochanters between 12-15 years; while lower limb centres are fused before 17 years.

This study also showcase a statistical alternative using Bayesian clustering with a Dirichlet process mixture model to combine multiple sites for age estimation. Key results from the model average delineated six variables that highly contribute to model fit, while cluster analysis identifies four key developmental milestones which coincide with significant ossification activity in modern individuals. We also provide skeletal alternatives for substitution into the model, in the event of recovering isolated or fragmentary remains.

References

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- ² Scheuer L, Black SM. *Developmental Juvenile Osteology*. San Diego CA: Academic Press, 2000.
- ³ Cardoso, HFV (2008) Epiphyseal Union at the Innominate and Lower Limb in a Modern Portuguese Skeletal Sample, and Age Estimation in Adolescent and Young Adult Male and Female Skeletons. *AJPA* 135, pp. 161-170.