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Using Cranial Ontogeny to Improve Subadult Biological Profile Parameters

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Summary
Quantifiable examinations of subadult cranial growth trajectories across the entire ontogenetic period (from birth to adulthood) are needed to improve biological profile estimations within the forensic sciences. Univariate and multivariate methods were applied to a sample of 571 individuals drawn from a virtual anthropology database to assess patterns of ontogenetic development. Results indicate differential regional stabilization across ages, but sex differences are not significant until adolescence. Understanding cranial ontogeny is essential for improving the subadult biological profile.

Keywords: growth and development, craniometrics, virtual anthropology

Introduction
Estimation of subadult biological profile parameters (e.g., sex, population affinity) are often lacking because of limited skeletal samples. However, virtual anthropology facilitates research that was previously impossible. Quantifiable examinations of subadult cranial growth patterns across the entire ontogenetic period (from birth to adulthood) are needed to understand when the phenotype stabilizes, which impacts the ability to estimate sex and population affinity of younger adults in the forensic sciences.

Objective
The objective of this research is to understand ontogenetic patterns of the cranium to inform development of biological profile models for subadults.

Methods
A sample of individuals aged between birth and 20 years (n=571) was drawn from the Subadult Virtual Anthropology Database (SVAD). Interlandmark distances (ILDs) were derived from computed tomography (CT) scans. The sample was assessed through life history stages (LHS): infancy, childhood, juvenile, adolescence, and adulthood. Univariate methods (multivariate adaptive regression splines) and multivariate methods (linear discriminant analysis) were used to analyze ILDs.

Results and Discussion
Univariate analyses identify growth trajectories across the neurocranium, basicranium, and splanchnocranium. Neurocranial size peaks in early childhood, while the basicranium stabilizes in infancy with a secondary growth peak during both juvenile and adolescent LHS, and splanchnocranial size stabilizes around puberty. The overall growth timing for males and females is comparable for all cranial regions prior to adolescence but diverges during that stage with the difference increasing in magnitude with age. There are negligible differences in the multivariate cranial complex in the adolescent LHS. When multivariate data is applied for sex estimation, the results have high accuracy (>85%) beginning in adolescence (12 years of age for females and 13 years of age for males).

Conclusion
Research on subadult cranial variation is restricted by small sample sizes. This impacts our ability to improve estimation of the subadult biological profile. Virtual anthropology repositories like SVAD provide an opportunity to examine subadult cranial growth patterns in more depth than previously possible. By better understanding growth trajectories and the timing of stabilization for both univariate craniometric variables as well as the cranial complex as a whole, forensic anthropologists can better mobilize these variables when estimating the subadult biological profile.

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