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A comparison of multifactorial statistical models for age-at-death estimation from the adult skeleton, tailored to a South African forensic context

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ABSTRACT

Age-at-death estimation from the skeleton is routinely completed as part of a forensic anthropological investigation. The changes in the appearance of the skeleton that are associated with age, are also influenced by various biological and lifestyle factors. The imperfect relationship between skeletal appearance (i.e., biological age) and chronological age makes age estimation difficult. Research to improve the results of age-at-death estimation includes more complex statistical analyses, combining multiple indicators from the skeleton into a single technique and reducing or accounting for confounding factors (e.g., population and sex). The aim of this study was to assess the accuracy and usability of various statistical models commonly used in age estimation, in a South African population. Approximately 330 skeletons of known individuals from the Raymond A Dart and Pretoria Bone Collections (South Africa) were used to gather population specific data related to age changes in the skeleton from 51 age-related components identified from literature. Components that contained the most age-related information (vertebral bodies, pubic symphysis and acetabulum) were combined into five multifactorial models (2 non-specific for sex, 1 for females, 2 for males). The first non-specific model combined information from the acetabular fossa, posterior median palatine suture, S1/S2, superior rim of L5. The second non-specific model combined information from the pubic symphysis, acetabular fossa, posterior iliac exostoses, zygomaticomaxillary suture and the superior rim of L5. The male model duplicated the second non-specific model but contained either information from the phase-based pubic symphysis or only the superior apex respectively. The female model duplicated the first non-specific model but substituted the pubic symphysis for the posterior median palatine suture. Three separate statistical methods - basic descriptive statistics, multiple linear regression and transition analysis - were used to combine the selected components. The accuracy and precision of the age estimates produced by each statistical method were tested using a hold-out sample (N = 30). Most of the age indicators used expressed low coefficients of determination (r^2-values = 30 - 50%). The coefficient of determination could be strengthened by a maximum of 10% by combining traits, but multicollinearity and sample size are concerns when creating multifactorial models. Age estimation results from the validation study indicate that statistical complexity does not necessarily improve accuracy. Also, precision for intervals produced by the transition analysis method was particularly large. More advanced statistical methods alone are not the solution to improve age-at-death estimation from the skeleton.