A25 The Use and Misuse of Transition Analysis: An Assessment of the Boldsen et al. Age-at-Death Estimation Method

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Learning Overview: The goal of this presentation is to increase awareness of the proper use of the Transition Analysis (TA) age-at-death estimation method and its associated software, as well as to present a large-scale assessment of the method's performance across the adult lifespan.[1]

Impact on the Forensic Science Community: This presentation will impact the forensic science community by making practitioners aware of some of the most common mistakes made in the application of the TA method and will equip individuals to make informed decisions about the selection of appropriate software parameters for use in forensic contexts.

TA is the only existing adult age-at-death estimation method capable of statistically combining information from features of the cranial sutures, pubic symphyses, and iliac auricular surfaces.[1] Using an associated free computer program, probabilistic age information for independently scored traits and their character states in each skeleton are combined to produce a maximum likelihood estimate of age. This estimate can then be statically adjusted based on prior information about the age structure of the population the individual likely came from. The final result is a probabilistically tailored maximum likelihood point estimate of age with a confidence interval for each individual based on the skeletal features present and the consistency of the age information provided by each trait. Although TA is not as widely used as many traditional methods for the pubic symphysis and auricular surface, it has become increasingly popular in recent years. Increased visibility at professional conferences and in peer-reviewed journals has revealed several common areas of confusion in both the interpretation of trait definitions and the analysis of data using the TA software. In addition to clarifying common points of confusion, this presentation uses a large sample of documented individuals to demonstrate the method's accuracy and precision in each decade of adulthood, discusses the effects of using sex- and ancestry-specific reference samples, and describes the impact of using the archaeological and forensic prior distributions.

A sample of 839 individuals (579 males and 260 females) from five documented skeletal collections—Athens, Maxwell Museum Donated, JCB Grant, UI-Stanford, and St. Bride's Crypt—was evaluated between 2014-2016. Age was estimated for each individual using the latest version of the TA software (ADBOU 2.1.046). Prior to analysis, the TA program requires the selection of sex (male, female) and ancestry (White, Black) categories, as well as the selection of a prior distribution (archaeological, forensic). Selecting unknown for sex, ancestry, or both, results in the use of combined reference sample data; however, the resulting changes in the accuracy and precision of age estimates have not previously been demonstrated. Thus, in this study, age was calculated for each individual using the appropriate sex- and ancestry-specific categories indicated by collection documentation, as well as each of these in combination with an unknown sex or unknown ancestry, respectively.

In addition to a uniform prior—one in which an individual of every age is equally likely to die—the TA program includes two informed priors: a "forensic" distribution based exclusively on homicide data compiled by the Centers for Disease Control and Prevention (CDC) and an "archaeological" distribution derived from 17th-century rural Danish parish records that represents normal human mortality. Although the forensic distribution should be used only in forensic cases where homicide is suspected, as a result of its name, this distribution is often indiscriminately applied to all forensic cases. Previously published work has demonstrated the differences between estimates produced using the uniform and archaeological priors are minor until late adulthood (80+ years); however, the effects of the forensic prior have not previously been explored. Therefore, in this study, each sex and ancestry combination was also evaluated using the uniform, forensic, and archaeological distributions to allow for a systematic evaluation of the changes produced in different portions of the adult lifespan.

These analyses demonstrate that use of the archaeological distribution appears to marginally improve accuracy with the uniform distribution. In contrast, inappropriate use of the forensic distribution greatly reduces accuracy, particularly in older age categories. Although the overall performance of TA falls short of what is needed for forensic applications, particularly between 45 and 75 years of age, it represents a substantial improvement over traditional techniques. The method generates individualized age estimates for all of adulthood and, when used correctly, produces relatively high accuracy relative to the precision of its intervals. Additionally, contrary to common expectation, the method produces estimates with similar accuracy, but with greater precision, for the oldest individuals (80+ years) than for individuals in middle age. This effect is seen despite the method's reliance on the cranium and pelvis. Thus, this investigation demonstrates that the transition analysis approach represents a promising avenue for the improvement of adult age estimation if additional features can be identified and integrated into the procedure.

This research was supported by a National Science Foundation Doctoral Dissertation Research Improvement Grant.

Reference(s):

1. Boldsen, J.L., Milner, G.R., Konigsberg, L.W., and Wood, J.W. Transition Analysis: A New Method for Estimating Age From Skeletons. In: Hoppa R.D., Vaupel, J.W., editors. *Paleodemography: Age distributions from skeletal samples.* Cambridge, UK: Cambridge University Press, 2002; 73-106.

Transition Analysis, Age Estimation, Biological Profile