A52 Age Estimation in Modern Individuals Between Birth and Fourteen Years of Age Using Measurements of the Knee Joint

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After attending this presentation, attendees will understand the growth and development of the knee joint and how it can aid in age estimation, as well as becoming familiar with the radiographic data bank, PATRICIA, and how it can be used in further growth and development research.

This presentation will impact the forensic science community by providing an alternative to other age-estimation methods. Additionally, this presentation will illustrate the importance of large-scale databases and their contribution in estimating the normal growth curve and in detecting secular changes.

Age estimation of the juvenile skeleton has primarily been dominated by dentition, as it is less likely to be subjected to environmental factors; however, in many circumstances, the dentition is not recovered, forcing anthropologists to use other areas of the skeleton for age estimates.[1] The ossification patterns and fusion timing of the knee joint can provide a wealth of information in regard to age, especially for individuals between birth and two years of age. Despite the abundance of information available from this region of the skeleton, especially through radiographic analysis, very little research has been published in regard to metric assessment. The purpose of this study is to provide a method of juvenile age estimation using metric analyses of radiographic images.

Nine measurements were taken on a sample of more than 1,000 radiographic images of modern children between the ages of birth and 14 years. Six ratios have a statistically significant relationship with age and were analyzed using linear regression. For example, tibial metaphyseal breadth and tibial epiphyseal breadth show two distinct linear trends, forming a clear "elbow" prior to data transformation, suggesting a well-defined lower bound just after birth that can be used to estimate post-birth age versus fetal age; however, most of the data required transformation to better model the relationship between chronological age and measurement ratios from the knee. Each of the six ratios were squared and cubed to be analyzed using linear regression. Moreover, all statistically significant linear regression models exhibit adjusted R^2 values that were 0.90 or greater, suggesting a strong relationship between chronological age and measurement ratios from the knee. All statistically significant linear regression models were also evaluated using 95% prediction intervals; however, due to the nature of the growth curves and the forensic questions being asked, the derived lower bounds appear to be more useful.

The data also suggest that the growth and shape changes of the proximal fibula are significantly less important than those changes seen in the distal femur and proximal tibia; however, appearance of the proximal fibular head epiphysis proved to be useful and was seen in individuals as young as 1.87 years of age.

In metrically evaluating knee development, outliers were detected which included individuals with Osteochondrosis (OCD) and Cornelia de Lange Syndrome, both of which delay skeletal development. These individuals were noted as lying significantly below the normal growth curve, suggesting that this type of data may also be useful in detecting child abuse in living individuals.

Other statistical methods, including Multivariate Adaptive Regression Splines (MARS) and Partial Least Squares provide estimates that better adjust for the multicollinear nature of the measurements. These techniques will more accurately model the post-birth growth spurts, while simultaneously accounting for the deceleration in growth following puberty.

This study illustrates the importance of not only large-scale, modern, reference data banks, but also of metric observations and modern statistical methods for estimating age of the juvenile skeleton.

Reference:

1. Cardoso H.F.V. Environmental effects on skeletal versus dental development: using a documented subadult skeletal sample to test a basic assumption in human osteological research. *American Journal of Physical Anthropology* 2007:132:223-233.

Growth and Development, Radiographic Data Bank, Knee Joint