## H53 Subadult Age-at-Death Estimation From Human Metatarsals

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The goal of this presentation is to inform attendees about new methods for estimating the age-at-death of human subadult remains using linear measurements taken on the developing metatarsals, as well as transition analysis from epiphyseal union of the metatarsal heads.

This presentation will impact the forensic science community by demonstrating two simple methods for estimating subadult age-at-death from the developing human metatarsals.

Accurate estimation of age-at-death from the human skeleton can be especially difficult in cases of fragmentary or incomplete remains. While developmental age estimates from subadults are generally both precise and accurate, they tend to rely on certain skeletal regions, which, when unavailable hamper the ability of the practitioner to generate an age estimate. There is currently no method for estimating the age-at-death of subadults from the growth (size) or development (epiphyseal fusion) of the metatarsal (MT) bones of the human foot. The fusion of the epiphyseal heads of MT2 - MT5 is said to occur during the mid-teens, while the fusion of the head of MT1 occurs much earlier (Scheuer and Black 2000 and references therein).[1] Previous research has demonstrated a strong association between metatarsal size and fetal age (Ayres de Vasconcellos and Ferreira) as well as metatarsal development and age in primates and hominins (Susman et al.).[2,3] The approach taken here is similar to that of Passalacqua (In Press) regarding subadult age estimation from the calcaneus.[4]

The present sample consists of 67 European American and African American males and females with ages ranging from 1-25 years from the Hamann-Todd Collection. Transition analysis using a cumulative probit model was conducted on the timing of epiphyseal union of the calcaneal epiphysis using Nphases2 (Konigsberg).[5] Fusion was scored as (1) *unfused* (no bony bridging); (2) *fusing* (presence of bony bridging between epiphysis and calcaneal body); or (3) *completely fused* (obliteration of epiphyseal line). This method allows for the mean age-of-transition from one phase to the next to be determined in addition to associated standard deviations using a maximum likelihood method (Boldsen et al. 2002; Langley-Shirley and Jantz 2010 and references therein).[6,7]

Results indicate that bony fusion of the metatarsal head epiphyses to the metatarsal bodies for MT2-5 (transition from score 1 to 2) occurs at 12.5 +/- 10.2 years and complete fusion (transition from score 2 to 3) occurs at 15 +/- 10.2 years (2S). The bony fusion of the metatarsal head epiphysis for MT1 occurs much younger at 2.5 and 5 +/- 4.6 years (2S); however the posterior epiphysis for MT1 fuses at similar ages to the metatarsal heads of MT 2-5. The wide standard deviations for the ages of fusion for the metatarsal heads for MTs 2-5 are likely a factor of limited sample sizes for teen individuals in the present sample.

In addition, maximum length for each of the metatarsals was collected from a sub-sample of individuals where the metatarsal heads were not completely fused. In order to determine if there are any significant differences in bone growth/size related to sex or ancestry, an ANCOVA was performed. No significant differences (*p-value* < 0.05) were found for sex or ancestry, and all individuals were pooled into a single sample (n=33). Because the subadult metatarsals may not be distinguishable in younger individuals, especially in the context of incomplete sets of remains, the lengths of MTs 2-4 were pooled and averaged to create a more applicable method.

Linear regressions against age (in yrs) resulted in $r^2$ values of 0.92 for MT1, 0.90 for pooled MTs 2-4, and 0.88 for MT5 all with standard errors of the estimate lower than 1.8 years.

Results demonstrate that the linear regression models fit the data well and allow for age estimates with narrow standard errors. Additionally, transition analysis results for the fusion of the MT heads roughly correspond to age ranges cited in Scheuer and Black (2000) though it should be noted that Langley-Shirley and Jantz (2010) have demonstrated shifts in age-of-fusion of the medial clavicle due to secular changes.[1,7] The Hamann-Todd Collection (utilized here) is no longer contemporary and secular changes in the timing of epiphyseal fusion may be present, necessitating further research on a contemporary sample before widespread forensic application can be recommended.

**References:**

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**Metatarsals, Subadults, Age-at-Death Estimation**