H65 Using Growth Data to Understand Secular Trends in Femur Diaphyseal Size and Shape among American Adults

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The goal of this presentation is to demonstrate the secular changes in femur size and shape that have occurred among Americans born in the 1840s to the 1980s. The relationship between size and shape variables during growth will then be used to explain the likely proximate causes for the observed secular changes. Attendees will learn how stature, body build, and physical activity interact during life to establish adult femur morphology, and will also gain an appreciation of the impact that femur secular changes can have on the interpretation of modern forensic cases.

This presentation will impact the forensic community and/or humanity by demonstrating demonstrating that femur morphology is constantly changing and that methods for estimating sex from the femur, ancestry, and stature, most of which are derived from nineteenth century skeletal collections, must be constantly reassessed and renewed.

Secular changes in skeletal morphology have the potential to impact the validity of methods used by forensic anthropologists for developing an accurate biological profile. From the 1840s to 1980s, the femur has undergone significant secular changes among American Blacks and Whites. In general, the femur has increased in length, decreased in robusticity, and the midshaft diaphyseal shape has changed from relatively circular to anteroposteriorly (AP) elongated due to a decrease in the mediolateral (ML) dimension. Interestingly, femur head diameter, midshaft AP diameter, and subtrochanteric shape have not changed significantly during this time. Increases in femur length are most likely due to dietary and healthcare improvements, but secular changes in diaphyseal size and shape are usually thought to be associated with decreases in physical activity levels, especially terrestrial mobility, through time. However, the patterns of change in diaphyseal morphology, especially midshaft shape, do not correspond to those expected based on a decrease in terrestrial mobility alone. A biomechanical model would predict that a simple decrease in activity levels should result in the femur diaphysis becoming smaller through time but retaining a relatively circular midshaft shape.

Secular changes in femur morphology are demonstrated using measurements from 962 American adults with birthdates ranging from the 1840s to 1980s. To investigate the proximate causes for the secular change among American adults, patterns of change in femur diaphyseal shape, AP and ML diaphyseal dimensions, head diameter, and length during growth were examined using a sample of 64 subadults (birth to 18 years of age). No significant sex differences in the patterns of growth were observed, so subadult males and females were pooled. Regression analysis was used to examine the correlations and partial correlations between variables during growth.

The results show that subtrochanteric shape does not change significantly ($r^2 = 0.0001$, $p = 0.9271$) after a mature gait pattern is established at around 5 years of age. Femur midshaft shape, on the other hand, changes significantly with age throughout the growth process ($r^2 = 0.3983$, $p < 0.0001$). During growth, both femur midshaft dimensions (AP and ML) show a significant positive correlation with growth in length and head diameter. The squared correlation between midshaft AP diameter and length is 0.8064 ($p < 0.0001$) and the r^2 for midshaft ML diameter and length is 0.6978 ($p < 0.0001$). The relationship (r^2) between femur head diameter and midshaft AP and ML dimensions is 0.7772 ($p < 0.0001$) and 0.7687 ($p < 0.0001$), respectively. However, after controlling for growth in length, head diameter does not significantly ($p = 0.1038$) contribute to the variation in AP diameter. Conversely, growth in length does not make a unique contribution to the ML diameter ($p = 0.6529$) above that shared by head diameter.

These results suggest that changes in the midshaft AP diameter during growth are primarily associated with changes in femur length (i.e., stature) and changes in the ML dimension are mainly related to femur head diameter, which reflects body build. The non-significant secular change in the midshaft AP dimension among adults is most likely due to increases in femur length counteracting the changes expected due to decreases in activity levels. The significant negative secular change in midshaft ML diameter, on the other hand, reflects a decrease in activity combined with the retention of a relatively constant body build over the past 140 years. Thus, changes in the ML dimension are more indicative of the level of mechanical loading of the femur in modern Americans. In general, the femur morphology of modern Americans reflects the combination of changes in stature, body build, and activity level that have taken place over the past one and a half centuries. Since most methods for estimating sex, ancestry, and stature from the femur are based on nineteenth century skeletal collections, it is crucial that forensic anthropologists understand how these secular changes may affect

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the interpretation of today's forensic cases.

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