Y1 A Bone Elemental Age-at-Death Estimation of Deceased Adult Females: A Pilot Study

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Learning Overview: After attending this presentation, attendees will have a better understanding of bone elemental analysis using a scanning electron microscope with energy dispersive X-rays.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by offering data on Calcium/Phosphorus (Ca/P) ratios in adult females as a potential alternative to the common age-at-death estimation method.

In forensic anthropology, common age-at-death estimation methods rely on macromorphology of the skeleton, such as dental development and long bone length for juvenile individuals and teeth or bone wear for adult individuals. Biological and environmental factors such as health, biomechanical stress, socioeconomic status, and sex are factors among others that can affect bone aging and the appearance of wear in adult individuals. To mitigate these biological variations between individuals, common macromorphological methods provide a wide range of estimated age at death that can span 15–20 years or more for the elderly population. Developing a more precise age-at-death estimation method could help reduce those age ranges in adult individuals and provide a more precise biological profile to better support death investigations.

Studies showed that in healthy individuals, the inorganic osseous component consists primarily of Ca and P with a high molar ratio during fetal development and skeletal growth that gradually declines to a plateau at a ratio of 1.67 when reaching skeletal maturity.[1] It was hypothesized that natural aging processes impact levels of sex hormones, causing osseous Ca levels to decrease and Ca/P ratios to decline in the elderly population.[2] A pilot study on nine adult males demonstrated a linear relationship between declining Ca/P ratios and age at death at the midshaft of the femur.[3]

To control for sexual variation in bone aging and provide missing data on Ca/P ratios, the present pilot study investigated Ca/P ratios in relation to age at death of 16 adult females aged 49 to 101 years. The data collection was conducted blind to age at death, controlling against individuals with known osteoporosis or bone cancer diagnosis. Medallions were harvested from the femoral midshaft on adult females previously preserved for medical teaching purposes. The femoral cross-section was observed and analyzed using a scanning electron microscope with an energy dispersive X-rays. Ten fields of view of secondary osteons per individual were selected and analyzed elementally using backscatter electrons. The Ca/P ratios were calculated for each field of view, which was then averaged per individuals. The resulting 16 averaged Ca/P ratios were analyzed in relation to known age at death, with and without outliers, to identify possible disparities that could be due to biological variations within and between individuals.

The results of this pilot study were inconclusive; another study with a larger sample size of individuals representing all adult age categories for both male and females is necessary before evaluating if Ca/P ratio is a viable alternative method for age-at-death estimation in adult individuals.

Reference(s):

1. Hancock R., Grynpas M., Alpert B. 1987. Are archaeological bones similar to modern bones? An INAA assessment. *Journal of Radioanalytical and Nuclear Chemistry*. 110(1), 283-291.
2. Almeida M., Laurent M.R., Dubois V., Claessens F., O'Brien C.A., Bouillon R., Vanderschueren D., Manolagas S.C. 2017. Estrogens and androgens in skeletal physiology and pathophysiology. *Physiological reviews* 97(1): 135-187.
3. Clayton M. 2016. *Estimating age-at-death in bone—Elemental analysis of the calcium-to- phosphorus ratio.* Unpublished Master Research Paper, University of Toronto: Toronto

Age-at-Death Estimation, Elemental Analysis, Calcium/Phosphorus Ratio

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