# DETERMINING 'AGE AT DEATH': A NEW MULTIDISCIPLINARY LABORATORY METHOD BASED ON RIBS

**Andrea Bonicelli (1), Peter Zioupos (2), Bledar Xhemali (3), Elena F Kranioti (1)**

*1. Edinburgh Unit for Forensic Anthropology, Edinburgh Univ, UK; 2. Cranfield Forensic Institute, Cranfield Univ, Defence Academy of the UK; 3. Dept of Forensic Medicine, Tirana, Albania.*

## Introduction

Age estimation remains one of the most challenging tasks for forensic practitioners when establishing a biological profile of unknown skeletonised remains. Morphological methods [1] based on developmental markers of bones can provide accurate age estimates; yet, these become highly unreliable for ages over 35 when all developmental markers disappear. Current methods are also highly population and sex specific and individual differences must be considered when interpreting the results. Aspartic acid racemisation [2], Carbon dating [3] and DNA methylation [4] have all shown to be accurate to no better than +/- 5 years. A recent method using quantification of biomechanical properties in conjunction with bone microstructure for the mid-femur cortical bone has shown potential and more accurate results [5]. In the present study we use bone from the 4$^{th}$ rib of two cohorts. The physical characteristics of ribs are less influenced by mechanical stress compared to the femur throughout life and ribs are convenient to access from the thoracic cage during autopsy which would increase the applicability of any such rib-based method.

## Methods

This study used autopsy material (N=24) from two forensic departments in Albania and Greece. The sample was divided into two sets of twelve 4th ribs each. A set of 28 parameters were measured by standard bio-mechanical (nanoindentation), physical (DSc, Helium Pycnometer) and histomorphometry (porosity-ImageJ, in-vivo cracks #) methods.

## Results

Stepwise regressions were used to find those equations that would produce the best 'estimates of age at death' vs real age of the cadavers. Six equations were produced: In the best of cases an equation containing 7 parameters had an $R^2$=0.97 (Figure 1); the worst performing equation utilized just 2 parameters (cortical porosity/ImageJ & density Pycnometer) with $R^2$=0.80 and an average error estimate 4.49±0.34 (SD) yrs.

## Conclusions

This study explores well-known changes in the biomechanical properties of bone tissue and matrix, which continue to change with age even after skeletal maturity, and their potential value for age estimation.

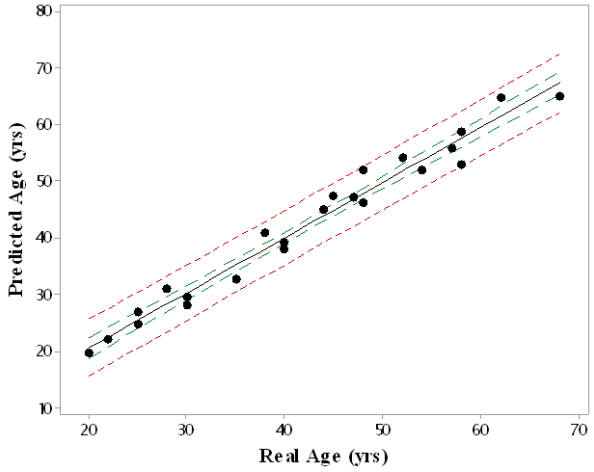


*Figure 1: Predictive equation of 'age at death' a function of = f(nano, DSc, Por, #) $R^2$=0.97, maximum error estimate 2.7yrs, average error = 1.78±0.68 (SD)*

As a proof of concept we investigated the relationship of 28 variables at the macroscopic and microscopic level in an autopsy sample of 24 ribs. Stepwise regression analysis produced an equation with $R^2$=0.972 and a standard error of 1.78 yrs ±0.68 (SD). This method outstripped all existing age-at-death methods based on ribs thus providing a novel accurate tool in the forensic investigation of human remains.

## References

1. Garvin, HM & Passalacqua, *J. Forensic Sci.* 57, 427-33; 2012.
2. Griffin RC, *et al. Forensic Sci. Int.* 175, 11–16; 2008.
3. Villa C & Lynnerup N. *Res. Rep. Forensic Med. Sci.* 4, 3-9; 2015.
4. Xu C. *et al. Scientific Rep.* 5, 17788; 2015.
5. Zioupos P, *et al. J. Mech. Behav. Biomed. Mater.* 33, 109-123; 2014.

## Acknowledgements

We thank Professor Manolis Michalodimitrakis for providing permission for the Greek samples, Dr Despoina Nathena and Mr. Stratos Kougios for collecting the samples and providing the demographic information and the Ethical Committee of the University Hospital in Heraklion, Crete (Protocol No. 530), Greece and Mr. Kostaq Beluri, Head of Control Department Investigation and Prosecution of the General Prosecutor, Ministry of Justice, Tirana, Albania for granting permission for this project (Protocol No. 1797/3 A. Xh. Protocol No. 795).

# Determining ‘Age at Death’: A new multidisciplinary laboratory method based on ribs

Bonicelli, A.

2016-07-10