H36 The Effects of Body Mass Index on Cremation Weight

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The goal of this presentation is to determine the relationship between cremains weight and perimortem body mass index (BMI) in a multi-regional United States sample. Additional contributing factors, sex, and age-at-death, are examined for their effect on cremains weight.

This presentation will impact the forensic community by demonstrating the utility of cremains weight in the estimation of age and sex. Furthermore, cremains weight may be used to validate their association with an individual whose body mass index may be calculated from known stature- and weight- at-death.

Cremation has become an increasingly popular funerary practice. Through this process bone is incinerated and mechanically reduced into particles comparable to sand or silt, ultimately removing most diagnostic features. Cremation is occurring with greater incidence in forensic contexts, presenting new challenges to forensic anthropologists in issues of evidence destruction, unethical disposal of remains, or disputed identity.

Most research on burning and charring of skeletal material takes the form of controlled experimentation and case studies. A small body of research has amassed on the physical properties of cremains. Previous research includes that of Warren and Maples (1997) sourced from Central Florida, and that of Bass and Jantz (2004), using samples from the Eastern Tennessee area. These studies investigated cremation weight and the rela- tionship with individual sex and age-at death. Both established a few general principles: cremains are derived almost exclusively from osseous material, and the heavier average weight of male versus female samples. In Bass and Jantz' sample of 306 individuals, the male average outweighed female average by approximately 500g; while Warren and Maples' male average was heavier by nearly 600g. In both studies, age-at death produced an expected negative correlation with advanced age.

Although results are comparable, geographic variation exists. A third study comparing regional cremation weights by Van Deest (2007) introduced a sample of cremations from California. Results for sex and age correlations were consistent with the previous studies. Notably, the Tennessee sample was consistently heavier across both variables of age and sex; a result Bass and Jantz attributed to higher incidence of obesity in Tennessee, inducing higher bone mass.

The present study addresses this issue, investigating the relationship between body composition and cremation weight. Body mass index (BMI) was adopted by the World Health Organization (WHO) in 1995 as the standard measurement of body fat in both health and epidemiological studies. Several difficulties surrounding BMI's predictive value exist, including the inability to distinguish between subcutaneous adiposity verses lean mass. However, for the purposes of this study BMI remains the only available method.

To obtain a sufficient sample size, data was combined from Warren and Maples (1997) anthropometry research, the William M. Bass Skeletal Collection of Knoxville, Tennessee, and the University of Tennessee-Chattanooga Donated Collection. All cremains were rendered through a commercial crematorium; amputees, bone donors, and skeletally immature samples were excluded from analysis. Total sample size contains 99 cremations, consisting of 61males and 38 females.

For each sample, body mass index (BMI) was calculated as weight divided by height squared: $(kg)/(m)^2$. WHO designates three levels of BMI: 18.5 to 24.99 "normal", 25.00 to 29.99 "overweight", and 30.00 marks the threshold of obesity. Individuals of unknown perimortem stature or weight were also eliminated, for inability to calculate BMI. The relationship between BMI and cremation weight was assessed using a correlation coef- ficient and multiple linear regression, using SAS 9.3.1 and NCSS 3.0 statistical software.

Pearson's Correlation Coefficient Test demonstrates a clear association between BMI and cremation weight ($r = 0.56$; $R^2 = 0.32$; $p = <0.0001$). However, multiple linear regression reveals that additional factors, sex and age have a significant association ($t = 7.198$; $t = -2.5$ respectively). When BMI, sex, and age are regressed in conjunction, they contribute approxi- mately 67% of all variation observed in cremation weight ($R^2 = .668$). Explanations include bone modification resulting from increased loading-stress, as well as glucose-intolerance and altered metabolic pathways related to obesity.

References:

1 Warren MW, and Maples MA. The anthropometry of contemporary commercial cremation. *Journal of Forensic Science* 1997; 42:417-423.

2 Bass WM, Jantz RL. Cremation weights in East Tennessee. *Journal of Forensic Science* 2002; 49:1-4.

Forensic Anthropology, Cremation, Body Mass Index (BMI)

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