

# An Evaluation of Preservation, Sex, and Age using Cremains Weight and Volume from a Bronze Age Cemetery in Hungary

**Overview:** Determining demographic information using classical anthropological methods such as examining morphological and metric traits is often difficult or impossible with cremated human bones (cremains) due to fragmentation and incomplete burials. Fragmentation can be caused by multiple factors that affect cremains' characteristics during life, just after death, and in the burial environment (Cerezo-Román 2014). In this study, cremains from Békés 103, a Bronze Age site located in southeastern Hungary, were analyzed using measurements of total cremains weight and volume. The weight and volume were analyzed with respect to preservation level of the burial, sex of the individual(s), and age at death of the individual(s) to determine whether the technique of weight and volume measurement can provide insight into taphonomic and demographic characteristics of the population when traditional morphological information is limited.

Previous authors have stated that preservation level alone cannot explain variation in bone weights (Gonçalves et al. 2015). For example, in studies of contemporary populations, the correlation between biological sex differences and cremated bone weight has been explored (e.g., Bass and Jantz 2004, Gonçalves 2013, Van Deest 2011). Determining sex differences based on bone weight has had limited success in archaeological assemblages (Cerezo-Román 2014, Clough 2006, Harvig and Lynnerup 2013, Reinhard 1978, and Ubelaker 2007); however, bioarchaeologists have successfully used the measures of weight and volume to assess skeleton completeness, number of individuals in a burial, and degree of fragmentation (Gonçalves 2016). Figure 1 shows adult cremains weights of archaeological samples including Békés 103, as well as a reference of modern American cremains weights reported by Bass and Jantz (2004).

**Results:** Based on analysis of Spearman rank order correlations, results show that weight and preservation were well-correlated, and that well-preserved burials had significantly higher weights than poorly preserved burials (Spearman's  $\rho = .581$ ,  $n = 60$ ,  $p < .01$ ). The same pattern was true for volume and preservation level as well (Spearman's  $\rho = .567$ ,  $n = 60$ ,  $p < .01$ ) (see Figure 2). Upon analysis of age at death, we found that subadults have lower weights and volumes than adults (Figure 3). Weight was well-correlated with age (Spearman's  $\rho = .727$ ,  $n = 57$ ,  $p < .01$ ), as was volume with age (Spearman's  $\rho = .713$ ,  $n = 57$ ,  $p < .01$ ). Analyzing weight and volume with respect to sex yielded no discernable pattern, perhaps because of small sample size, with only 4 confirmed male individuals and 10 confirmed females.

**Discussion and Conclusions:** At Békés 103 we found that the weight and volume of adult cremains in well preserved contexts are statistically distinct from poorly preserved contexts. This indicates that observable taphonomic processes such as modern plowing practices have significantly affected the preservation of the sample, and that poorly preserved burials should not be used for further analysis using weight and volume. While sex is not clearly correlated with weight or volume, age at death is. This indicates that bone weight and volume may provide insights as to whether an individual was an adult or subadult when morphological characteristics are lacking.

When we compare data from Békés 103 to regional archaeological samples from Csanytelek Palé (Bronze Age) and Ludas-Varjú dűlő (Iron Age), some interesting patterns emerge (Szalai 1995, Tankó and Tankó 2012) (Figure 4). The cremains from Békés 103 had similar weight distributions for adults and subadults to those of Csanytelek-Palé. These cemeteries are associated with different archaeological traditions (Gyulavarsánd and Vatyá, respectively) but overlapped in time frame. It is possible that similar cremation practices or taphonomic processes resulted in this pattern. However, the Iron Age cremains weights are consistently lower than the Bronze Age samples. Tankó and Tankó (2012) suggest that cultural processes (such the use of communal pyres and partial collection of remains from the pyre) may explain these low bone weights.

We explored the relationship between weight and volume at Békés 103, as well as at Csanytelek-Palé. This ratio, called the Fragmentation Index, has been used by Harvig and Lynnerup (2013) to evaluate overall fragmentation of the bones (i.e., higher volume/weight reflects less fragmentation, and lower volume/weight reflects increased fragmentation). In the case of Békés 103, both weight and volume are strongly correlated (Spearman's  $\rho = 0.975$ ,  $n = 63$ ,  $p < 0.01$ , all burials included). Burials with higher and lower volume relative to weight were not associated with other burial characteristics (e.g., sex, age).

## Comparison of Modern and Archaeological Cremains Weights

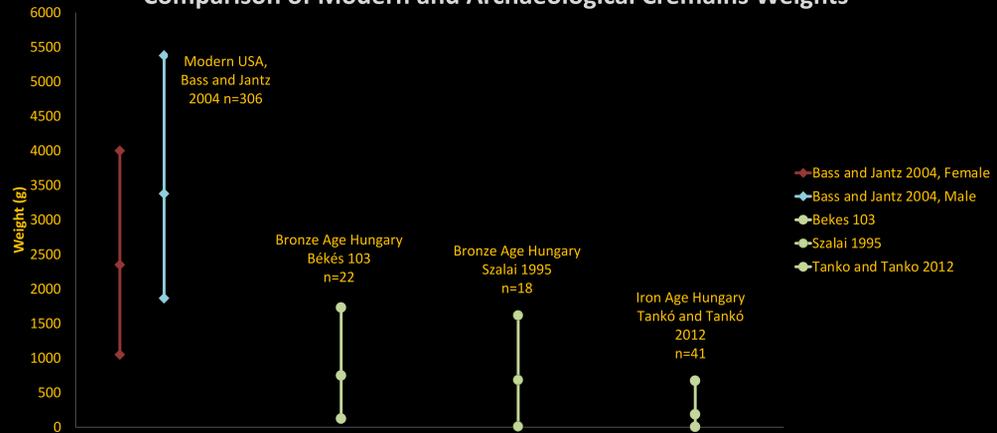


Figure 1. A comparison of minimum, mean, and maximum modern and archaeological cremains weights. Only adults are included.

## Preservation Categorization by Weight and Volume (Adults)

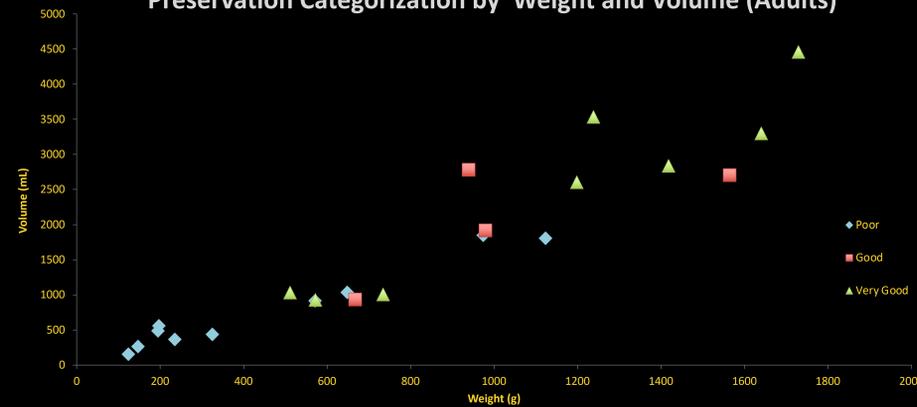


Figure 2. Weight and Volume of cremains from Békés 103, color coded by preservation level. Only adult burials are included.



## Age Categorization by Weight and Volume

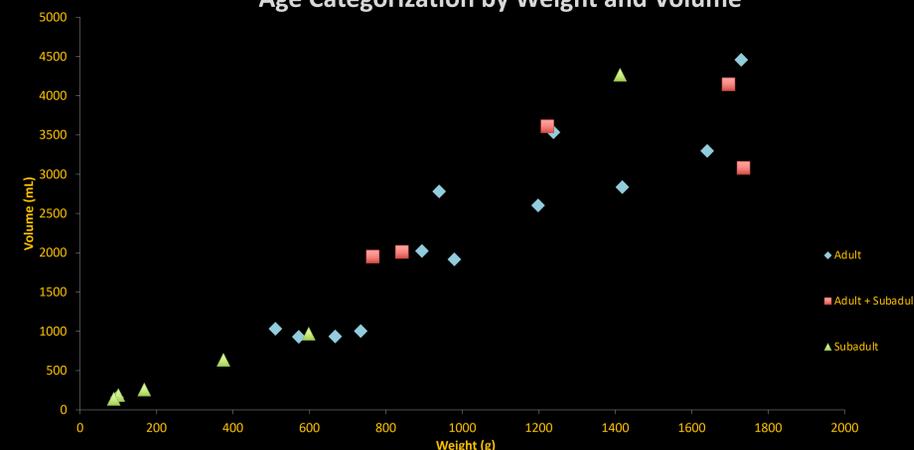


Figure 3. Age categorizations of burials with good and very good preservation only. Indeterminate age individuals have not been included.

## Regional Comparisons

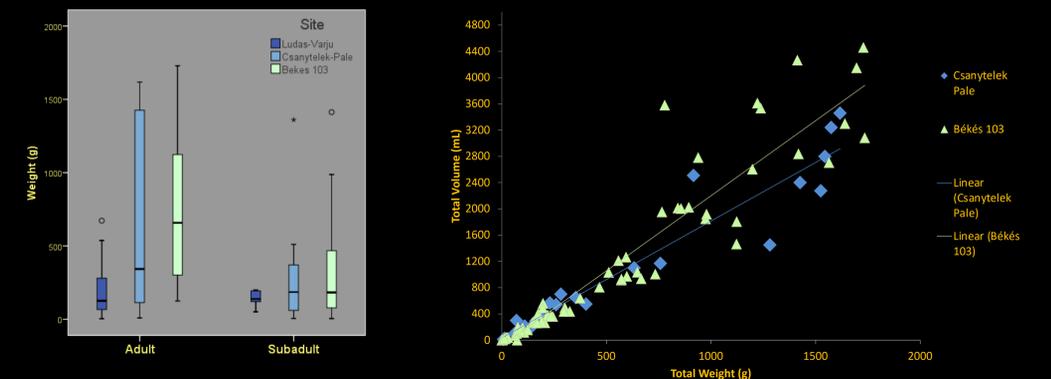


Figure 4. A boxplot comparison of adult and subadult cremains weights from Bronze Age and Iron Age sites, showing outliers.

Figure 5. A comparison of Fragmentation Index between Békés 103 and Csanytelek-Palé.

Interestingly, at the Csanytelek-Palé site, weight and volume are even more strongly correlated than Békés 103, showing that there is variation in the relationship between weight and volume between sites (Figure 5).

In conclusion, this study illustrates that the measurement of weight and volume is a simple and valuable technique for evaluating the impact of taphonomy, identifying demographic characteristics of the population (specifically age), and distinguishing different mortuary customs between sites and over time. There are several Bronze Age groups in the Carpathian Basin which either exclusively or occasionally used cremation as a funerary rite, such as the Füzesabony, Vatyá, and Encrusted Ware traditions (Sørensen and Rebay-Salisbury 2008). In weighing and measuring bone volume for the cremated burials at Békés 103 we hope to establish a comparative database to describe how lifestyle, cultural practices, and taphonomy may be differentially (or similarly) affecting cremated bone throughout the region.

## Acknowledgements:

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