



A2 Systematic Bias in Estimating Body Mass of Korean Samples With the Morphometric Method of Ruff et al. (2005)

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After attending this presentation, attendees will appreciate the magnitude and cause of systematic bias in applying Ruff et al.'s morphometric method for body mass estimation to Asian samples, particularly to Korean samples.¹ Attendees will therefore be aware of the necessity of applying an adjustment factor that compensates for the bias prior to using this method for Asian populations.

This presentation will impact the forensic science community by quantifying potential errors associated with application of Ruff et al.'s morphometric method to Asian samples, and this research provides a theoretical basis for the bias.¹

The morphometric method by Ruff *et al.*, a widely used body mass estimation method, is based on the cylindrical model.¹ The cylindrical model states that given specific density, the weight of a cylinder can be calculated from its height and breadth. For the morphometric method to have global applicability, the body composition of people (i.e., density of a cylinder) must be constant across populations; however, body composition differs between populations, particularly between Asians and non-Asians. It has been reported that the body fat percentage (BF%) of Asians is higher than of non-Asians with the same Body Mass Index (BMI) by 3%-5% points. Despite this difference, validation tests for this method have rarely been performed. In this research, the degree of potential bias was quantified when this method was applied to one population in Asia, Korean skeletal remains.

The body mass of 59 complete Korean male skeletons was morphometrically reconstructed using Ruff *et al.*, on which a regression equation was generated with the femoral head diameter.¹ Then, this new equation was applied to 54 Korean War casualties, whose estimated body mass was compared to the reported body mass of the Korean conscripts during the Korean War.² Although the 54 casualties were not identical to the individuals used in Park *et al.*, no significant discrepancy in body mass was anticipated between them since these individuals shared a similar background (i.e., Korean male conscripts in their early 20s during the Korean War).²

The results of the one-sample *t*-test showed that the estimated body mass from the 54 individuals (61.3kg) was significantly higher than the reported body mass (56.8kg) by 4.5kg ($t=7.383$, $p<0.001$).

In the cylindrical model, the weights of two cylinders with the same volume (i.e., same height and breadth) but different density cannot be identical. Due to a relatively higher percentage of fat in Asian populations, Asian and non-Asian individuals of the same shape (i.e., same stature and body breadth) do not have the same weights. In this case, the non-Asians will be heavier than the Asians, because muscle is denser than fat. In addition, the morphometric method of Ruff *et al.* was mostly based on non-Asian samples with only one Asian population, Japanese, included.¹ Therefore, the morphometric method devised from the non-Asian samples tends to produce overestimated body mass for Asian individuals. In fact, when this method was applied to the referenced Japanese sample using the given stature and bi-iliac breadth data in Ruff *et al.*, the Japanese body mass was also overestimated by 6.2kg and 4.7kg for females and males, respectively.³

In applying the Ruff *et al.*'s morphometric method to Asian populations, it is recommended that one be aware of the potential magnitude of bias associated with the method through a validity test and, if available, use an adjustment factor.¹

Reference(s):

1. Ruff C., Niskanen M., Junno J.A., Jamison P. Body mass prediction from stature and bi-iliac breadth in two high latitude populations, with application to earlier higher latitude humans. *J Hum Evol* 2005;48(4):381-392.
2. Park T., Choung H., Lee M., Chang S. Anthropological studies on the Korean: I. Pro-standard of the length, weight and girth of the chest of recruit. *Med* 1953;1:107-112
3. Ruff C. Morphological adaptation to climate in modern and fossil hominids. *Yearb Phys Anthropol* 1994;37:65-107.

Body Mass Estimation, Morphometric Method, Korean Skeletal Remains