Comparison of three body composition models in trained and sedentary males

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The hydrodensitometric two compartment body composition model separates the body into the fat mass (FM) and fat free mass (FFM) which are assumed to have densities of 0.9007 and 1.1000 $g.cm^{-3}$, respectively. Hence, the percent body fat (%BF) can be estimated from body density (BD) which is measured via underwater weighing (UWW). However, variability in the proportions of the four FFM components (water; protein; bone mineral; non-bone mineral) can result in a deviation from the assumed density of 1.1000 $g.cm^{-3}$ which is based on analyses of only three male cadavers (1). The three (FM; total body water or TBW; fat free dry solid) and four compartment (FM; TBW; bone mineral or BM; residual) models in part account for variations in FFM density by incorporating measured values for TBW and BM in their estimates of %BF. The aim of this study was therefore to compare %BF estimates via two, three and four compartment body composition models in trained (TM) and sedentary males (SM). Twelve middle distance runners (X ± SD: 22.3 ± 5.1 yr; 175.2 ± 5.7 cm; 67.87 ± 5.30 kg) and 12 sedentary males (X ± SD: 24.7 ± 4.5 yr; 178.1 ± 8.5 cm; 73.33 ± 9.70 kg) were accordingly measured for BD, TBW and BM via UWW, deuterium dilution and DXA, respectively. The results (X ± SD) are summarised below:

Models	Two compartment		Three compartment		Four compartment	
Group	TM	SM	TM	SM	TM	SM
%BF	9.8 ± 3.6	19.5 ± 8.3	12.0 ± 2.8	21.7 ± 8.1	12.1 ± 2.8	21.8 ± 8.2
FFM (kg)	61.17 ± 4.67	58.59 ± 6.39	59.73 ± 4.66	56.96 ± 6.22	59.65 ± 4.60	56.92 ± 6.24

While greater validity should be associated with the measurement of more compartments, individual differences between the two and three compartment models for both groups (X ± SD; TM: 2.15 ± 1.88 %BF; SM: 2.25 ± 1.28 %BF) were significant (TM: $P \leq 0.002$; SM: $P \leq 0.000$) while those between the three and four compartment models (X ± SD; TM: 0.12 ± 0.25 %BF, SM: 0.04 ± 0.23 %BF) were not. The higher %BF for the three compartment model compared to the two compartment one is because the mean FFM hydration for both groups (X ± SD; TM: 72.45 ± 1.29%; SM: 72.20 ± 0.97%) was less than the hydrodensitometric assumption of 73.7% that was derived from cadaver analyses (1). Lower FFM hydrations would increase BD and result in a lower estimation of %BF via hydrodensitometry. The additional incorporation of BM to generate a four compartment model impacted little on the %BF estimates because the BM fraction of the FFM (X ± SD; TM: 5.67 ± 0.44%; SM: 5.69 ± 0.29%) differed little from that of 5.63% for the three cadavers (1) and our data were very homogeneous for this variable which comprises a much smaller percentage of the FFM than water. Our data on TM and SM therefore suggest that: (i) the three compartment model is more accurate than the two compartment hydrodensitometry one because it controls for biological variability in TBW; (ii) the four compartment model, which controls for inter-individual variability in both TBW and BM, achieves negligible extra accuracy compared with the three compartment model.

1. Brozek J, Grande F, Anderson JT, Keys A. Densitometric analysis of body composition: revision of some quantitative assumptions. Ann NY Acad Sci 1963;110:113-40.