

# Accessible Five Compartment Body Composition via 3-Dimensional Imaging and Bioelectrical Impedance

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## Background

- In vivo body composition methods are subject to technical errors that limit accuracy and precision [1]
- Five compartment (5C) models reduce assumptions by measuring specific components via multiple techniques [2]
- MC measures are time consuming, prohibiting field use for body fat and hydration assessments
- Objective:** To examine the accuracy and precision of a simplified 5-compartment model (3DO-5C) of body composition using 3-dimensional optical imaging (3DO) and bioelectrical impedance analysis (BIA)

## Methods

- Student/club-sport athletes were recruited from the University of Hawaii for the Dakine Study and had duplicate measures performed for each testing method
- Criterion 5C (Wang-5C) measures include deuterium dilution (D2O) for total body water (TBW) and soft mineral (Ms), dual energy x-ray absorptiometry (DXA, Hologic Discovery/A) for osseous mineral (Mo), air displacement plethysmography (ADP) for body volume (BV), and body mass (BM) [3]:

$$\text{Equation 1. Wang 5C Fat Mass (kg)} = 2.748 * BV - 0.715 * TBW + 1.129 * Mo + 1.222 * Ms - 2.051 * BM$$

- 3DO (Fit3d) and BIA (InBody S10) were calibrated for the 3DO-5C model using the following equations:

$$\text{Equation 2. } BV(L) = 1.81959 + .99470 * 3DO$$

$$\text{Equation 3. } TBW(L) = 2.99328 + .92087 * BIA$$

- BMC was estimated using a combination of 3DO and demographic data:

$$\text{Equation 4. } BMC(kg) = - 3.270 + 0.00284 * \text{left thigh girth} + 0.0178 * \text{right wrist girth 20cm} - 0.00697 * \text{right wrist girth 40cm} + 0.0114 * \text{height}$$

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## “Simplified multicompartment models provide a feasible body composition assessment and tracking tool in the field”

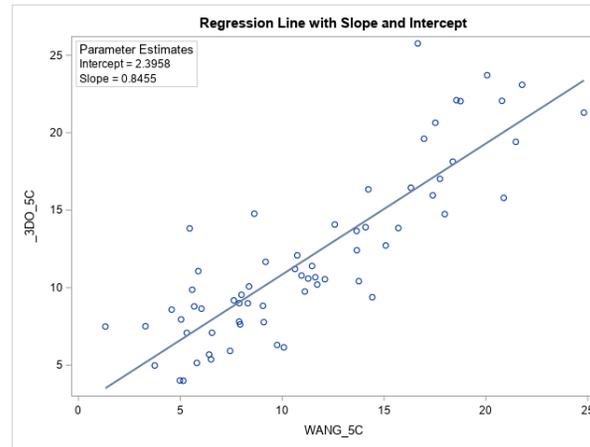


Figure 1. Accuracy of fat mass measured by Wang-5C and 3DO-5C



Figure 2. L to R: Fit3D (3DO) and BIA (InBody S10)

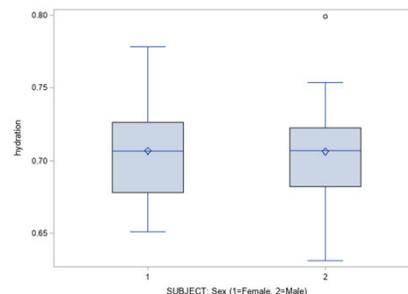


Figure 3. No significant differences in hydration were observed between genders

## Results

- 65 participants were used in the final analysis; data reported in Table 1.

Table 1: Participant demographics

	Males (n = 35)	Females (n = 30)
Age (years)	24.4 ± 5.0	21.9 ± 3.9
Height (cm)	181.2 ± 10.1	168.6 ± 8.7
Weight (kg)	82.4 ± 10.5	63.9 ± 10.6
BMI (kg/m <sup>2</sup> )	25.1 ± 3.0	22.4 ± 3.0

- Compared to the criterion Wang-5C, 3DO-5C showed an accurate assessment of fat mass (slope = .85  $r^2 = .74$ , RMSE = 2.8 kg)
- Precision for fat mass RMSE (%CV) was 3.0 kg (10 %) for 3DO-5C, .23 kg (5 %) for Wang-5C
- Average 3DO-5C hydration of lean body mass was 70.6% ± 3.2%, similar to values reported in hydration studies [4]. Precision was .09 %.

## Conclusion

- 3DO-5C offers an accurate and accessible way to measure fat mass independent of hydration status. Further research is warranted to improve the precision of this model for monitoring change accurately.
- The 3DO-5C model provides a feasible and accessible method for body composition assessment. In addition, multiple within-day measurements allow for better mean measures for monitoring intraday hydration changes in sports.

## References

- Ward, L.C., *Human body composition: yesterday, today, and tomorrow*. European Journal of Clinical Nutrition, 2018. 72(9): p. 1201-1207.
- Withers, R.T., et al., *Comparisons of two-, three-, and four-compartment models of body composition analysis in men and women*. Journal of Applied Physiology, 1998. 85(1): p. 238-245.
- Wang, Z., et al., *Multicomponent methods: evaluation of new and traditional soft tissue mineral models by in vivo neutron activation analysis*. The American Journal of Clinical Nutrition, 2002. 76(5): p. 968-974.
- Wang, Z., P. Deurenberg, and S.B. Heymsfield, *Cellular-level body composition model: a new approach to studying fat-free mass hydration*. Annals of the New York Academy of Sciences, 2000. 904(1): p. 306-311.