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]:

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

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

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

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

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

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

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"Simplified multicompartment models provide a feasible body composition assessment and tracking tool in the field"

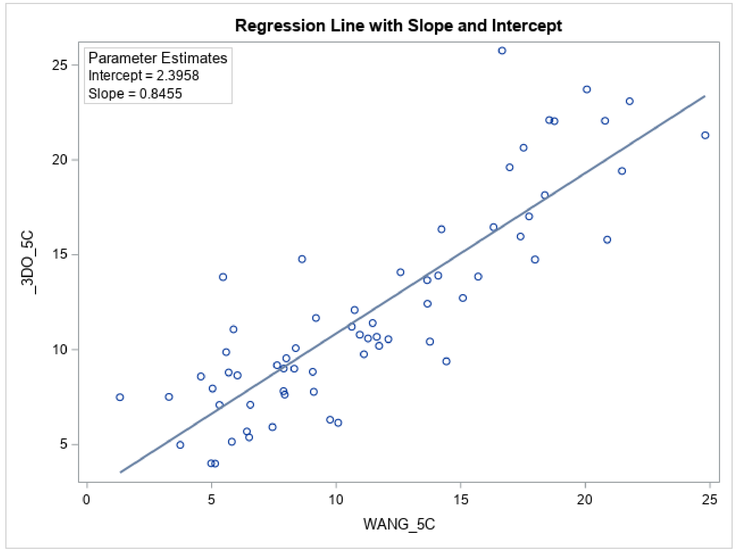

Figure 1. Accuracy of fat mass measured by Wang-5C and 3DO-5C

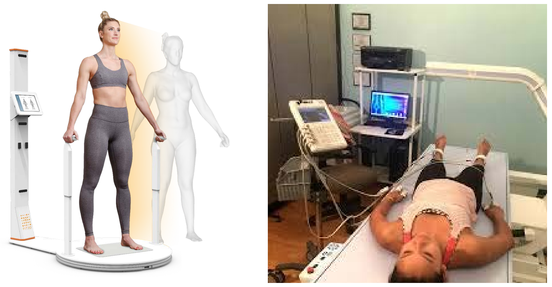

Figure 2. *L to R:* Fit3D (3DO) and BIA (InBody S10)

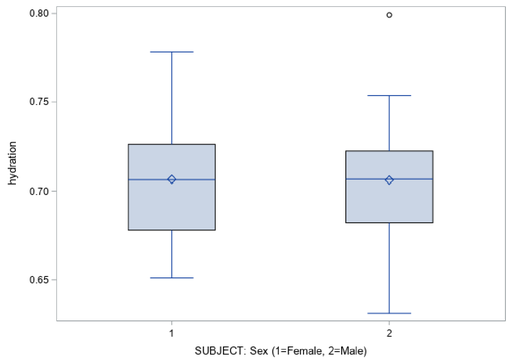

Figure 3. No significant differences in hydration were observed between genders

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^2)	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

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