Accessible multicompartment body composition for monitoring sarcopenia risk in older adults

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Introduction

- Progressive loss of muscle and strength with aging are associated with decreased quality of life, fall and fracture risk, physical disability, and death (*1*)
- Muscle mass assessments are routinely performed using technologies that assume a constant hydration level, where abnormal hydration in older adults, clinical populations, and athletes can invalidate these results (2)
- Criterion multicompartment models are costly and time-consuming (>4 hours), limiting their access as part of routine clinical care in older adults (3)
- *Objective*: We sought to develop a simplified multicompartment model of body composition able to provide accurate and rapid measurements in populations that experience abnormal hydration

Methods

- We recruited 80 intramural and student-athletes (≥18y) at the University of Hawai'i at Manoa as part of the *Da Kine* study
- Athletes were chosen as candidates because they cycle between exercise and recovery, which impacts total body water (TBW) and hydration (2)
- The criterion multicompartment model of body composition was modeled using the following methods:
  - Body volume (BV): Air-displacement plethysmography via Bod Pod (Cosmed USA, Inc., Concord, CA)
  - TBW: Deuterium (D_2O) dilution saliva measurement by isotope ratio mass spectrometry
  - Bone mineral content (BMC): Dual energy X-ray absorptiometry (DXA; Hologic Discovery/A, Marlborough, MA)
  - Body mass (BM): digital scale (Seca 264, Chino, CA)

Figure 1: Rapid multicompartment body composition using 3-dimensional optical scanning (left) and bioelectrical impedance analysis (right)

Variable	Mean (SD)	Min	Max
Age (years)	23.3 (4.8)	18.0	37.0
Height (cm)	175.6 (11.4)	154.7	203.0
Weight (kg)	74.0 (14.7)	43.9	102.5
BMI (kg/m^2)	23.9 (3.5)	17.8	32.2
$Wang_{5C}$ PBF	17.2 (8.4)	4.2	45.4
		Count	**%**
Ethnicity			
Asian		111	22.2
NH Black		131	26.1
Hispanic		69	13.8
NHOPI[1]		44	8.8
NH White		146	29.1

Table 1: Participant demographics

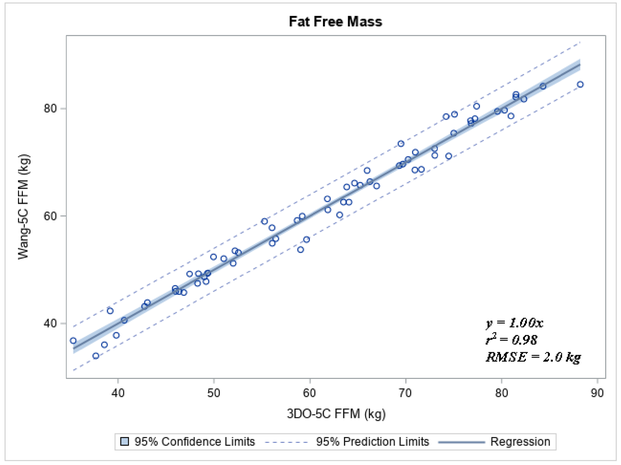

Figure 2: Agreement of 3DO-5C to criterion for fat free mass estimation

"Rapid multicompartment body composition can help identify acute changes to muscle, fat, and hydration for improved clinical decision-making in older adults at risk of sarcopenia"

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Methods (cont.)

- Osseous mineral (Mo) and soft tissue mineral (Ms) were modeled using equations 1 and 2:

$$Equation\ 1: M_o = BMC_{DXA} * 1.0436\ (4)$$

$$Equation\ 2: M_s = TBW_{D2O} * 0.0129\ (3)$$

- The final multicompartment model fat mass (FM) and fat free mass (FFM = BM – FM) were calculated using Equation 3:

$$Equation\ 3: FM = 2.748 * BV - 0.715 * TBW + 1.129 * M_o + 1.222 * M_s - 2.051 * BM\ (2)$$

- The rapid multicompartment model utilized 3-dimensional optical (3DO) scans for BV, bioelectrical impedance analysis (BIA) for TBW and M_s, and participant demographics for BMC
- The rapid model, named 3DO-5C (*Figure 1*), which can be completed in <5 minutes with minimal patient burden, was compared via mean agreement and Lin's Concordance Correlation Coefficient

Results

- 68 participants (31 female) were used in the final analysis
- The 3DO-5C model was generated using Equation 4:

$$Equation\ 4: 3DO\text{-}5C_{FM} = -3.746702 + sex * 2.089649 + BV_{3DO} * 0.302018 + TBW_{BIA} * -0.870090 + weight * 0.677510$$

- $3DO\text{-}5C_{FFM}$ (61.4 ± 13.8 kg) and $Wang\text{-}5C_{FFM}$ (61.4 ± 13.9 kg) showed no mean difference (0.0 ± 0.1 kg; 95% limits of agreement -3.9 to +3.9) and Lin's Concordance Correlation Coefficient was 0.99 (95% CI: 0.98-0.99).

Conclusion & Future Directions

- Rapid assessment of body composition by 3DO-5C showed a strong agreement to the criterion model
- This method requires minimal time and patient burden for assessment in ambulatory and clinical populations
- Future validation of BV by 2-dimensional imaging can result in criterion multicompartment modeling in bed-ridden patients

References

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