Detecting Significant Body Composition Change with Digitally Reposed 3D Optical Meshes: A Prospective Shape Up! Study

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Background

- Advanced statistical shape models using 3D optical (3DO) meshes have been used to predict body composition (BC) with accuracy and precision[1]
- Using models with reposed 3DO meshes have shown to improve BC models accuracy and precision[3]
- The test-retest precision of 3DO body composition approaches that of dual-energy X-ray absorptiometry (DXA)[2] but 3DO's ability to monitor change in body composition is unknown.
- ***Objective:*** To estimate the accuracy of monitoring change in 3DO estimated body composition compared to DXA.

Methods

- All participants were recruited for the Shape Up! Adults study
- Each participant was involved in a 12 week weight-loss intervention (time-restricted eating or bariatric surgery)
- Participants received two optical scans on a Fit3D ProScanner and two DXA scans on a Hologic Discovery/A system during baseline (week 0) and follow-up (week 12)
- Optical scans from both visits were reposed (Figure 2), body composition values were predicted from existing models[3], duplicate scans taken on participants were averaged, and optical change was compared to DXA change

Results

- 44 participants completed the study at the time of analysis (42 diet and 2 bariatric surgery participants).
- 3DO baseline and follow-up total fat mass (FM) and fat-free mass (FFM) had good agreement with DXA (r^2s; 0.87 - 0.94) for males and females (Table 2).
- 3DO percent fat and visceral adipose tissue had similar agreement to DXA when compared past work[1,3] (r^2s; 0.52 - 0.68).
- The percent of males that exhibited significant change or no significant change in both 3DO and DXA was [FM: 52%; FFM: 56%; %Fat: 41%; VAT: 85%] and similarly in females. (Table 3)

Conclusion

- 3DO can predict body composition accurately and detect significant change in body composition. This is the first time 3DO was used to evaluate change in both males and females. However, prediction of change accuracy may be hindered by models built with cross-sectional data. We plan to build upon this and improve our models.

References

1. Ng BK, et al. Detailed 3-dimensional body shape features predict body composition, blood metabolites, and functional strength: the Shape Up! studies. The American journal of clinical nutrition. 2019.
2. Liu YE, et al. Using 3D Optical Body Shape To Predict Body Composition Change in the Shape Up! Adults study. Obesity Week 2019.
3. Wong et al. Digitally Reposing 3D Optical Scans Improves Accuracy of Body composition and Health Assessments. Current developments in nutrition. Submitted Octobet 2020.

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Current generation 3DO systems can be used to monitor change in body composition but not as sensitively as DXA

Figure 1. (Top from left to right) Fit 3D Proscanner and Hologic Discovery A DXA scanner. (Bottom left to right) 3D optical scan of a subject with the corresponding DXA scans

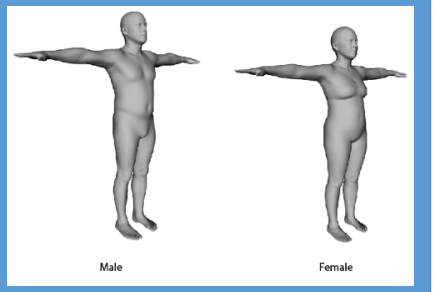

Figure 2. Male and female example of reposed meshes to standardize pose

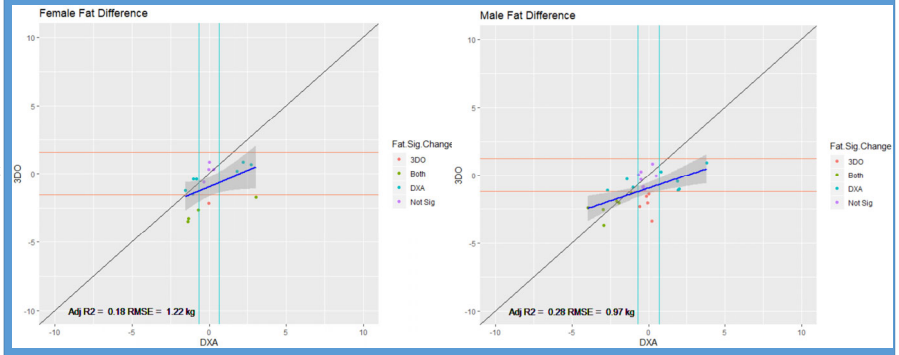

Figure 3. Plots of fat mass change between baseline and follow-up. 3DO vs DXA change for females (left) and males (right).

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Table 1. Demographic characteristics of sample

	Female	Male
Baseline	Mean (Standard Deviation)	
N	17	27
Age (years)	45.17 (10.15)	42.86 (11.82)
Height (cm)	165.69 (6.54)	176.16 (7.35)
Weight (kg)	85.51 (12.56)	96.49 (14.39)
Body Mass Index	31.10 (3.81)	31.05 (4.08)
Total Fat Mass (kg)	33.5 (6.11)	27.9 (6.76)
Total FFM (kg)	52.0 (7.50)	68.8 (9.49)
Follow-up		
N	17	27
Age (years)	45.33 (10.28)	42.93 (11.85)
Height (cm)	162.94 (0.47)	178.27 (7.22)
Weight (kg)	85.11 (12.90)	94.23 (15.12)
Body Mass Index	32.04 (6.51)	29.53 (2.26)
Total Fat Mass (kg)	33.5 (6.87)	27.4 (7.53)
Total FFM (kg)	51.6 (6.92)	68.0 (9.53)

Table 2. 3DO accuracy as it relates to DXA

	Baseline		Follow-up	
	Female	Male	Female	Male
Outcome	r^2 (RMSE)			
Total Fat Mass (kg)	0.90 (2.12)	0.87 (2.07)	0.88 (2.18)	0.90 (2.02)
Total FFM (kg)	0.92 (1.90)	0.94 (2.31)	0.89 (2.18)	0.94 (2.30)
Percent Fat (%)	0.60 (2.47)	0.68 (1.95)	0.54 (2.35)	0.68 (2.02)
VAT (kg)	0.58 (0.10)	0.52 (0.13)	0.64 (0.09)	0.61 (0.13)

Table 3. Percentage of sample that exceeded least significant (LSC) change by 3DO and DXA

	Females		Males	
Outcome	**LSC**	**% > LSC**	**LSC**	**% > LSC**
Total Fat Mass (3DO) (kg)	1.52	31%	1.22	41%
Total Fat Mass (DXA) (kg)	0.64	69%	0.69	52%
Total FFM (3DO) (kg)	1.52	19%	1.22	41%
Total FFM (DXA) (kg)	0.75	44%	0.94	63%
Percent Fat (3DO)	2.27%	12%	1.58%	11%
Percent Fat (DXA)	0.91%	38%	0.78%	56%
VAT (3DO) (kg)	0.06	25%	0.06	7%
VAT (DXA) (kg)	0.08	19%	0.08	15%

LSC: minimum amount of change to determine if the change is significant and not due to chance with 95% confidence
% > LSC: denotes the percentage of the sample that exceeded the least significant change

Table 4. Percentage of participants that had no significant change or significant change on 3DO and DXA

Outcomes	Females	Males
Total Fat Mass (kg)	50%	52%
Total FFM (kg)	63%	56%
Percent Fat (%)	50%	41%
VAT (kg)	56%	85%

Abbreviations: R^2 (coefficient of determination; RMSE (root mean square error); kg (kilogram); DXA (dual energy X-ray absorptiometry; SD (standard deviation; N (number of participants)