Change in 3D optical body shape accurately predicts change in fat masses including visceral fat

Using 3D Optical Body Shape to Predict Body Composition Change in the Shape Up! Adults Study.

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Background

- Recent advancements in three-dimensional optical (3DO) imaging have made this technology readily available in fitness centers across the world.
- Advanced statistical methods have also been used to convert digital anthropometry and body shape avatars into accurate and precise measures of regional and total body composition. However, it is unknown how well one can track body composition changes using 3DO.
- ***Objective***: We investigate the accuracy of changes in body composition estimated by 3DO compared to the criterion DXA measures.

Methods

- Fifty participants from the Shape Up! Adults Study were to participate in longitudinal protocol meant to alter their weight or body composition.
- Each subject had a baseline and follow-up visit at either the end of their three-month follow up visit (dietary) or four-month follow up visit (bariatric). Each visit included a DXA scan on a Horizon/A system APEX 5.6.0.4 (Hologic, Inc) and 3DO surface imaging (Fit3D Inc). 3DO scans were spatially registered using a standardized 60,000 vertex template. Body shape variation was described using principal component analysis.
- Estimates of fat mass (FM), fat-free mass (FFM), percent body fat (PBF), and visceral adipose tissue (VAT) were predicted using equations from Ng et al., 2019. Changes in FM, FFM, PBF, and VAT were calculated between follow-up and baseline measurements.
- 3DO body composition measurements were compared against DXA as the criterion method.
- Actual body composition change from the 3DO scans was determined using the least significant change (LSC) formula: Ideal LSC = 2.77*precision error (Shepherd et al., 2018) and precision error from Ng et al., 2019.

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

SCAN ME

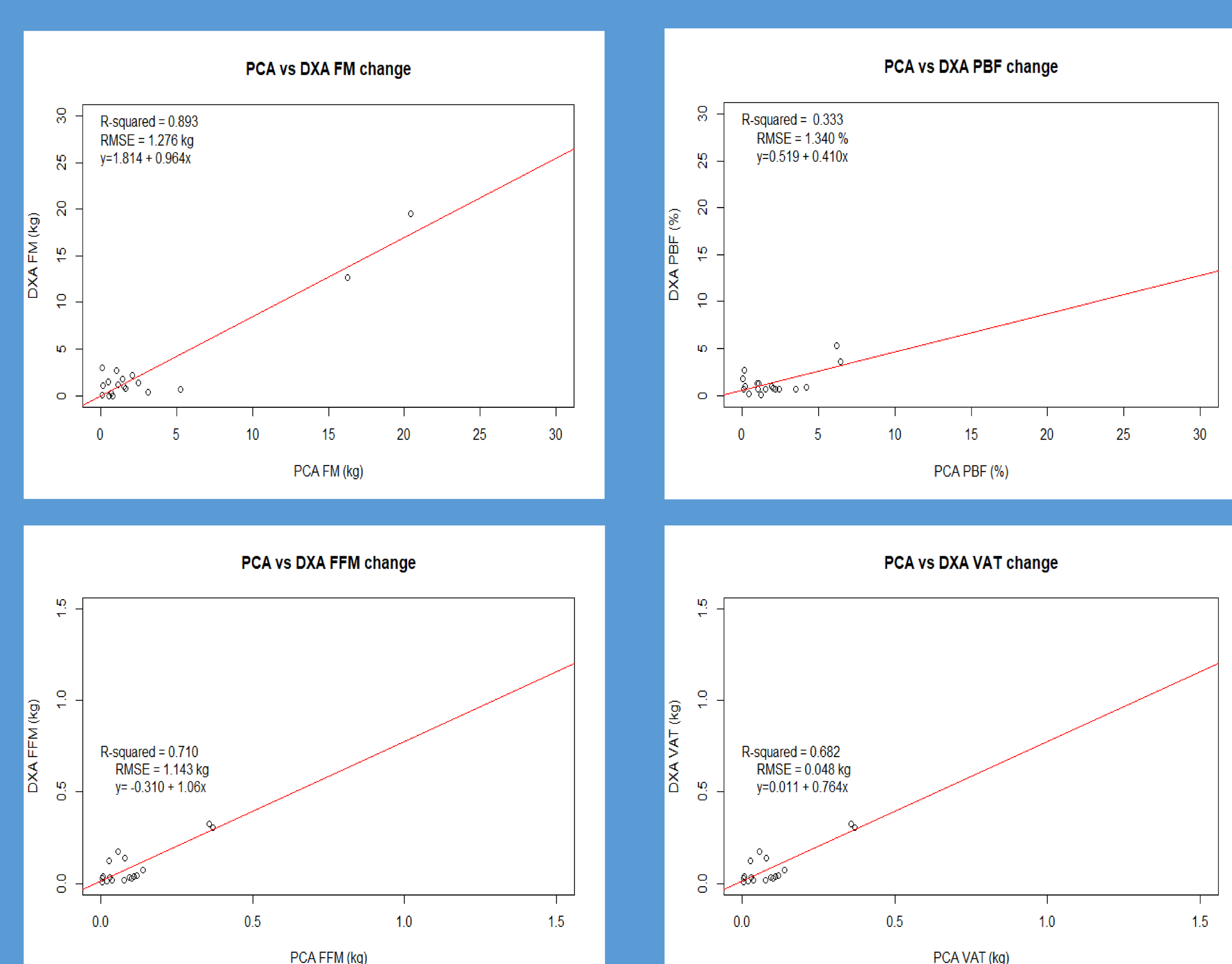

Figure 2. Correlation of FM (fat mass), PBF (percent body fat), FFM (fat-free mass), and VAT (visceral adipose tissue) between PCA and DXA.

Results

- Data from 18 females (12 White, 2 Black, 2 Asian, and 2 Hispanic) were available at the time of analysis.
- 3DO changes in the variables were highly correlated to DXA: FM (R^2=0.893, RMSE=1.2kg), FFM (R^2=0.710, RMSE=1.1kg), PBF (R^2=0.333, RMSE=1.3%), and VAT (R^2=0.682, RMSE=0.05kg).
- 33%, 39%, 22%, and 50% of the study population showed a change with a 95% confidence in FM, FFM, PBF, and VAT, respectively.

Conclusion

- Changes in 3DO PCs well represented changes in DXA body composition.
- 3DO scans are non-invasive, quick, and accessible technology that can be used often to improve the precision of its estimates while DXA cannot due to dose.
- This novel approach may have a high value for individuals undergoing lifestyle interventions and improve adherence.

Table 1. Subject Characteristics

Parameter	Units	N	Mean	SD	Min	Max
Age	years	18	46.1	10.6	30.1	63.8
Height	cm	18	165	6	153	179
Weight	kg	18	89.5	19.1	68.6	142.7
BMI V1	kg/m²	18	32.8	6.6	26.5	51.3
BMI V2	kg/m²	18	31.7	4.6	26.2	40.6
FM V1	kg	18	35.6	10.2	25.7	65.4
FM V2	kg	18	34.1	7.3	24.7	47.5
FFM V1	kg	18	53.9	9.7	41.6	77.0
FFM V2	kg	18	52.6	7.8	42.7	67.2
PBF V1	%	18	39.4	3.9	31.3	45.9
PBF V2	%	18	39.1	3.7	30.5	45.2
VAT V1	kg	18	0.67	0.29	0.23	1.13
VAT V2	kg	18	0.65	0.26	0.20	1.26

Abbreviations: FM (Fat Mass); FFM (Fat-Free Mass), PBF (Percent Body Fat); VAT (Visceral Adipose Tissue); V1 (Visit 1); V2 (Visit 2).

Table 2. DXA vs 3DO LSC

Parameter	Units	Mean
DXA FFM LSC	%	56%
DXA FM LSC	%	72%
DXA PBF LSC	%	50%
DXA VAT LSC	%	28%
PC FFM LSC	%	39%
PC FM LSC	%	33%
PC PBF LSC	%	22%
PC VAT LSC	%	50%

References:

Ng, B. K et al. (2019). Detailed 3-dimensional body shape features predict body composition, blood metabolites, and functional strength: the Shape Up! studies. *The American Journal of Clinical Nutrition*. doi: 10.1093/ajcn/nqz218

Shepherd, J. A., Morgan, S. L., & Lu, Y. (2008). Comparing BMD Results Between Two Similar DXA Systems Using the Generalized Least Significant Change. *Journal of Clinical Densitometry*, *11*(2), 237–242. doi: 10.1016/j.jocd.2008.02.001

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