3-Dimensional Optical Imaging Body Shape Improves the Prediction of Metabolic Syndrome Over Body Mass Index

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Background

- Metabolic syndrome (MetS) is defined as possessing ≥3 interrelated metabolic risk factors that are associated with increased diabetes and cardiovascular disease risk [1,2]
- Clinicians commonly rely on body mass index (BMI) as a measure of overweight to indicate increased risk of MetS
- BMI is limited due to the presence of MetS in normal weight adults and no MetS in many overweight adults
- Body shape provides an indirect measure of body fatness that may improve the identification of MetS in adults
- ***Objective:*** To examine the ability for body shape as measured by 3-dimensional optical imaging (3DO) to improve the prediction of MetS in a sample of adults

Methods

- Adults (>18y) were recruited as part of the Shape Up! Adults study
- MetS was diagnosed using the National Cholesterol Education Program (NCEP) guidelines for diagnosis [3]:

Cutoff	Males	Females
Waist circumference	≥102 cm	≥88 cm
Blood triglycerides	≥150 mg/dL	
Blood pressure	≥130 mm Hg systolic *or* ≥85mm Hg diastolic	
Fasting glucose	≥100 mg/dL	
HDL-C	<40 mg/dL	<50 mg/dL

Table 1: NCEP criteria for MetS diagnosis

- Body shape was assessed through 3DO scans using a Styku S100 (Styku, Los Angeles, CA) scanner
- MetS was coded as a binary outcome (MetS – vs. MetS +) and predicted using logistic regression in SAS version 9.4 (SAS Institute, Cary, NC)
- We compared the ability to predict MetS using BMI, demographic-adjusted BMI, 3DO , and BMI + demographics + 3DO models (Model 4) using receiver operating characteristic curves

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"Body shape provides an easily accessible tool to improve the prediction of metabolic syndrome"

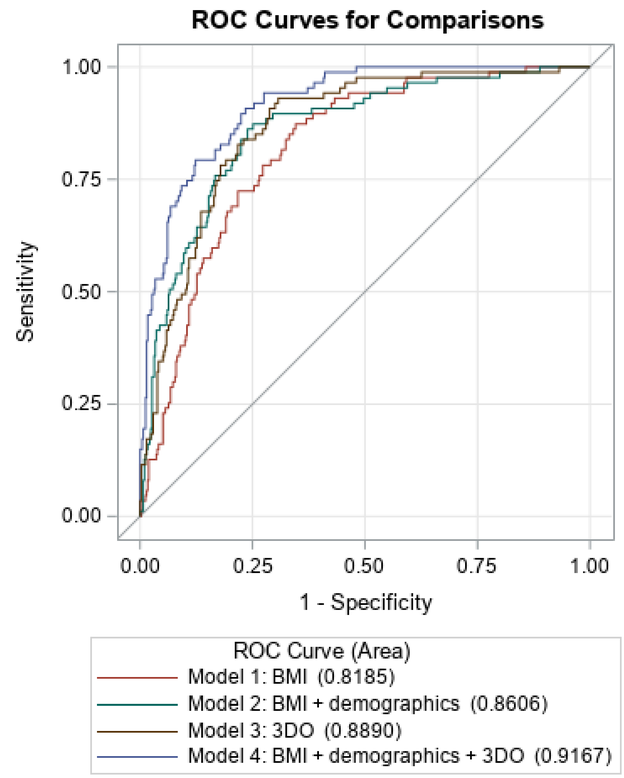

Figure 1. Receiver operating characteristic curve of MetS prediction models

Figure 2. Styku S100 3DO body shape scanner

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Results

- 501 participants (230 female) were used in the final analysis with 87 participants being MetS+; data reported in *Table 2.*

Table 2: Participant demographics

Variable	Mean (SD)	Min	Max	
Age (years)	46.2 (16.5)	18.0	89.0	
Height (cm)	167.7 (10.0)	144.1	202.1	
Weight (kg)	77.8 (22.2)	35.4	173.5	
BMI (kg/m^2)	27.5 (7.0)	14.2	52.6	
		Count	**%**	**MetS+**
Ethnicity				
Asian		111	22.2	22
NH Black		131	26.1	15
Hispanic		69	13.8	7
NHOPI[1]		44	8.8	15
NH White		146	29.1	28

- The 3DO variables included in model 4 were, in order of importance: waist to hip ratio, percent bone mass, waist circumference, and calf volume.
- Model 4 predicted 78 of 87 (89.7%) MetS+ subjects and 349 of 414 (84.3%) MetS- cases
- Model 4 correctly identified all 7 participants with normal weight MetS+ and correctly predicted MetS- in 201 of 222 (90.5%) overweight subjects

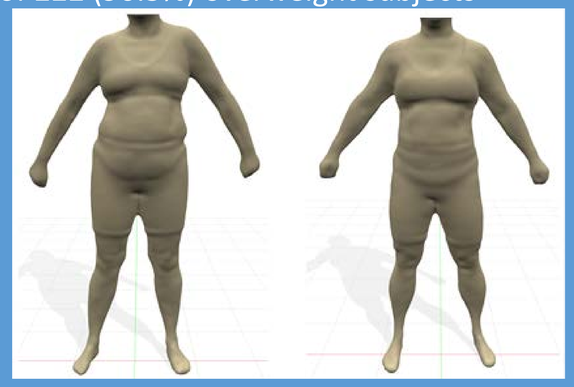

Figure 3: MetS+ (left) vs. MetS- (right) in subjects matched for BMI, ethnicity, age despite differences in regional fat distribution. Both participants were correctly identified using the 3DO model (Model 2).

Conclusion

- Body shape measures by 3DO improves the prediction of MetS and is an easily accessible, cost-effective tool for long-term clinical use in disease prevention and detection.

References

1. Ford, E.S., C. Li, and N. Sattar, *Metabolic Syndrome and Incident Diabetes: Current state of the evidence.* Diabetes Care, 2008. **31**(9): p. 1898-1904.
2. Malik, S., et al., *Impact of the Metabolic Syndrome on Mortality From Coronary Heart Disease, Cardiovascular Disease, and All Causes in United States Adults.* Circulation, 2004. **110**(10): p. 1245-1250.
3. Health, N.I.o., *ATP III guidelines at-a-glance quick desk reference.* NIH publication, 2001: p. 01-3305.