

8-2014

# DEXA-Measured VAT Robustly Predicts Impaired Glucose Tolerance and Metabolic Syndrome in Obese Women

Xia Bi

*Jefferson Medical College, Thomas Jefferson University, xia.bi@jefferson.edu*

C. D. Keil

*Vanderbilt University*

L. Seabolt

*Vanderbilt University*

R. Tyree

*Vanderbilt University*

M. Buchowski

*Vanderbilt University**See next page for additional authors*

## [Let us know how access to this document benefits you](#)

Follow this and additional works at: <http://jdc.jefferson.edu/sigmaxi> Part of the [Medicine and Health Sciences Commons](#)

---

### Recommended Citation

Bi, Xia; Keil, C. D.; Seabolt, L.; Tyree, R.; Buchowski, M.; Kang, H.; Shibao, C.; and Silver, H. J., "DEXA-Measured VAT Robustly Predicts Impaired Glucose Tolerance and Metabolic Syndrome in Obese Women" (2014). *Sigma Xi*. Paper 4.  
<http://jdc.jefferson.edu/sigmaxi/4>

This Article is brought to you for free and open access by the Jefferson Digital Commons. The Jefferson Digital Commons is a service of Thomas Jefferson University's [Center for Teaching and Learning \(CTL\)](#). The Commons is a showcase for Jefferson books and journals, peer-reviewed scholarly publications, unique historical collections from the University archives, and teaching tools. The Jefferson Digital Commons allows researchers and interested readers anywhere in the world to learn about and keep up to date with Jefferson scholarship. This article has been accepted for inclusion in Sigma Xi by an authorized administrator of the Jefferson Digital Commons. For more information, please contact: [JeffersonDigitalCommons@jefferson.edu](mailto:JeffersonDigitalCommons@jefferson.edu).

---

**Authors**

Xia Bi, C. D. Keil, L. Seabolt, R. Tyree, M. Buchowski, H. Kang, C. Shibao, and H. J. Silver



# DEXA-Measured VAT Robustly Predicts Impaired Glucose Tolerance and Metabolic Syndrome in Obese Women

<sup>1</sup>Bi X., <sup>2</sup>Keil C.D., <sup>2</sup>Seabolt L., <sup>2</sup>Tyree R., <sup>2</sup>Buchowski M., <sup>2</sup>Kang H., <sup>2</sup>Shibao C., <sup>2</sup>Silver H.J.

<sup>1</sup>Jefferson Medical College of Thomas Jefferson University, Philadelphia, PA

<sup>2</sup>Department of Medicine, School of Medicine of Vanderbilt University, Nashville, TN

## ABSTRACT

Abdominal visceral adiposity (VAT) has been shown to be an independent risk factor for metabolic and cardiovascular disease. Using enCORE analysis version 13.6 on a GE Lunar iDXA, a new fully automated analysis software to measure VAT, we determined the strength of associations between DEXA-derived VAT and other known indicators for diabetes and cardiovascular disease risk in Caucasian and African American obese women. We collected anthropometrics, vital signs, lipid profile, and DXA whole body composition scan for 229 subjects with BMI 30.0 – 49.9 kg/m<sup>2</sup> & age 21 to 69 y. We then performed the non-parametric Spearman correlation analysis and found that in subjects overall, DEXA-VAT is positively associated with triglyceride, fasting glucose, fasting insulin, and HOMA-IR, and negatively associated with HDL. Among all anthropometric, body composition and cardiometabolic variables, DEXA-VAT was the most robust predictor of impaired glucose tolerance (IGT) and metabolic syndrome (MetSx) in binary regression analysis, even after adjusting for race. LASSO regression after adjusting for covariates that best predicted IGT and MetSx showed that HOMA-IR and DEXA-VAT most significantly predicted IGT ( $p < 0.001$ ,  $p < 0.001$ , respectively), and DEXA-VAT most significantly predicted MetSx ( $p < 0.001$ ). These observations have implications for VAT associated risk in diabetes and cardiovascular disease.

## INTRODUCTION

- Abdominal obesity, especially the visceral component of adipose tissue (VAT), is strongly associated with metabolic and cardiovascular risk in humans (1-2).
- The differences in sex and race with regard to body composition and metabolic risk have also been demonstrated with VAT associated risk.
- Although CT and MRI are considered the “gold standards” in the measurement of type and distribution of body fat, dual energy X-ray absorptiometry (DEXA) can accurately measure body composition with high-precision, low X-ray exposure, and short-scanning time (3).
- We previously showed strong correlations between DEXA and MRI whole body composition, with coefficients of variation of  $\leq 2\%$  for DEXA-derived adiposity measures (4).
- In addition to whole body composition, we now have a newly available software to estimate VAT area (cm<sup>3</sup>) and mass (g) using enCORE analysis version 13.6 (5) on a GE Lunar iDXA.

## METHODS

**Study:** Cross-sectional design of subjects previously recruited for studies at the Vanderbilt Clinical Research Center.

**Subjects:** 229 subjects with BMI 30.0 – 49.9 kg/m<sup>2</sup> & age 21 to 69 y. All records de-identified.

### Measures

#### Anthropometrics

Height, weight, BMI, Waist & hip circumference (WC & HC), waist-to-hip ratio (WHR), waist-to-height ratio (WtHR)

#### Lipid profile

Total cholesterol, HDL, LDL, triglyceride (TG) Fasting glucose, insulin, HOMA-IR

#### DEXA whole body composition scan

#### Metabolic disease states

- Impaired Glucose tolerance (IGT): fasting glucose  $\geq 100$  mg/dL
- Metabolic Syndrome defined as  $\geq 3$  of the following: 1. WC ( $>102$  cm for  $\sigma$ ,  $>88$  cm for  $\rho$ ); 2. TG ( $\geq 150$  mg/dl); 3. HDL ( $<40$  mg/dl in  $\sigma$ ,  $<50$  mg/dl in  $\rho$ ); 4. hypertension ( $\geq 130/\geq 85$  mmHg); 5. impaired fasting glucose ( $\geq 100$  mg/dl).

**Analysis:** R version 3.0.1 analyzed with non-parametric distribution.

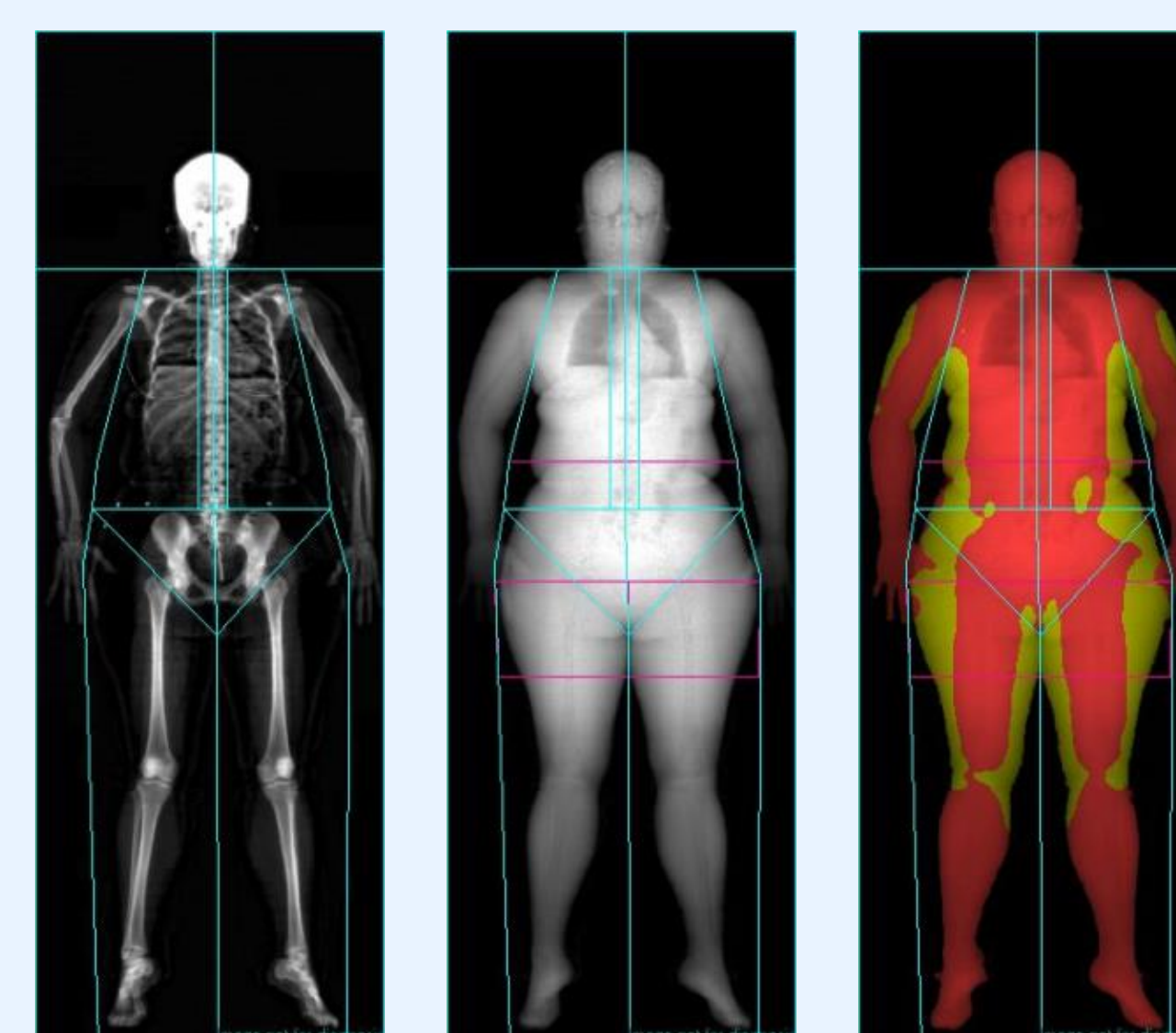


Figure: Coronal DEXA image for a sample subject. The blue trapezoidal region of interest is used for reporting the DEXA trunk (abdominal) adipose and lean soft tissue masses.

## RESULTS

DEXA-VAT Associations with Metabolic Risk Factors

Risk Factors	p value	DEXA-VAT	
		p adjusted for Race	p adjusted for int'n w/ Race
SBP	0.01	<0.001	0.24
DBP	0.01	<0.001	0.19
HR	0.37	0.96	0.42
Total Cholesterol	0.51	0.72	0.06
HDL	<0.001	0.62	0.85
LDL	0.13	0.13	0.06
TG	<0.001	0.08	0.95
HsCRP	0.33	0.07	0.01
Glucose	<0.001	0.43	0.11
Insulin	<0.001	<0.001	0.78
HOMA-IR	<0.001	0.01	0.40

Overall, DEXA-VAT was positively associated with SBP, DBP, TG, fasting glucose & insulin, HOMA-IR, and negatively associated with HDL. DEXA-VAT was still associated with SBP, DBP, insulin, and HOMA-IR after adjusting for race, and associated with hsCRP after adjusting for the int'n with race.

## RESULTS

### Multivariate LASSO Regression for IGT

Impaired Glucose Tolerance	OR	SE	z	p value	95% CI	
					Lower	Upper
A HOMA-IR	6.28	0.48	3.82	1.33E-04	2.66	17.46
VAT	2.60	0.30	3.19	1.40E-03	1.52	4.93
HR	0.56	0.23	-2.47	0.01	0.35	0.87
SBP	1.15	0.22	0.63	0.53	0.75	1.75
hsCRP	1.22	0.20	0.97	0.33	0.82	1.82
BMI	0.70	0.24	-1.50	0.13	0.43	1.10

	Deviance	D.f.	p value
B A adjusted for Race	0.64	1	0.42
C A adjusted for int'n w/ Race	1.14	2	0.56

**A:** combination of anthropometric, body composition, and cardiometabolic variables guided by previous binary regressions presented with adjusted odds ratios (OR); **B:** ANOVA analysis of A adjusted for race; **C:** ANOVA analysis of A adjusted for interaction with race.

### Multivariate LASSO Regression for MetSx

Metabolic Syndrome	OR	SE	z	p value	95% CI	
					Lower	Upper
A VAT	2.78	0.31	3.32	9.09E-04	1.58	5.29
BMI	1.42	0.22	1.58	0.11	0.93	2.24
HOMA-IR	2.99	0.42	2.63	0.01	1.39	7.20
LDL	1.61	0.19	2.47	0.01	1.11	2.38
Body Fat (%)	0.66	0.23	-1.75	0.08	0.41	1.04

	Deviance	D.f.	p value
B A adjusted for Race	1.46	1	0.23
C A adjusted for int'n w/ Race	2.75	2	0.25

**A:** combination of anthropometric, body composition, and cardiometabolic variables guided by previous binary regressions presented with adjusted odds ratios (OR); **B:** ANOVA analysis of A adjusted for race; **C:** ANOVA analysis of A adjusted for interaction with race.

## CONCLUSION

- DEXA-VAT was positively associated with TG, fasting glucose & insulin, and HOMA-IR, and negatively associated with HDL-C
- In binary regression analysis, DEXA-VAT was a more robust predictor of IGT and MetSx than other anthropometric and body composition variables
- In Multivariate LASSO regression, the odds ratio for having IGT was most robustly predicted by HOMA-IR and DEXA-VAT; the odds ratio for having MetSx was most robustly predicted by DEXA-VAT

## REFERENCES

- Canoy D. Distribution of body fat and risk of coronary heart disease in men and women. *Curr Opin Cardiol.* 2008 Nov;23(6):591-8.
- Shuster A, Patlas M, Pinthus JH, Mourtzakis M. The clinical importance of visceral adiposity: a critical review of methods for visceral adipose tissue analysis. *Br J Radiol.* 2012 Jan;85(1009):1-10.
- Direk K et al. The relationship between DXA-based and anthropometric measures of visceral fat and morbidity in women. *BMC Cardiovasc Disord.* 2013 Apr 3;13:25.
- Silver HJ et al. Comparison of gross body fat-water magnetic resonance imaging at 3 Tesla to dual-energy X-ray absorptiometry in obese women. *Obesity.* 2013 Apr;21(4):765-74.
- Kaul S, et al. Dual-energy X-ray absorptiometry for quantification of visceral fat. *Obesity (Silver Spring).* 2012 Jun;20(6):1313-8.

## ACKNOWLEDGEMENT

Research supported by multiple sources obtained by Silver, Buchowski, Shibao & NIH T35DK007383