8-2014

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

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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/m2 & 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 ≤ 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^3) 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^2 & 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 (WHtR)

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 ≥100 mg/dL
- Metabolic Syndrome defined as ≥ 3 of the following: 1. WC (>102 cm for♂, >88 cm for♀); 2. TG (≥150 mg/dl); 3. HDL (<40 mg/dl in♂, <50 mg/dl in♀); 4. hypertension (≥130/≥85 mmHg); 5. impaired fasting glucose (≥100 mg/dl).

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

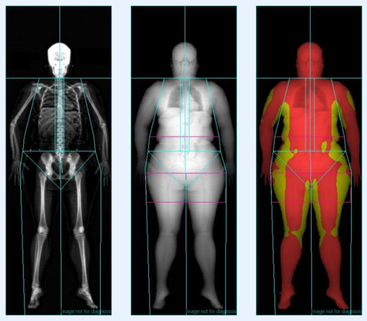

Figure: Coronal DEXA image for a sample subject. The blue trapezoidal region of interest is used for reporting the DEXA trunk (abdominal) adipose and lean soft tissue masses.

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	95% CI 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	95% CI 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 Mutivariate 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

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ACKNOWLEDGEMENT

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