Abdominal obesity and the metabolic syndrome

George Valsamakis PhD
Endocrinologist
Evgenideion University Hospital
Athens, Greece

IDF Criteria of the Metabolic Syndrome

Similar to the AHA/NHLBI except required waist circumference and lower thresholds for abdominal obesity

- High waist circumference

  Plus any two of

- ↑ Triglycerides (≥ 1.7 mmol/L [150 mg/dL])
- ↓ HDL cholesterol
  - Men < 1.0 mmol/L (40 mg/dL)
  - Women < 1.3 mmol/L (50 mg/dL)
- ↑ Blood pressure ≥ 130 / ≥85 mm Hg
- ↑ FPG (≥ 5.6 mmol/L [100 mg/dL]), or diabetes

Alberti KGMM, et al. International Diabetes Federation. *Lancet* 2005; 366:1059-1062

IDF Criteria: Abdominal Obesity and Waist Circumference Thresholds

	Men	Women
European	≥94 cm (37.0 in)	≥80 cm (31.5 in)
South Asian	≥90 cm (35.4 in)	≥80 cm (31.5 in)
Chinese	≥90 cm (35.4 in)	≥80 cm (31.5 in)
Japanese	≥85 cm (33.5 in)	≥90 cm (35.4 in)

AHA / NHLBI criteria: ≥102 cm (≥40 in) in men, ≥88 cm (≥35 in) in women

- Some US adults of non-Asian origin with marginal increases should benefit from lifestyle changes. Lower cutpoints (≥ 90 cm in men and ≥ 80 cm in women) for Asian Americans

Alberti et al. *Lancet* 2005; 366:1059-1062
Grundy S et al. *Circulation* 2005;112:2735-2752

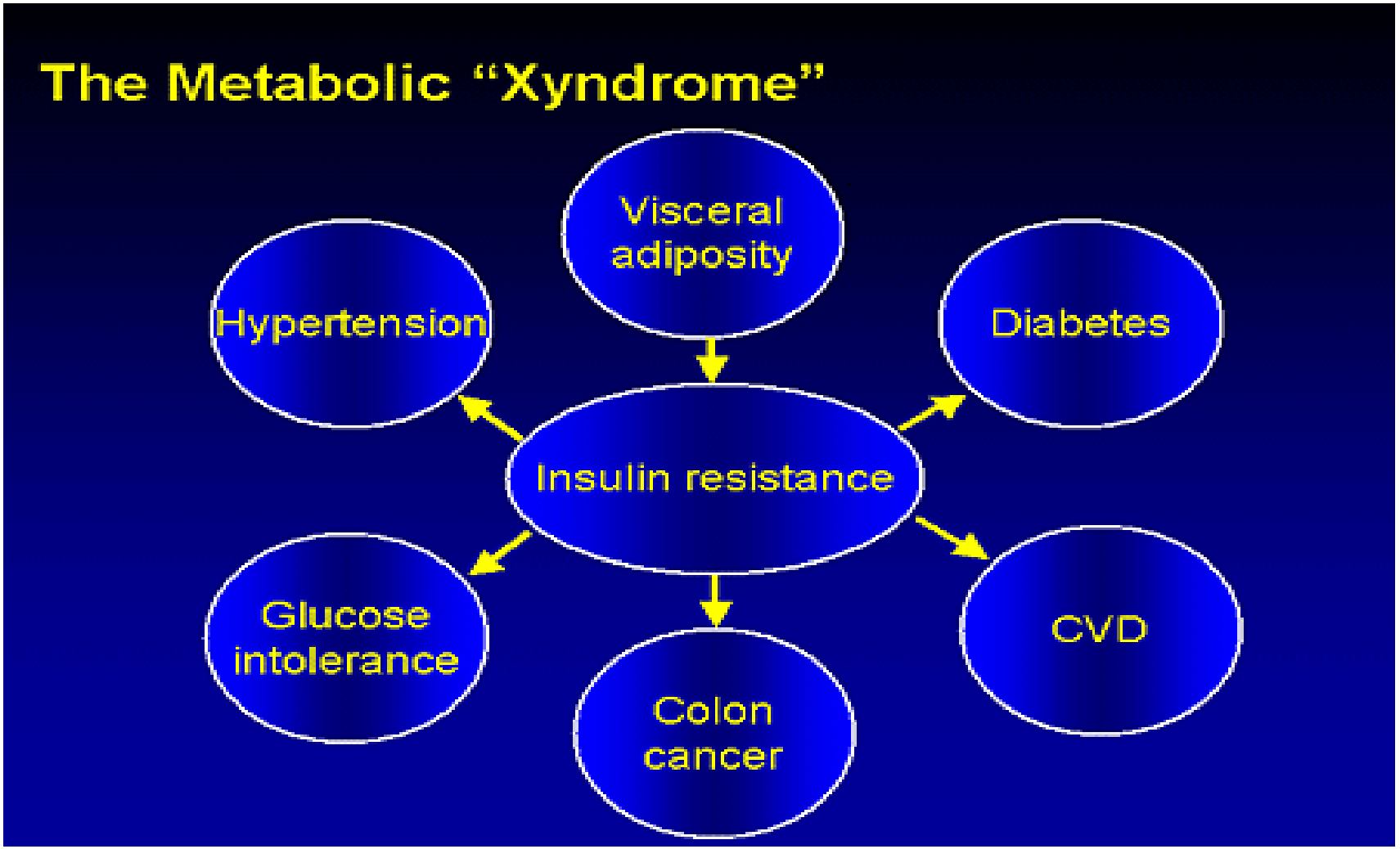
ATP III: The Metabolic Syndrome*

*Diagnosis is established when ≥3 of these risk factors are present.

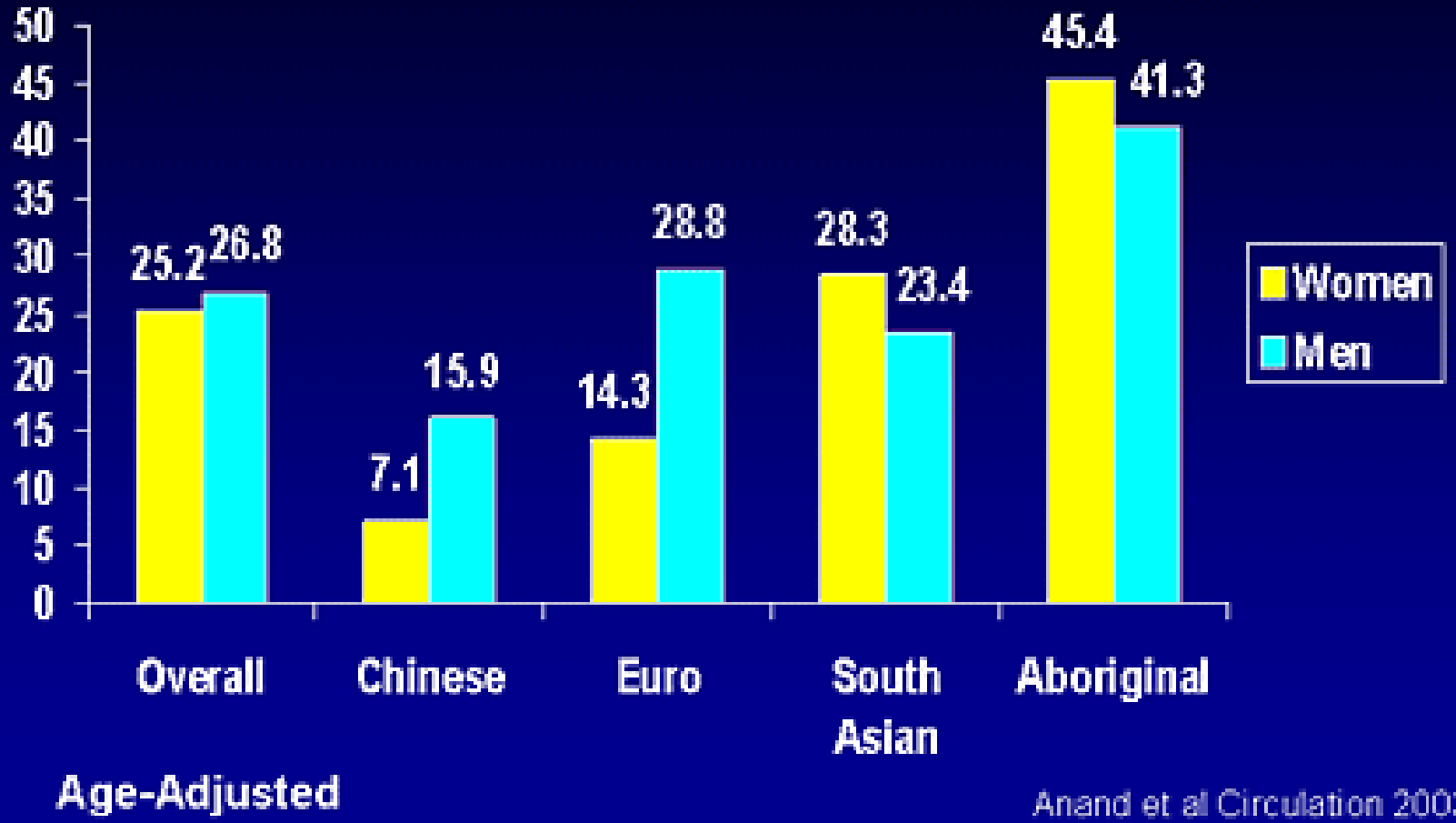
Risk Factor	Defining Level
Abdominal obesity (Waist circumference)	
Men	>102 cm (>40 in)
Women	>88 cm (>35 in)
TG	≥150 mg/dL
HDL-C	
Men	<40 mg/dL
Women	<50 mg/dL
Blood pressure	≥130/≥85 mm Hg
Fasting glucose	≥110 (≥100 (ADA)) mg/dL

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. *JAMA*. 2001;285:2486-2497.

Metabolic syndrome and associated diseases

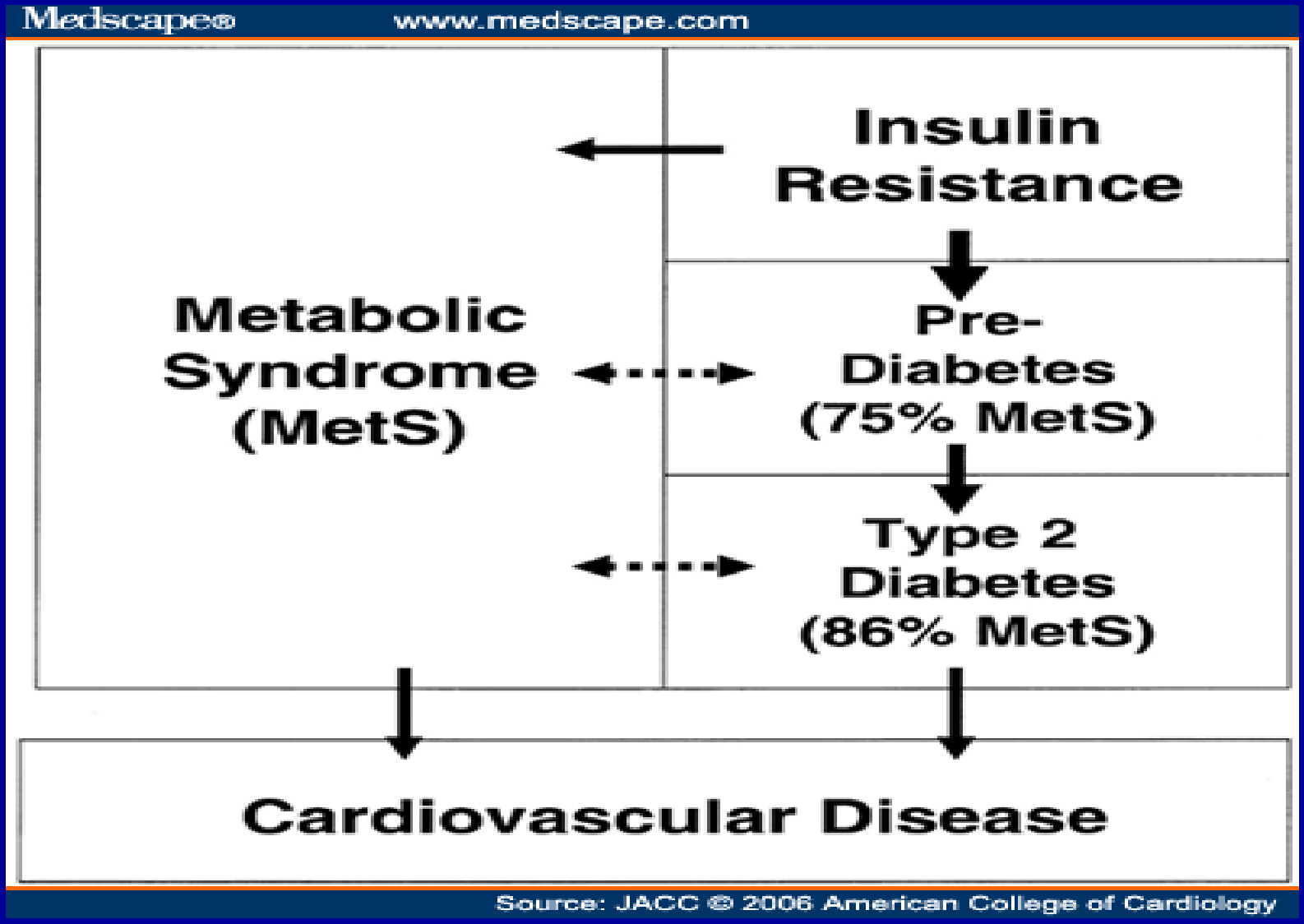


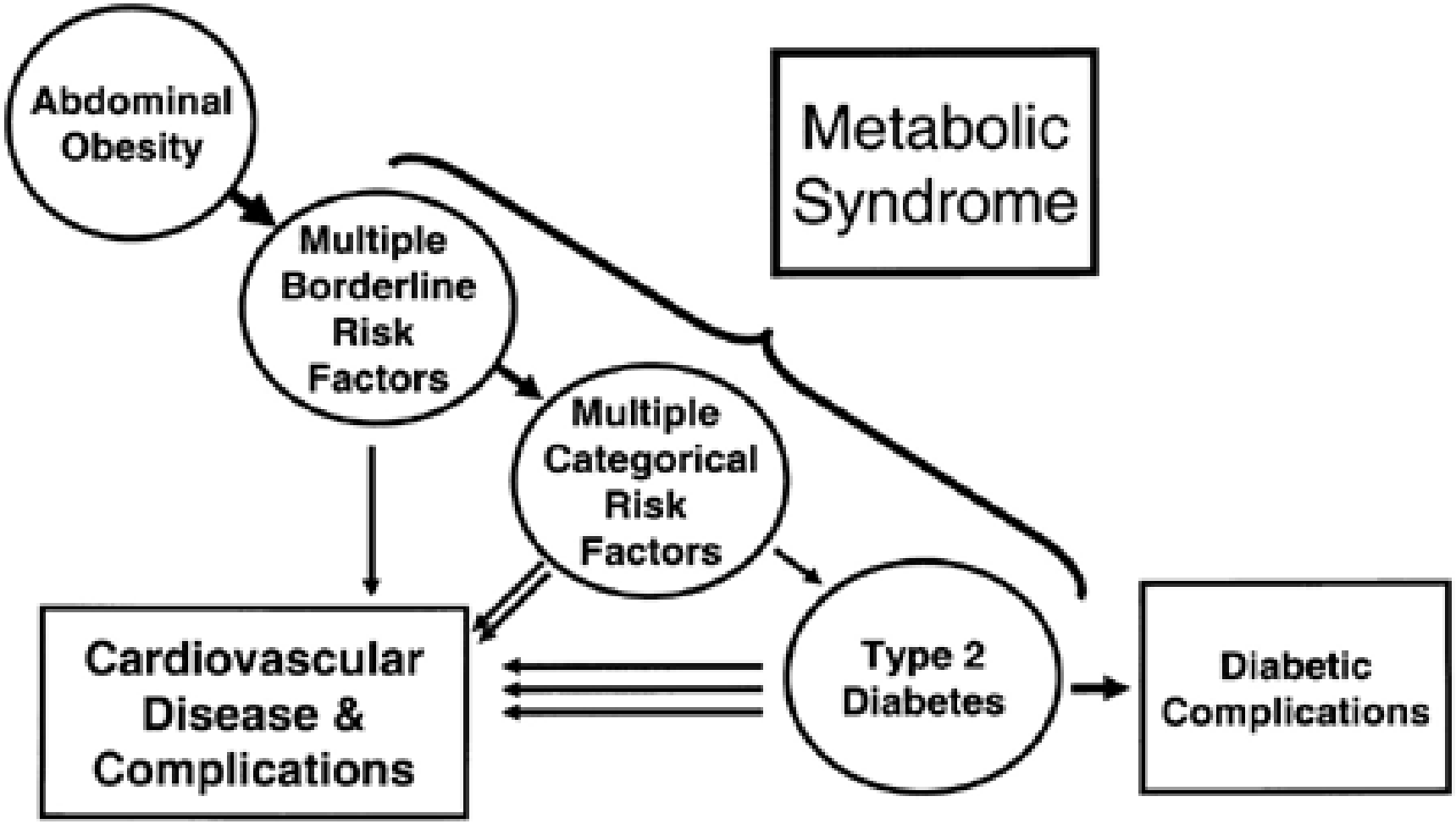
Age-Adjusted Prevalence of Metabolic Syndrome in Canada



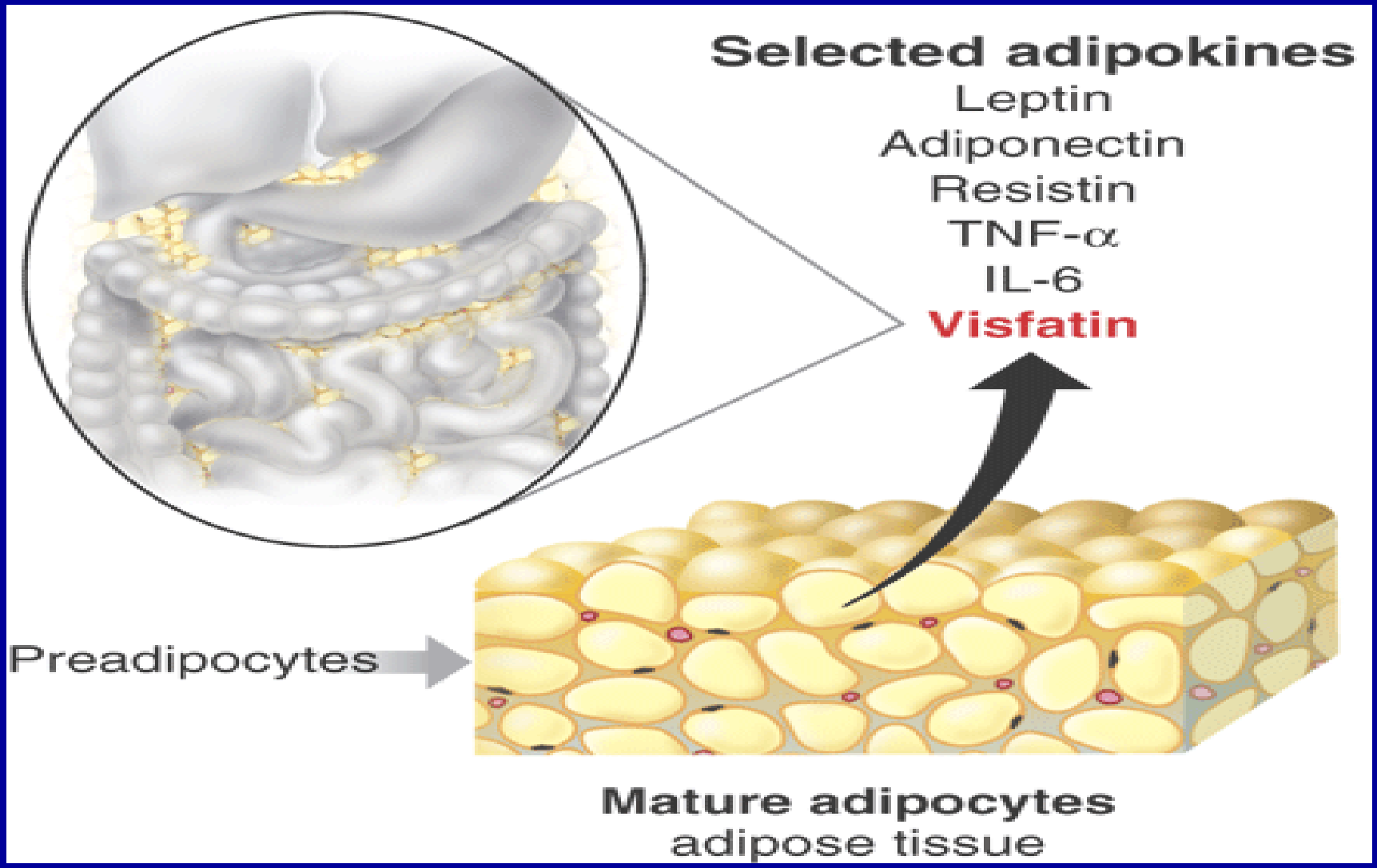
Anand et al Circulation 2003

Connection of metabolic syndrome with Cardiovascular Disease





Visceral fat as an endocrine organ

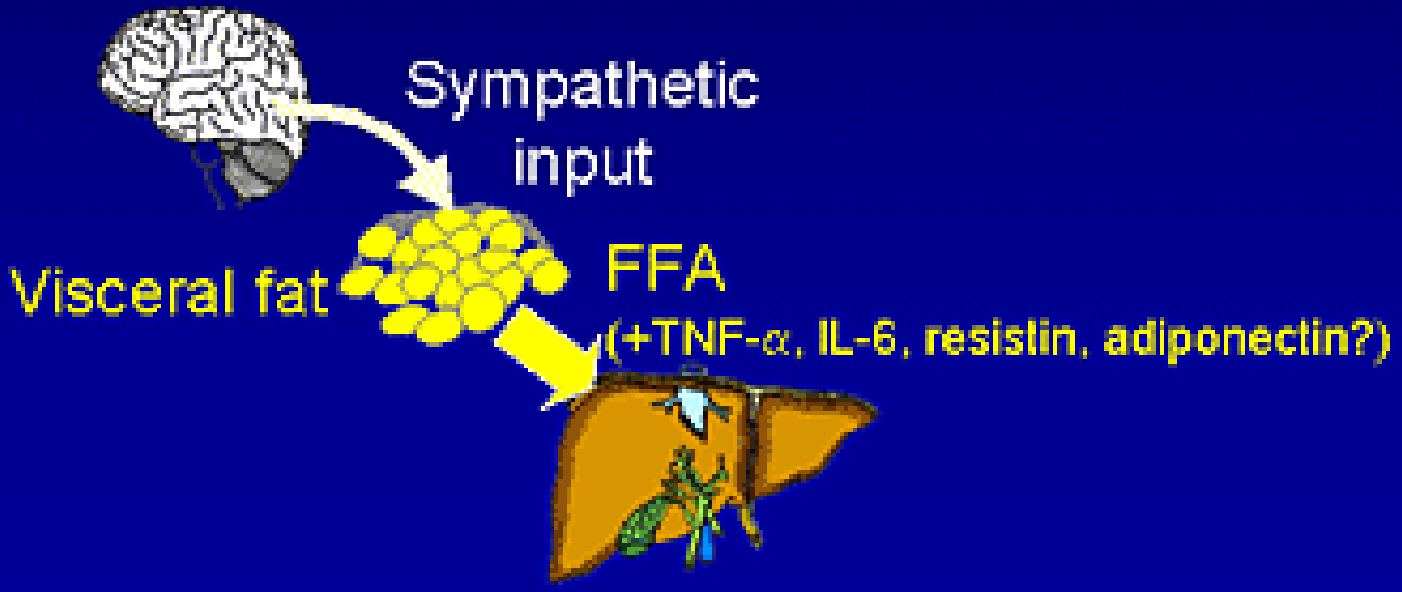


Adipocytokines	Effects on
LPL	Lipid metabolism
HSL	Lipid metabolism
Perilipin	Lipid metabolism
aP2	Lipid metabolism
CETP	Lipid metabolism
RBP	Lipid metabolism
IL-6	Inflammation, atherosclerosis, insulin resistance
TNF-α	Inflammation, atherosclerosis, insulin resistance
Adipsin/ASP	Immune—stress response
Metallothionein	Immune—stress response
Angiotensinogen	Vascular homeostasis
PAI-1	Vascular homeostasis
Adiponectin	Inflammation, atherosclerosis, insulin resistance
PPAR-γ	Lipid metabolism, inflammation, vascular homeostasis
CRP	Inflammation, atherosclerosis, insulin resistance
IGF-1	Lipid metabolism, insulin resistance
TGF-b	Cell adhesion and migration, growth and differentiation
Monobutyrin	Vasodilation of the microvessel
Uncoupling proteins	Energy balance and theromoregulation
Steroid hormones	Lipid metabolism, insulin resistance
Leptin	Food intake, reproduction, angiogenesis, immunity
Resistin	Inflammation, insulin resistance
P450 arom	Lipid metabolism
Apelin	Insulin resistance
Visfatin	Insulin resistance
ZAG	Lipid metabolism, cancer cachexia

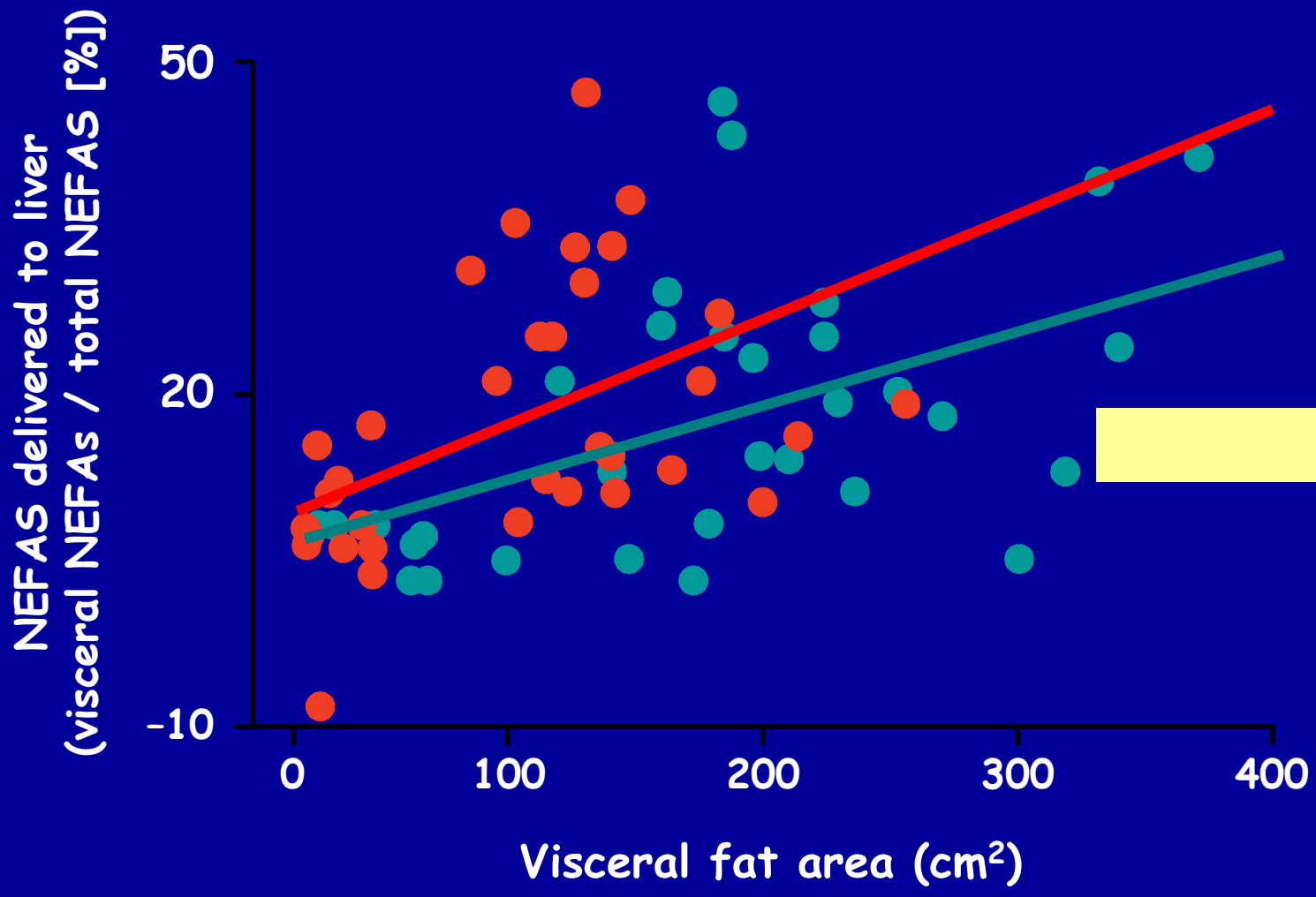
Abbreviations: LPL, lipoprotein lipase; HSL, hormone-sensitive lipase; aP2, adipocyte lipid-binding protein; RBP, retinol-binding protein; IGF-1, insulin-like growth factor-1; TGF-b, transforming growth factor-b; PPAR-g, peroxisome proliferator-activated receptor g; ZAG, zinc-a2-glycoprotein.

Flux of FFA to the Liver

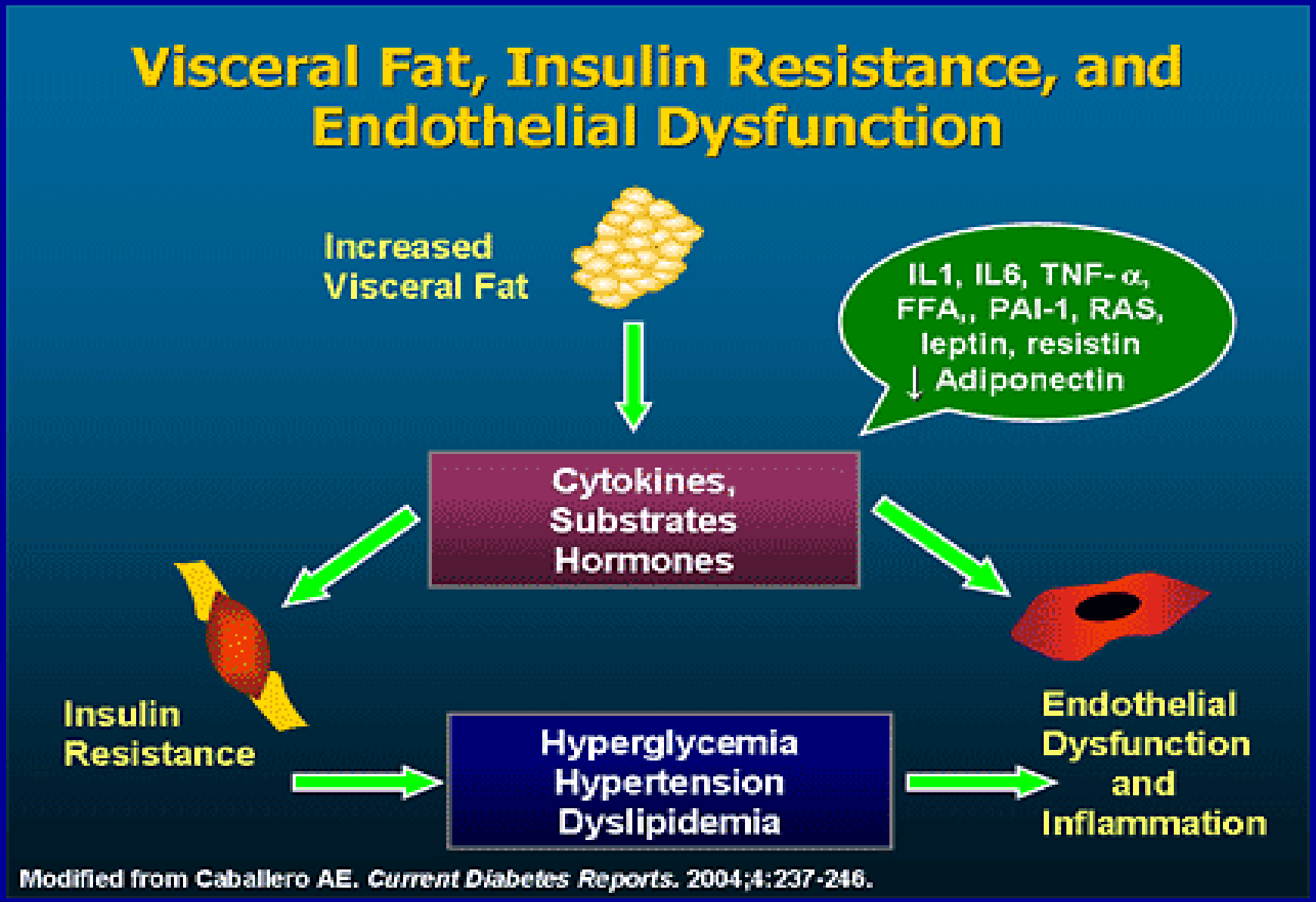
- Increased visceral adiposity
- Increased turnover of omental depot
- Extreme insulin resistance of central adipocytes
- Sympathetic activation



Nielsen S et al., JCI, 2004, 113: 1582-1588

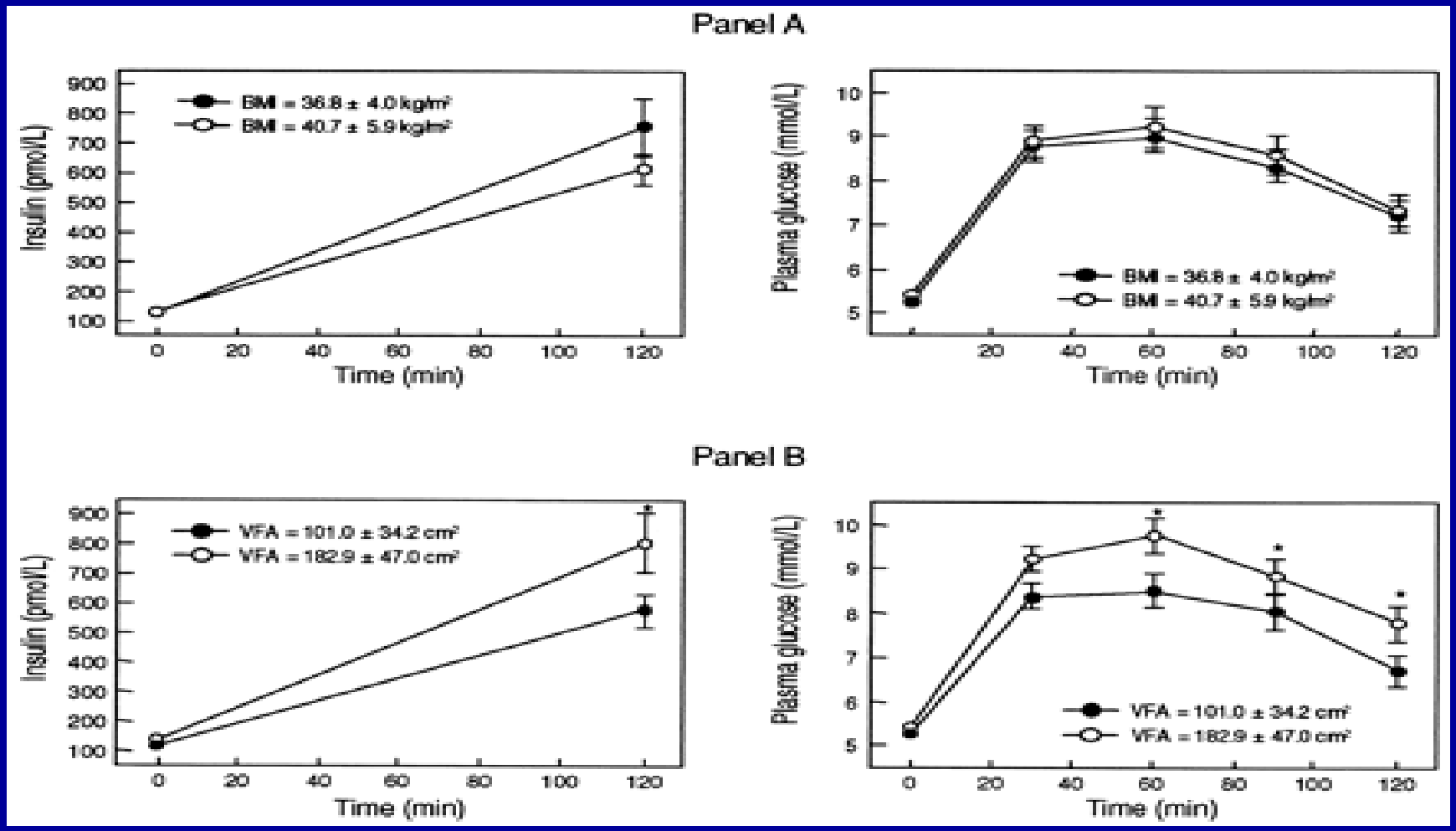


Visceral Fat, Insulin Resistance, and Endothelial Dysfunction

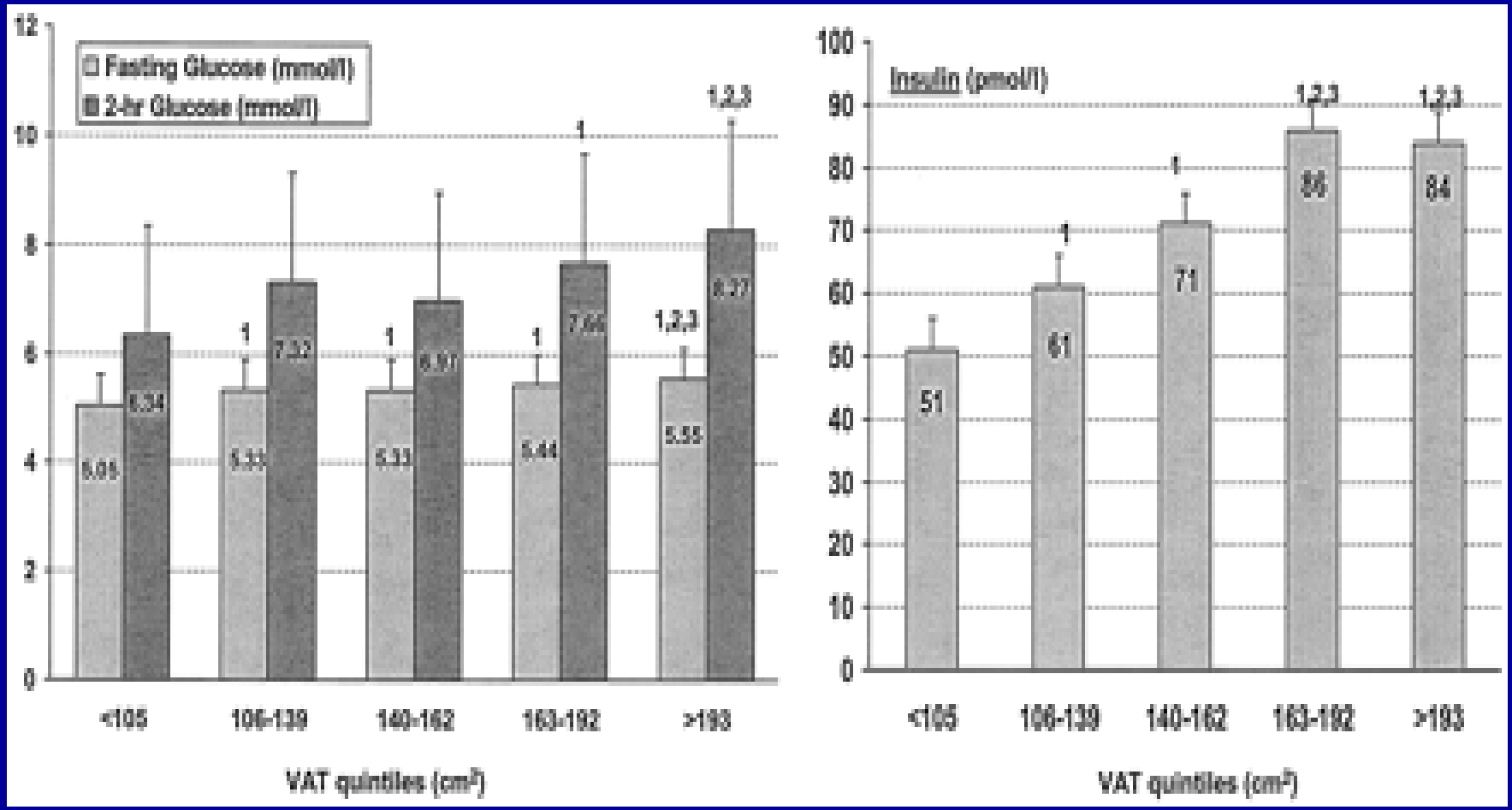


Modified from Caballero AE. *Current Diabetes Reports.* 2004;4:237-246.

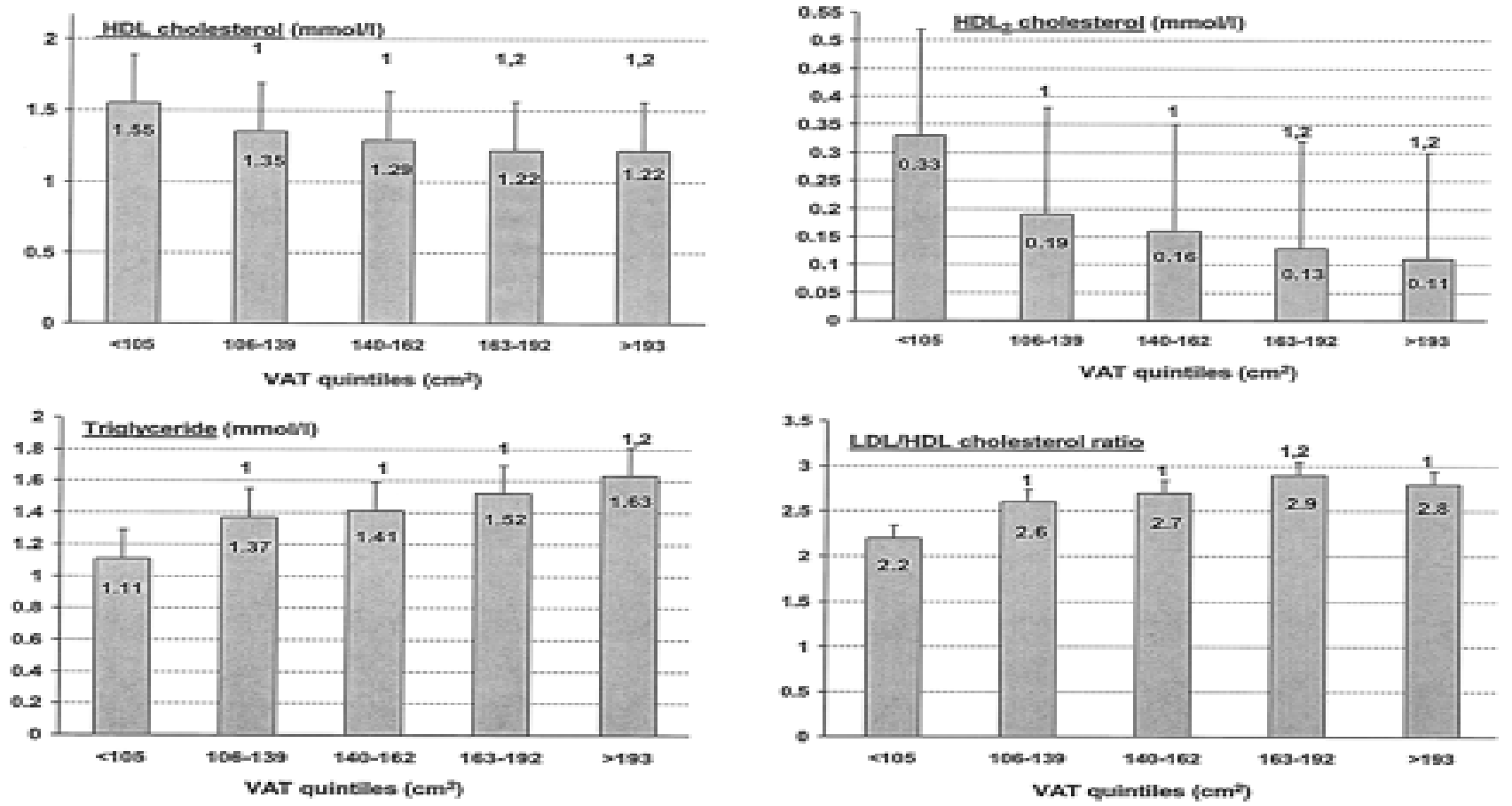
Insulin and glucose levels according to visceral fat in BMI matched female subjects (Ribeiro et al *Diab Care* 2003)



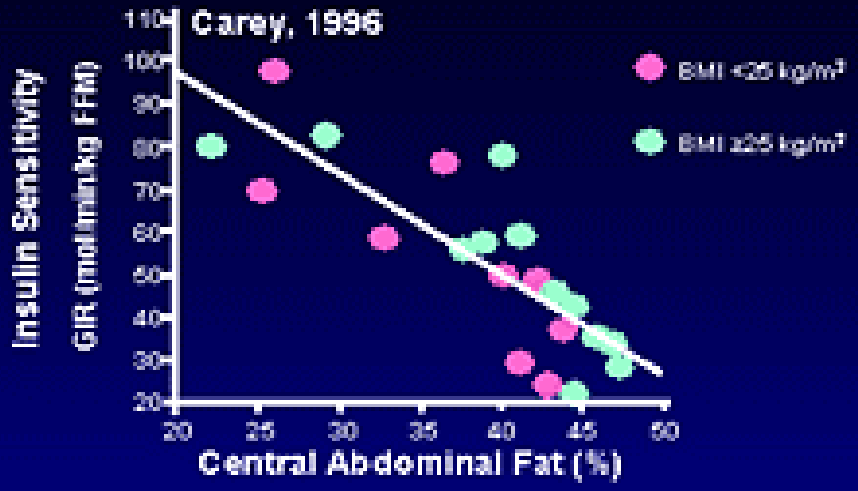
Association of visceral fat volume with glucose and insulin levels (Nicklas et al *Diab Care* 2003)

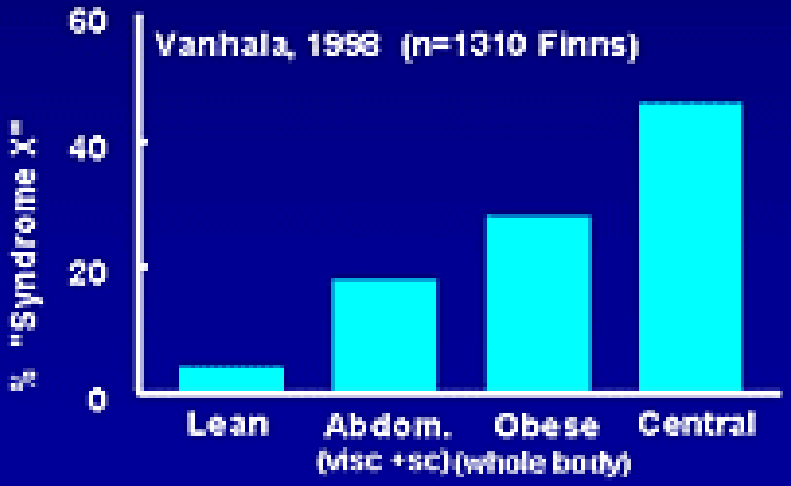


Association of visceral fat volume with lipids (Nicklas et al *Diab Care* 2003)

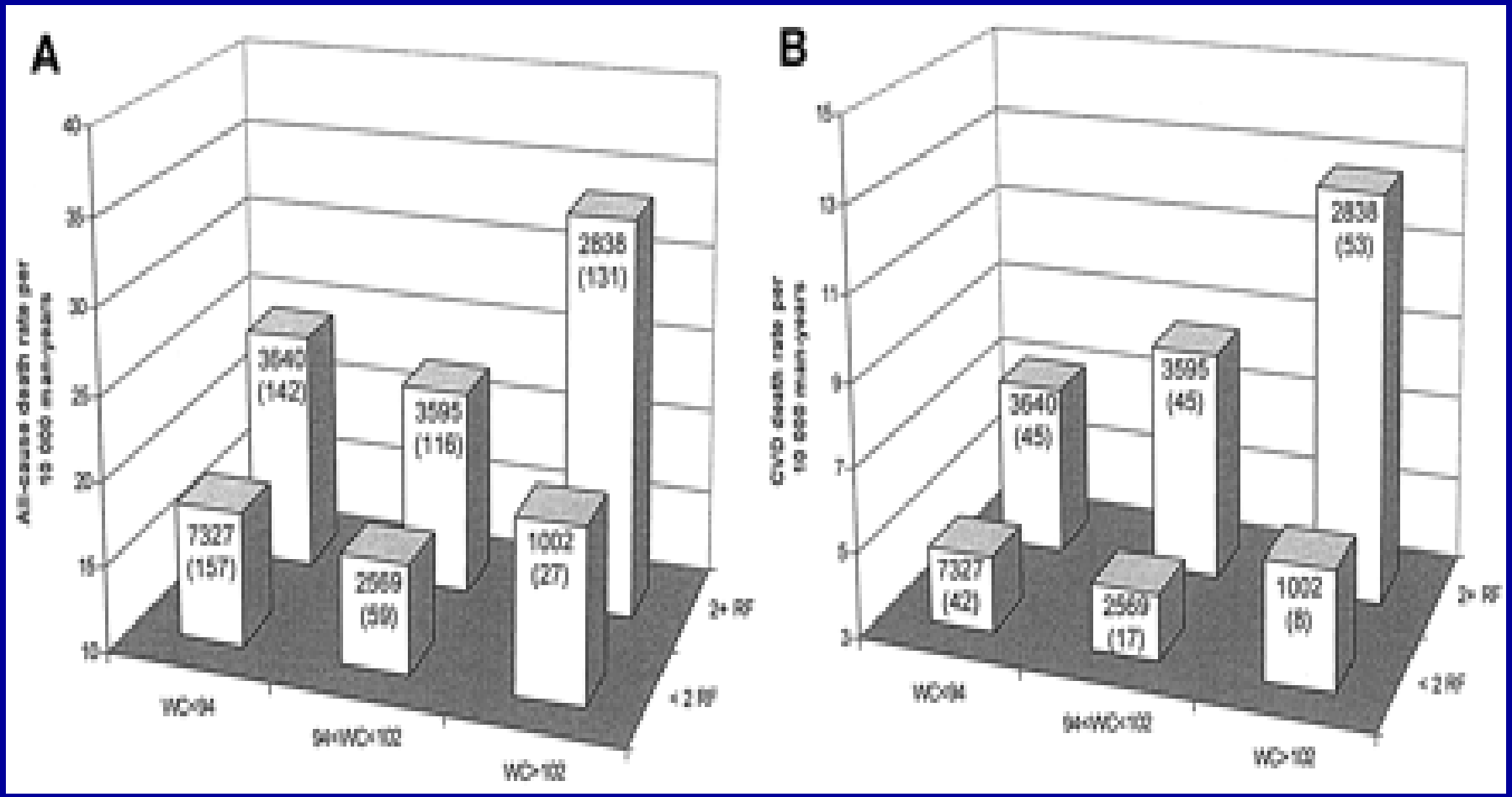


Deleterious Effects of Visceral Obesity

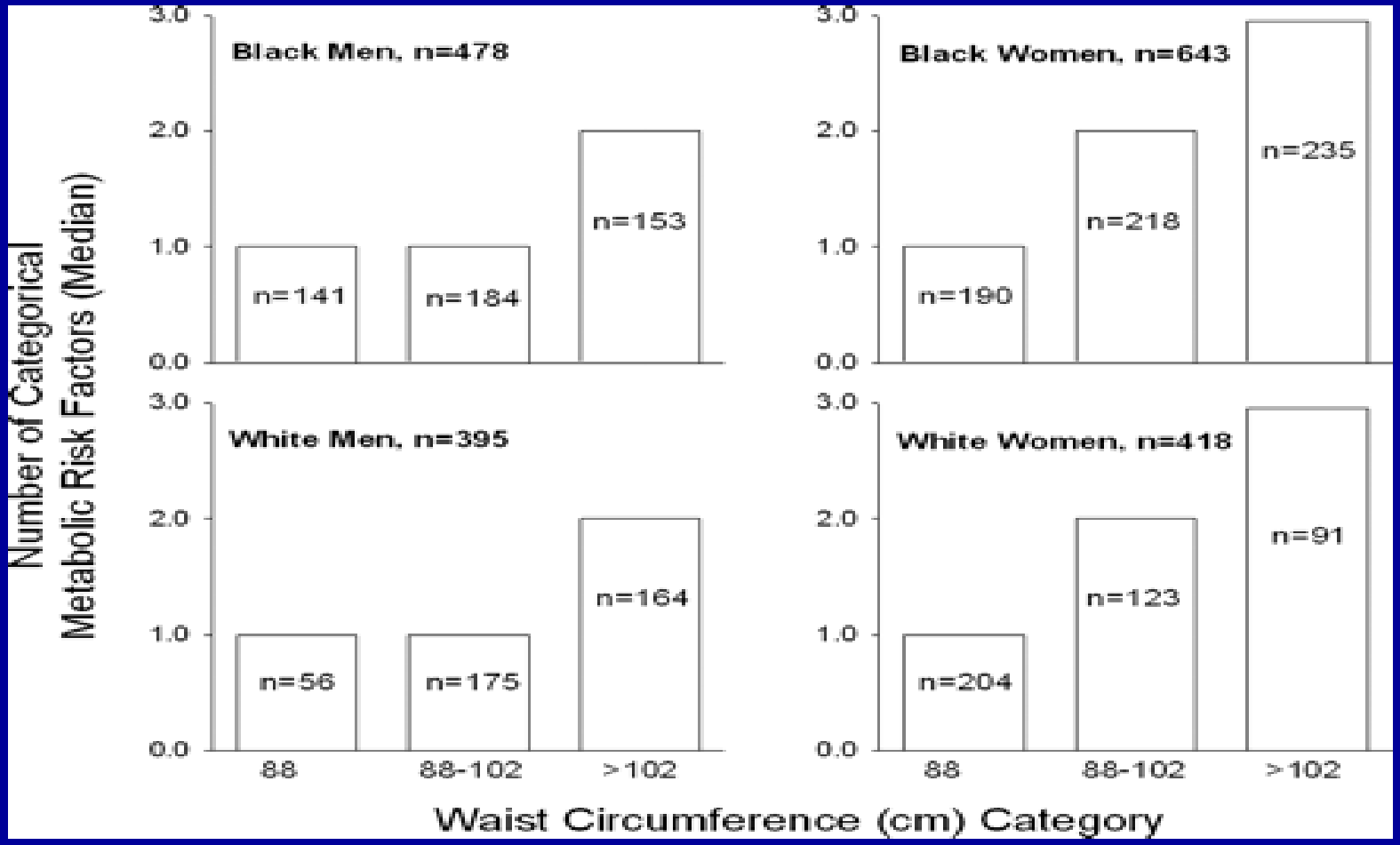




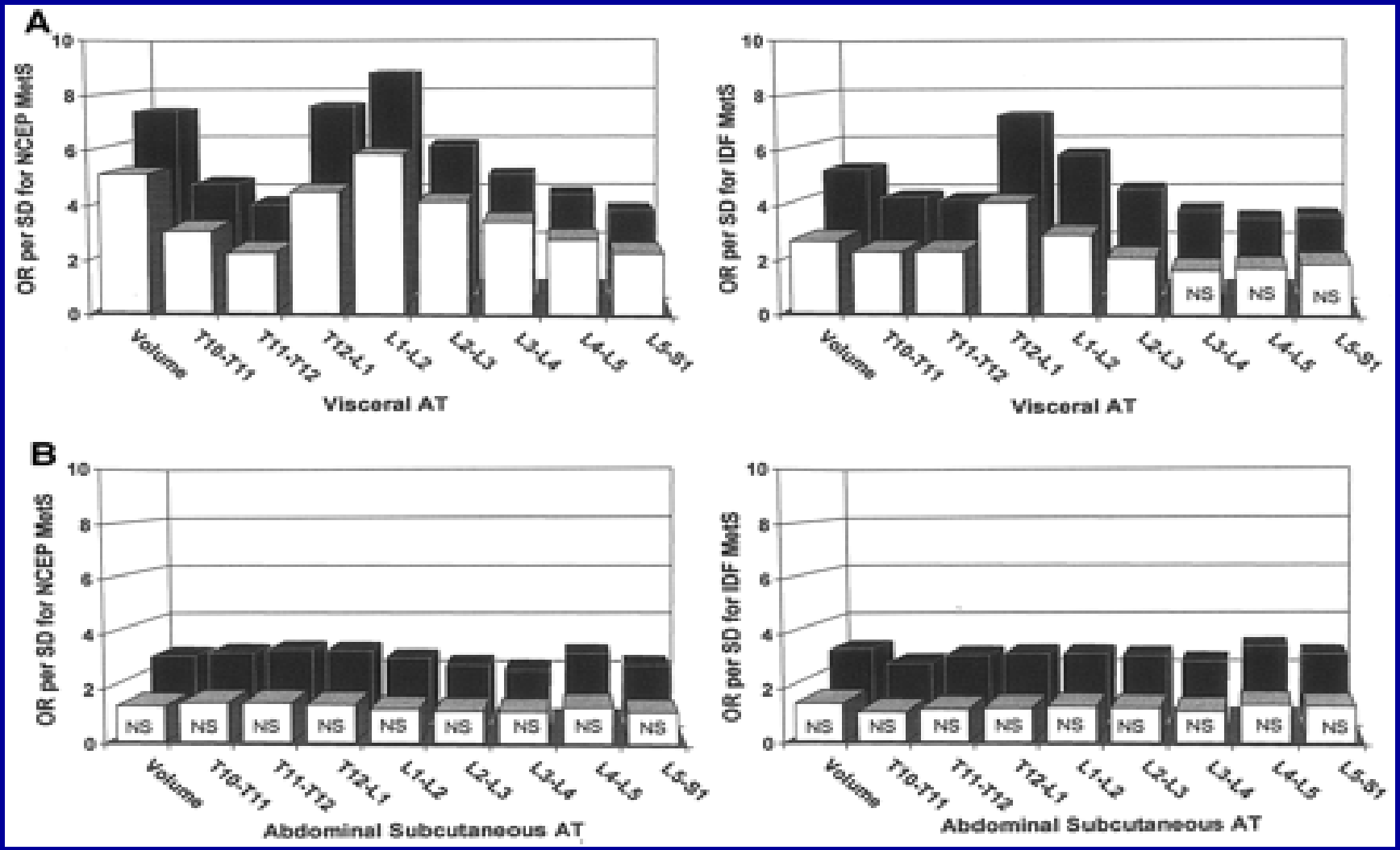
All cause (A) and CVD death (B) rates according to waist circumference levels and the presence or absence of 2 or more of other metabolic syndrome risk factors (Katzmarzyk et al *Diab Care* 2006)



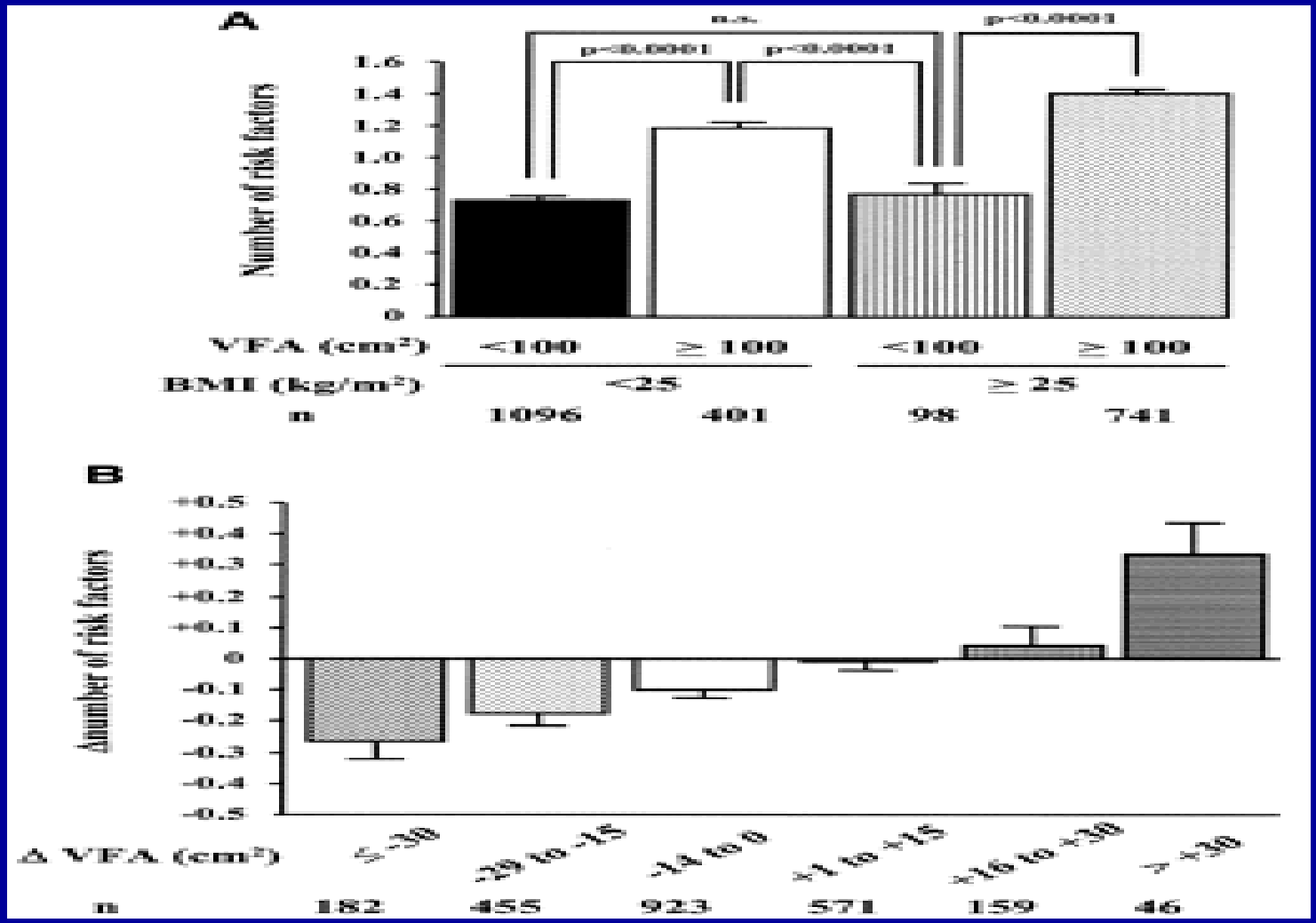
Number of metabolic risk factors according to waist circumference (Vega et al *JCEM* 2006)



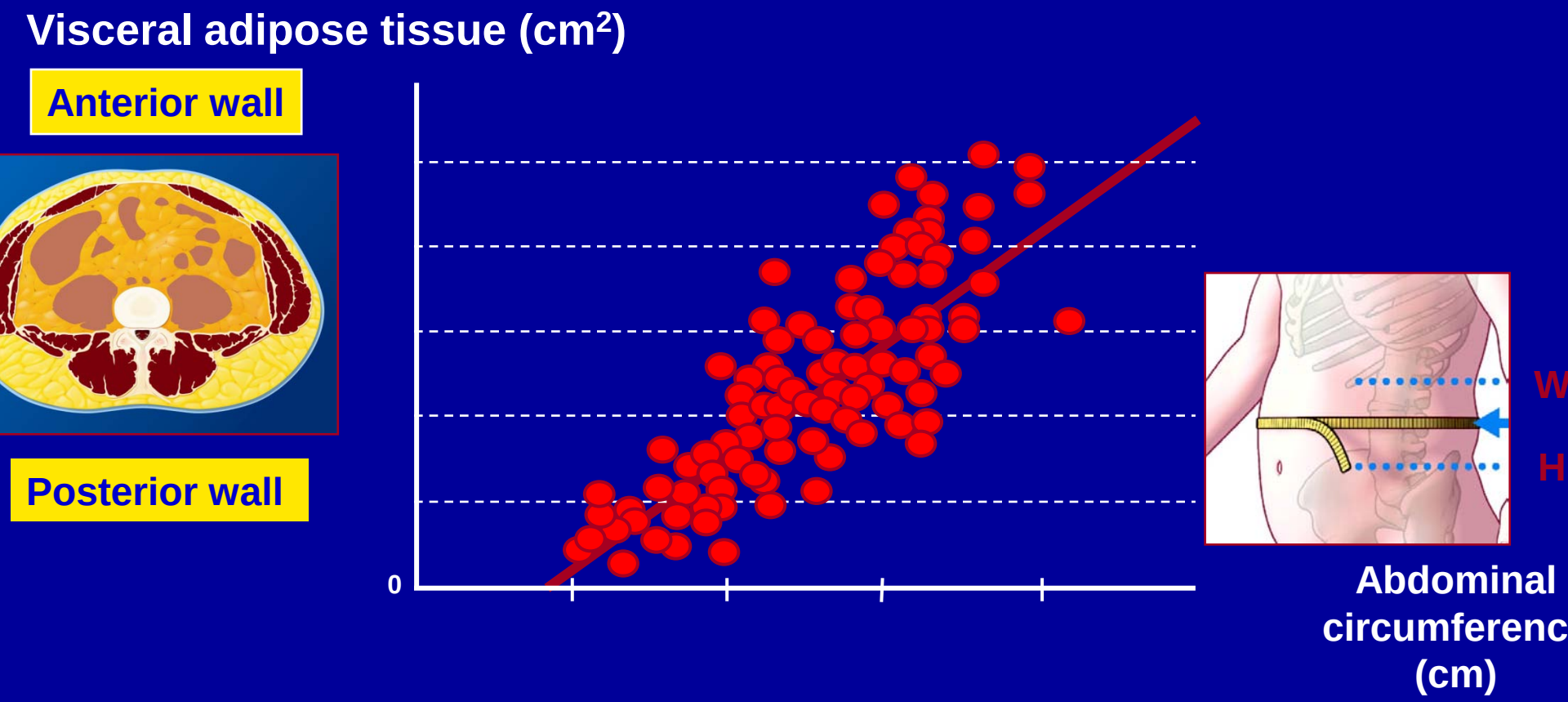
Prevalence of metabolic syndrome based on abdominal fat deposition level (Kuk JL et al *Diab Care* 2006)



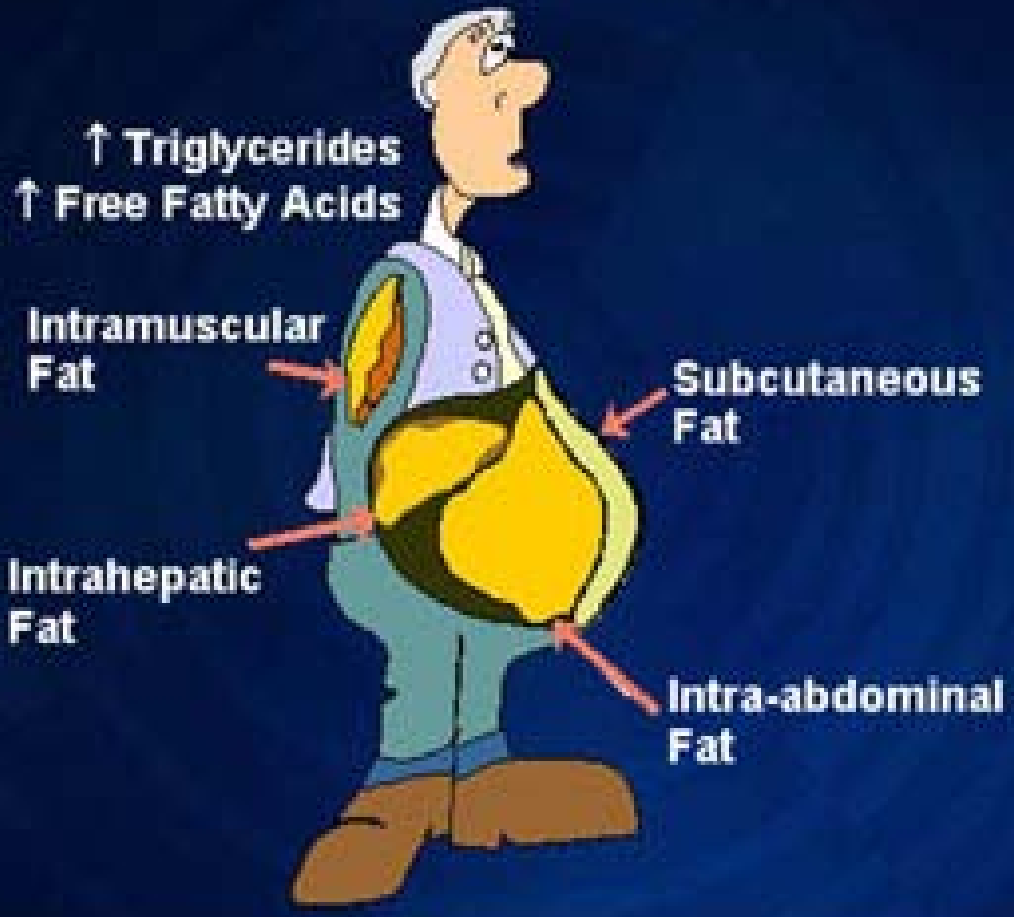
Association of change of visceral fat volume with changes of metabolic risk factors (Okauchi et al *Diab Care* 2007)



Association between waist circumference and visceral fat



Central Adiposity



Adapted from DeFronzo RA. *Br J Diabetes Vasc Dis*. 2003;3(suppl 1):S24-S40.

Joslin Diabetes Center

Is waist circumference an essential component of the Metabolic Syndrome? (Lorenzo C et al. *Diab Care* Aug 2007)

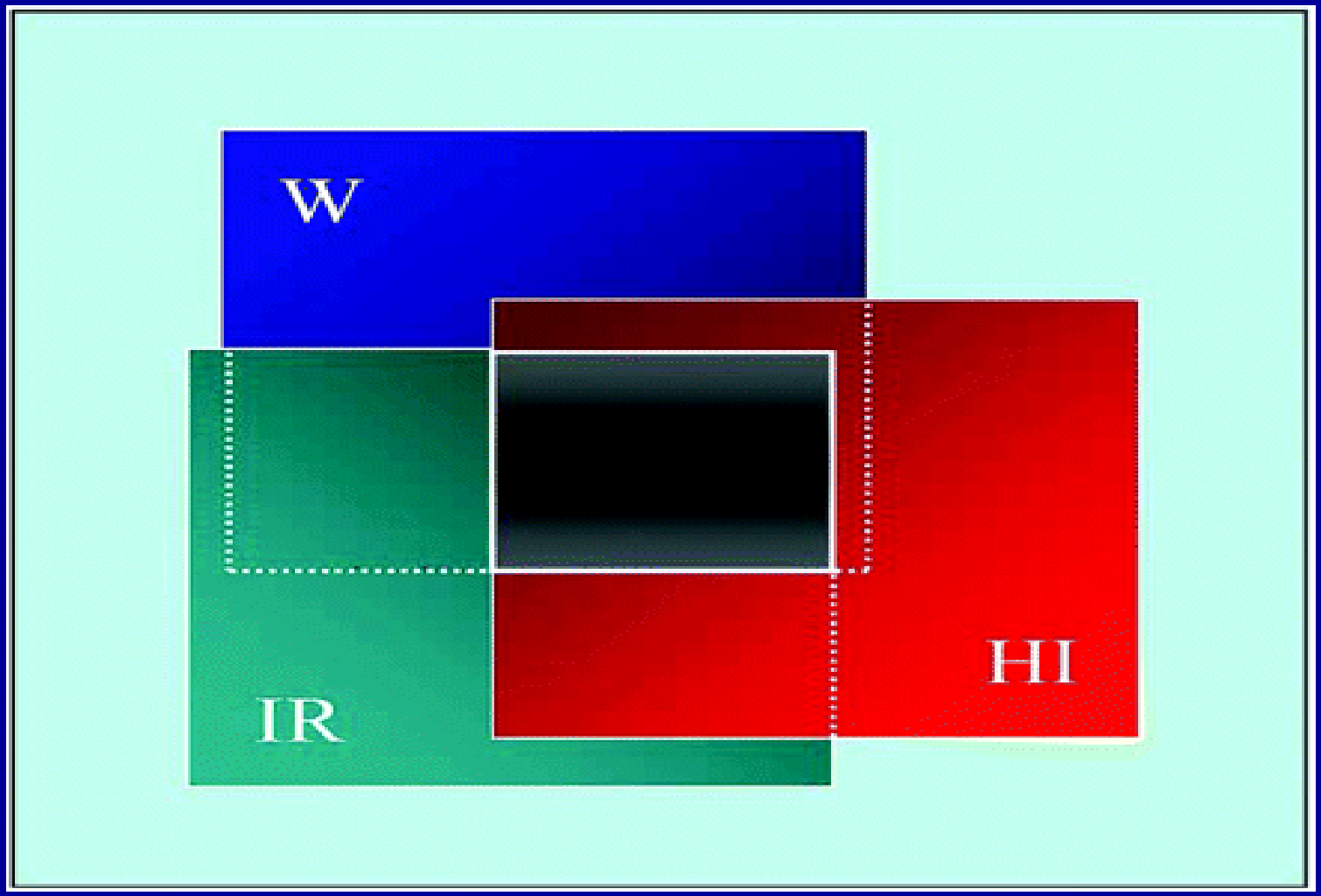
- 2 epidemiologic studies a) Mexico City Diabetes Study (more T2DM, low HDL, trigl) with 1918 subjects b) and Spanish Insulin Resistance Study (more hypertension and total chol) with 1311 subjects

- Studies based on IDF criteria on Metabolic syndrome and Framingham risk equation to estimate CHD risk

- Alexander CM et al. NCEP defined metabolic syndrome, diabetes, and prevalence of coronary heart disease among NHANES III participants age 50 years and older. *Diabetes* 52: 2003

- Girman CJ et al. An exploratory analysis of criteria for the metabolic syndrome and its prediction of long term cardiovascular outcomes: The Hoorn Study. *Am J Epidemiol* 162: 2005

Insulin Resistance, Insulin Response and Obesity as indicators of Metabolic Risk (Ferrannini E et *JCEM* Aug 2007)



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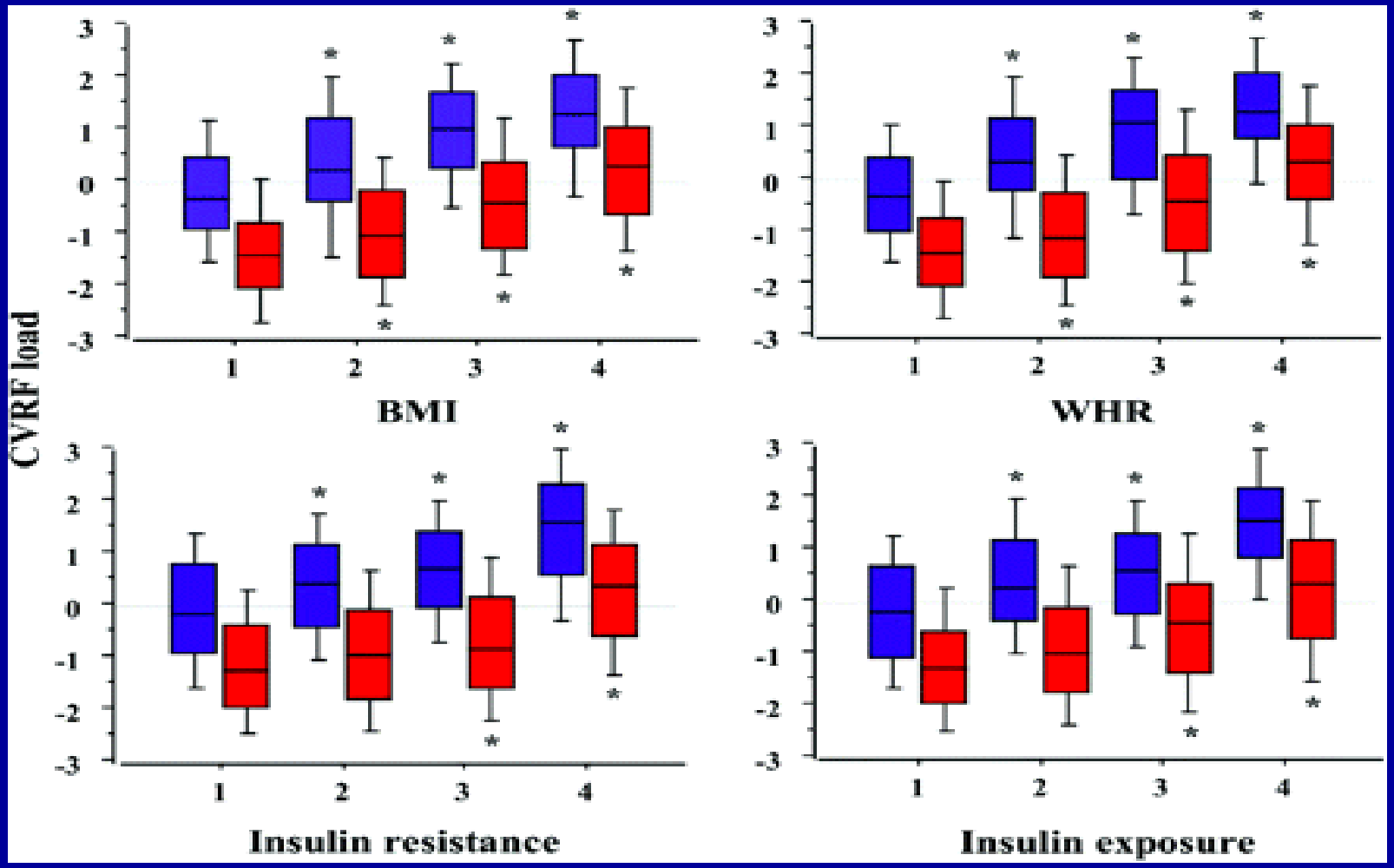
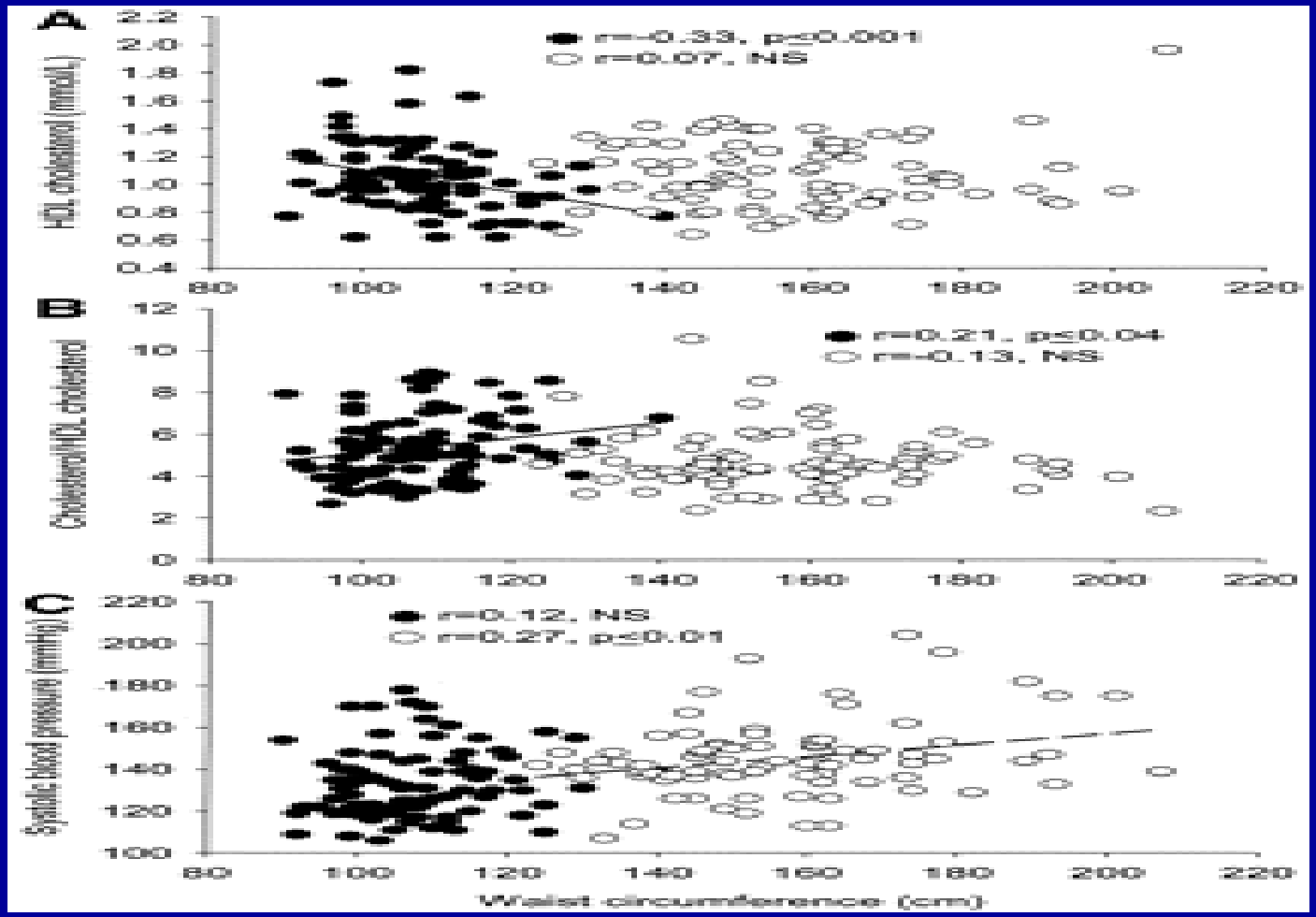


Waist does not predict metabolic complications in severely obese men (Lemieux I., Quebec Health Study, *Diab Care* 2006)

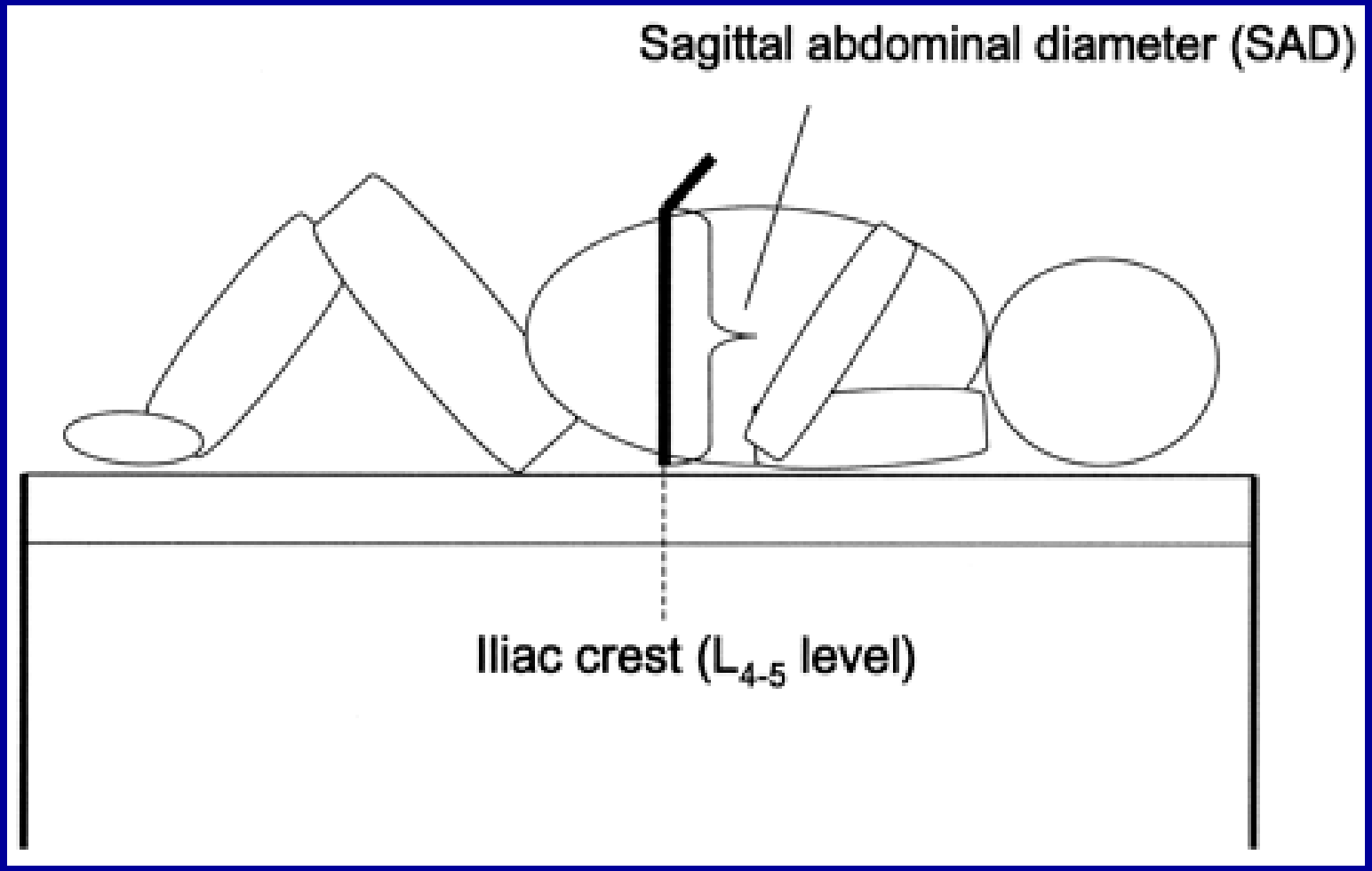


All visceral depot is not the same regarding obesity related metabolic complications

- Mauriege P et al. Regional variation in adipose tissue metabolism of severely obese premenopausal women. *J Lipid Res* 1995

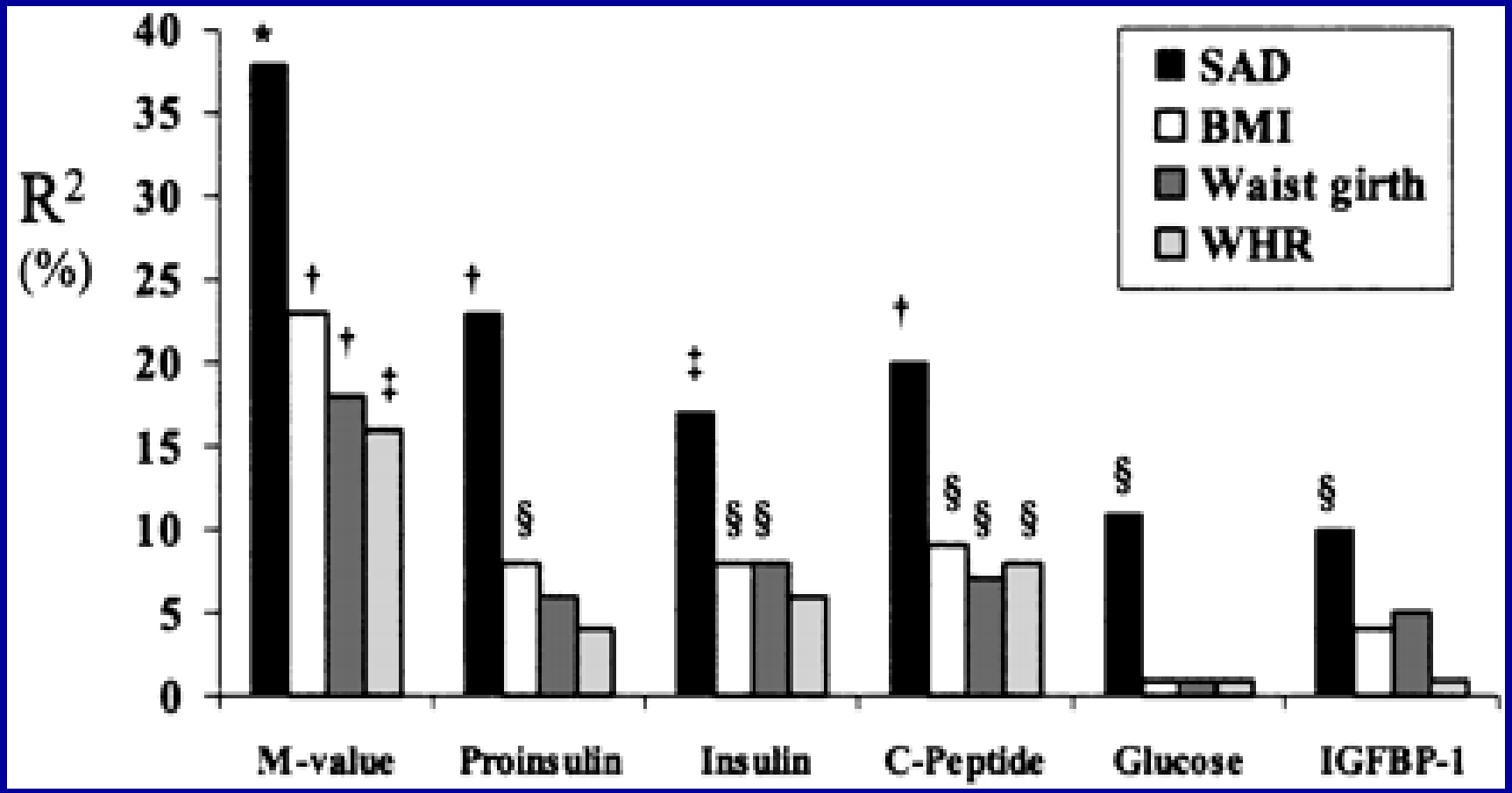
- Fried SK et al. Lipolysis in intraabdominal adipose tissue of obese women. *Obes Res*. 1993

Sagittal abdominal diameter measurement




sagittal
abdominal
diameter
TERVEYS
HÄLSA
HEALTH
2000
Measurements 6/10

Sagittal abdominal diameter a strong anthropometric marker of insulin resistance and hyperinsulinaemia in obese men (Riserus U. et al *Diab Care* 2004)



Anthropometry and CVD risk (Ohrvall et al *Int. J. Obes.2000)*

Table 6 Correlation coefficients between anthromometric measurements corrected for height and risk factors for coronary heart disease in all subjects

	SAD	*Waist*	*W/H*
S chol	0.34*	0.32*	0.29*
S LDL chol	0.34*	0.33*	0.28*
S HDL chol	− 0.34*	− 0.37*	− 0.38*
LDL/HDL	0.43*	0.43*	0.43*
S TG	0.50*	0.49*	0.48*
S glucose	0.31*	0.30*	0.26*
S insulin	0.49*	0.48*	0.44*
apo A-I	− 0.08 ($P = 0.0206$)	− 0.11 ($P = 0.0021$)	− 0.14 ($P < 0.0001$)
apo B	0.47*	0.45*	0.41*
PAI	0.50*	0.49*	0.44*
SBP	0.41*	0.37*	0.35*
DBP	0.45*	0.44*	0.42*
Alpha tocopherol	− 0.23*	− 0.22*	− 0.21 ($P < 0.0013$)

*$P < 0.0001$.
SAD = sagittal abdominal diameter. W/H = waist-to-hip ratio.

Relation of abdominal height to cardiovascular risk factors in young adults (The Bogalusa Heart Study, USA)

-

Am J Epidemiol 2000

Community based epidemiological study, Louisianna USA

-409 Blacks and 1011 whites aged 20-38 yrs, BMI 26-30 (393 white males, 606 white females, 152 black males nad 254 black females)

-Abdominal height was correlated more strongly with the coronary disease risk factor variables than were other obesity measures like waist circumference

Detection of impaired glucose tolerance and undiagnosed type 2 diabetes in UK South-Asians: an effective screening strategy (Hanif W, Valsamakis G et al. *Diab Obes Metab* in press 2007)

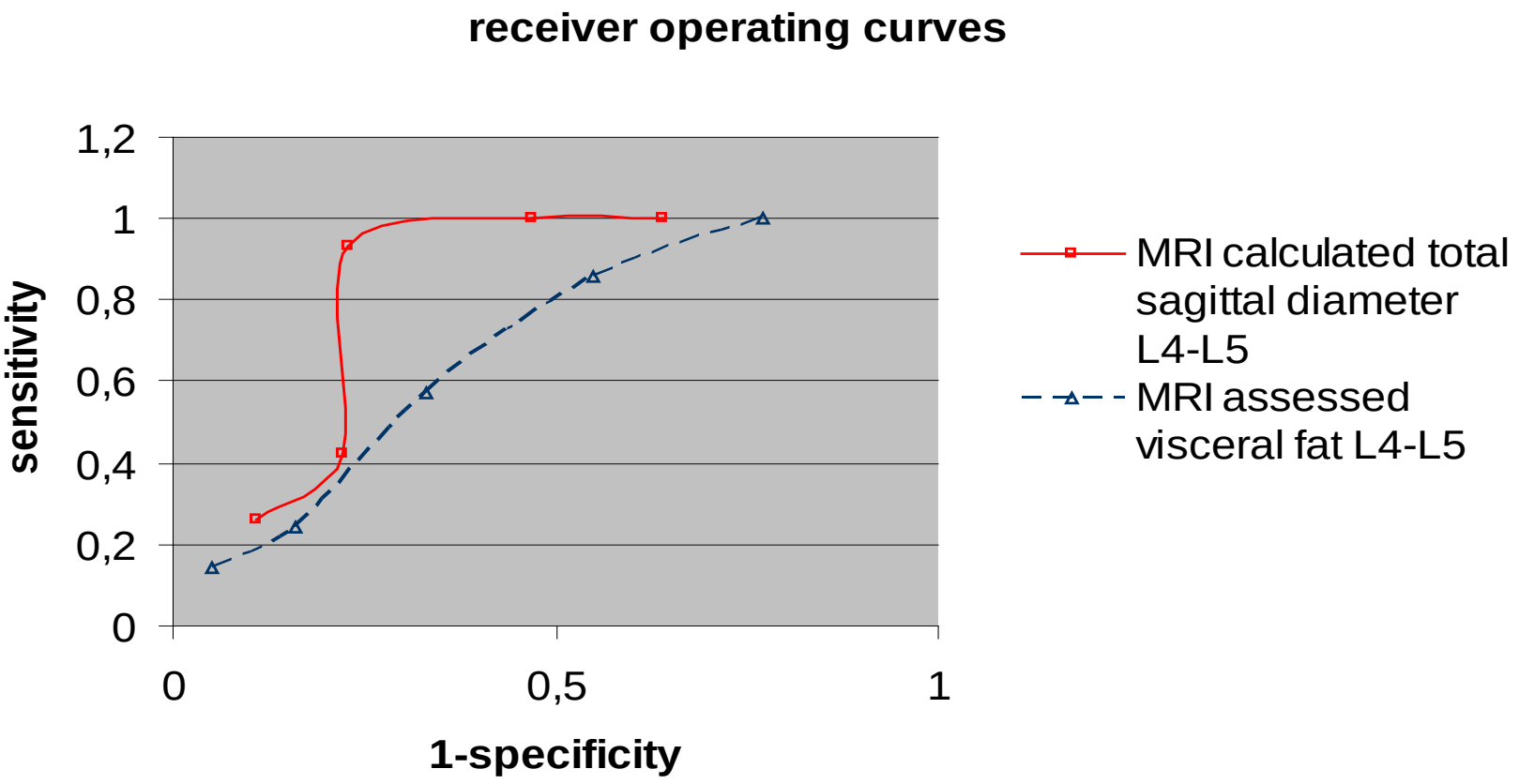
	NGT	IGT	DM	IGT+DM	All
N	97	126	74		
BMI (kg/m^2)	25.8±3.3	28.0±4.4 *	29.7±4.2 #	28.7±4.4	27.0±3.9
age	48.3 ±11.7	54.4± 11.9	48.9 ±10.5		
Weight (kg)	77.2±12.8	74.8±12.2	80.0±11.2	76.5±12.1	76.8±12.4
%BF	27.8±7.9	32.2±8.2*	31.8±11.6	32.1±8.7	30.2±8.6
Lean Body Mass (kg)	49.4±15.9	50.1±9.7	52.5±10.2	50.5±9.7	50.0±12.7
Waist circ. (cm)	93.6±16.8	96.7±19.6	98.3±19.3	97.3±19.3	95.6±18.2
Hip circ. (cm)	101.5±16.2	101.9±18.5	103.8±20.1	102.6±18.9	102.0±17.6
Sag. Diam (mm)	23.9±3.8	24.2±3.6	26.5±3.0#	24.9±3.5	24.4±3.7
OGTT Glucose 0 min (mmol/L)	5.2±0.7	5.7±1.0*	7.9±2.3# †	6.6±0.7	5.9±1.6
Random Meter Blood sugar (mmol/L)	6.3±1.3	6.9±1.6*	9.0±2.1# †	7.7±2.1	6.7±2.1
Sibling with Diabetes (%)	8.2	29.0*	37.2#	32.4	20.0
Diagn. Of Hyp. or Ischemic Dis. (%)	19.8	52.5*	65.1#	57.7	38.1

Association of simple anthropometric measures of obesity with MRI assessed visceral fat and the metabolic syndrome (Valsamakis G et al. *Diab Med* 2004)

- Anthropometric measures of sagittal diameter and waist circumference had the most significant correlation with the MRI assessed visceral fat at L4-L5

- Sagittal diameter was the most significant predictor of the metabolic syndrome status compared to waist circumference

MRI abdominal total sagittal diameter better predicts metabolic syndrome compared to visceral fat at L4-L5 level in diabetic and non-diabetic male subjects (Valsamakis G et al. *Diab Obes Metab* submitted)



Conclusions

- Abdominal-central fat is an important component of the metabolic syndrome
- All visceral depot is not the same regarding obesity related metabolic complications
- More studies are needed that will be able to more accurately predict the CVD risk of certain dimensions of central fat deposition