WAIST CIRCUMFERENCE IS AN INDEPENDENT PREDICTOR OF INSULIN RESISTANCE IN BLACK AND WHITE YOUTHS

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Objectives **We examined how well waist circumference (WC) reflects total and abdominal fat and whether WC predicts insulin resistance independent of body mass index (BMI) percentile in youths.**

Study design **Body composition was measured by dual-energy x-ray absorptiometry and abdominal adiposity by computed tomography. Insulin sensitivity was measured by the hyperinsulinemic-euglycemic clamp.**

Results **Both BMI percentile and WC were significantly associated ($P < .01$) with total and abdominal fat and insulin sensitivity. WC remained a significant ($P < .01$) correlate of total and abdominal fat and insulin sensitivity after controlling for BMI percentile. By contrast, BMI percentile did not remain a significant correlate of visceral fat and markers of insulin resistance after controlling for WC. Without exception, WC explained a greater variance in abdominal fat and metabolic profiles than did BMI percentile.**

Conclusions **Our findings suggest that the prediction of health risks associated with obesity in youths is improved by the additional inclusion of WC measure to the BMI percentile. Such observations would reinforce the importance of including WC in the assessment of childhood obesity to identify those at increased metabolic risk due to excess abdominal fat.** ***(J Pediatr 2006;148:188-94)***

Abdominal adiposity as assessed by waist circumference (WC) is a significant predictor of cardiovascular disease and type 2 diabetes independent of overall adiposity in adults.[1,2] Several epidemiological studies indicate that WC in conjunction with body mass index (BMI) is a better predictor of metabolic risk than either measure alone.[3-5] However, recent evidence [6] suggests that WC and not BMI explains obesity-related health risk in a representative sample of adult population. Although the mechanisms that explain the increased metabolic risk associated with WC are unclear, it is reported that WC is a strong predictor of abdominal fat,[7] a well-known predictor of metabolic dysfunction. The ability of WC to predict abdominal fat and related comorbid conditions in youths is currently unknown.

Despite the strong association between BMI and total fat,[8] the use of BMI as an indicator of adiposity in youths has an important limitation due to an individual's variation in growth rates and maturity levels.[9] Indeed, it has been reported that increases in BMI during childhood is largely determined by increases in lean body mass rather than fat mass.[10] Previous studies have examined the utility of WC as an index of health risk in youths.[11,12] Maffeis et al[12] demonstrated that WC is associated with fasting insulin, blood pressure, and insulin resistance index in obese girls. Whether WC is independently related to insulin sensitivity and β-cell function in children and adolescents is currently unknown.

Waist circumference during the past 10 to 20 years in youths has increased much faster than BMI over the same time period.[13] This is of great concern because abdominal fat conveys substantial health risk for cardiovascular and metabolic disease.[14] Given the escalation in the prevalence of childhood obesity and its related metabolic disorders,[15] identification of youths at high risk is important because these are antecedents of adulthood morbidities.[16,17] Thus, the purpose of this study was twofold: first, to determine how well WC reflects total, abdominal subcutaneous, and visceral fat in youths, and, second, to examine whether WC predicts insulin resistance independent of BMI percentiles.

BMI	Body mass index	WC	Waist circumference
DEXA	Dual-energy x-ray absorptiometry		

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Table I. Subject characteristics

	Black			White		
	29 M + 27 F			47 M + 42 F		
	Mean ± SD	Median	Range	Mean ± SD	Median	Range
Anthropometric						
Age (y)	12.5 ± 2.0	12.6	8.5–16.8	12.9 ± 2.1	13.1	8.0–17.2
Tanner stage						
I	14			17		
II–V	42			72		
Weight (kg)	61.7 ± 28.3	55.4	27.6–128.8	62.2 ± 27.6	53.7	25.3–139.1
BMI (kg/m^2)	25.1 ± 9.1	22.2	14.7–49.6	24.2 ± 8.0	21.8	13.9–47.1
BMI percentile	72.5 ± 27.2	81.0	4.0–99.0	70.3 ± 30.5	81.0	0.3–99.0
Waist circumference (cm)	77.4 ± 17.9	73.8	52.0–109.2	80.8 ± 20.8	76.0	51.0–139.0
Body composition						
Total body AT (kg)*	18.1 ± 15.4	12.9	2.7–51.0	17.1 ± 13.2	11.6	3.2–47.7
Total abdominal AT (cm^2)	270.1 ± 269.1	139.9	26.2–957.1	277.8 ± 249.0	182.8	31.3–930.1
Visceral AT (cm^2)	34.0 ± 29.7	19.8	3.2–108.1	41.0 ± 36.6	27.2	5.2–161.4
ASAT (cm^2)	236.1 ± 243.2	113.8	19.6–890.1	237.9 ± 216.8	157.2	20.8–822.6
Metabolic variables						
Fasting glucose (mg/dL)	95.1 ± 5.4	94.8	84.7–108.0	96.4 ± 6.2	95.3	84.3–117.7
Fasting insulin (μU/mL)	24.3 ± 18.1	17.8	8.1–91.1	24.5 ± 14.7	19.8	6.8–95.5
Proinsulin (pmol/L)†	21.8 ± 23.7	12.0	3.2–112.0	21.3 ± 20.0	12.8	3.2–108.0
Insulin sensitivity‡ (mg/min per kg FFM per μU/mL)	10.7 ± 6.3	11.4	1.1–24.2	12.6 ± 7.2	11.5	1.9–40.1

Data are shown as mean ± SD.
AT, Adipose tissue; ASAT, abdominal subcutaneous adipose tissue.
*n = 53 and n = 83 in black and white, respectively.
†n = 54 and n = 88 in black and white, respectively.
‡n = 52 and n = 83 in black and white, respectively.

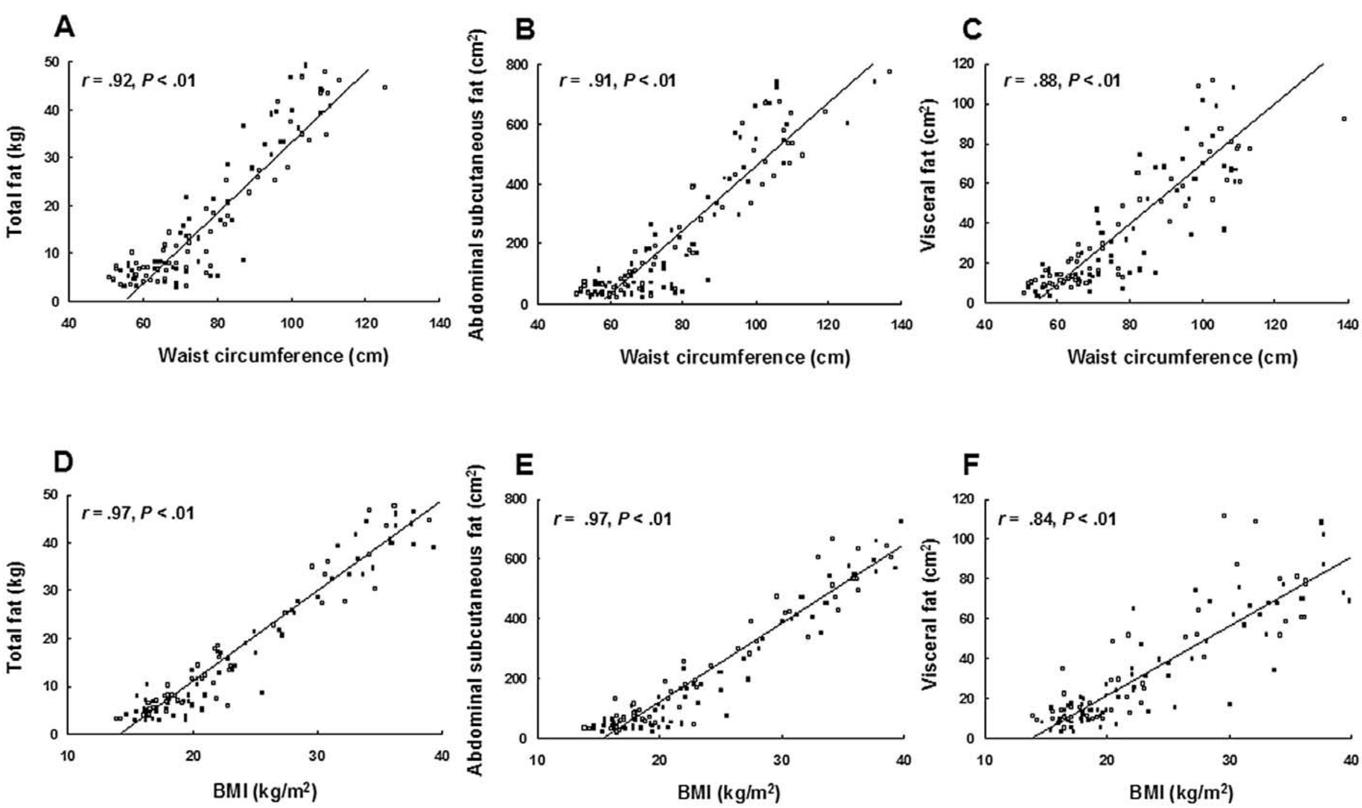

Figure 1. Association of WC (upper panel, **A** through **C**) and BMI (lower panel, **D** through **F**) with total, abdominal subcutaneous, and visceral fat. *Black squares* indicate blaack; *white squares*, white.