Waist Circumference and Waist-to-Hip Ratio Are Related to Gestational Glucose Tolerance

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OBJECTIVE — To evaluate the relationship of central fat distribution with gestational glucose tolerance during the usual time for screening gestational diabetes.

RESEARCH DESIGN AND METHODS — This cross-sectional study investigated 1,113 consecutive women, ≥20 years old, pregnant for ~21 to 28 weeks, without history of previous diabetes outside pregnancy, who attended two general prenatal care units in Porto Alegre, Brazil, from 1991 to 1993. Weight, height, waist and hip circumferences, and skinfolds were measured, and a 2-h, 75-g glucose tolerance test was performed. Data were analyzed using multiple linear regression models.

RESULTS — Waist-to-hip ratio (WHR) and waist circumference were independently associated with higher 2-h glycemia. Glycemic level was 0.11 and 0.13 mmol/l greater for each standard deviation increase in WHR (0.06) and waist circumference (8.0 cm), respectively ($P < 0.02$). Restricting analyses to the subset of women with uterine height ≤26 cm improved the association (0.13 and 0.19 mmol/l, respectively, $P < 0.02$); differences of 0.22 and 0.19 mmol/l were observed for 1 SD changes in the sum of skinfold thicknesses (24.7 mm) and in age (5.5 years), respectively.

CONCLUSIONS — Central fat distribution measured in pregnancy is an independent predictor of gestational glucose intolerance. This finding supports the concept that NIDDM and gestational diabetes are parts of the same disease, differing basically in their moment of detection. The usefulness of these anthropometric measurements in identifying pregnant women at high risk of having gestational glucose intolerance merits further investigation.

Gestational diabetes shares major etiologic and pathophysiological aspects with NIDDM, being increasingly considered as a different moment of the same disease (1–3). Central fat deposition, assessed by waist-to-hip ratio (WHR), has been recognized as an important and independent risk factor for NIDDM (4–8). Waist circumference has recently been claimed to be a better measure of risk (9,10). WHR measured in a nonpregnant state has been associated with previous (11) and posterior (12) gestational diabetes occurrence, but the association has not been evaluated during pregnancy, perhaps in part because of concerns of measurement error owing to uterine growth to the waistline.

This study evaluates the independence and strength of the relationships of WHR and waist circumference with gestational glucose tolerance, assessed during the usual time for screening gestational diabetes.

RESEARCH DESIGN AND METHODS

— A cross-sectional study of consecutive pregnant women was conducted in two general prenatal care units from 1991 to 1993 in Porto Alegre, Brazil. The study examined women ≥20 years old, without history of previous diabetes outside of pregnancy and at ~21–28 gestational weeks. Of the 1,113 women enrolled, 73 did not complete glucose testing and 15 were excluded because they had twins or had already been enrolled with a previous pregnancy in the study, leaving 1,025 for the analyses.

At enrollment, a standardized questionnaire was applied and anthropometric measurements were obtained in duplicate, according to a standard protocol (13). Measurements included weight, height, waist circumference (at the point of minimal abdominal girth), hip circumference (at maximal gluteal protrusion, viewed laterally), and skinfold thicknesses (bicipital, tricipital, subscapular, and suprailiac). Glycemia during a standardized 2-h, 75-g anhydrous glucose tolerance test (14) was measured by enzymatic method. As collection rooms were not temperature conditioned, ambient temperature on mornings of tolerance testing was recorded. The study protocol was approved by the local institutional ethics committees.

Data were analyzed using multiple linear regression, with 2-h glycemia as the dependent variable and WHR or waist as independent variables. Control variables were age, sum of skinfold thicknesses, height, ambient temperature, number of previous pregnancies, family history of diabetes, uterine height, skin color, obstetric antecedents, years of education, and prenatal clinic. Final models included only variables statistically associated with glycemia ($P < 0.05$). Statistical analyses were performed with the SPSS statistical package (15).

RESULTS

— Among the 1,025 women studied, mean ± SD age was 27.8 ± 5.5 years; mean BMI before pregnancy and at enrollment was 23.9 ± 4.0 and 26.7 ± 4.0 kg/m^2, respectively; mean uterine height was 21.9 ± 3.3 cm, and gestational age at enrollment was 23.4 ± 3.2 weeks. In the group, 66% were white, 16% black, and 17% of other color, mainly an admixture of black, white, and of American Indian ancestry. Family history of diabetes in at least one

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WHR, waist-to-hip ratio.

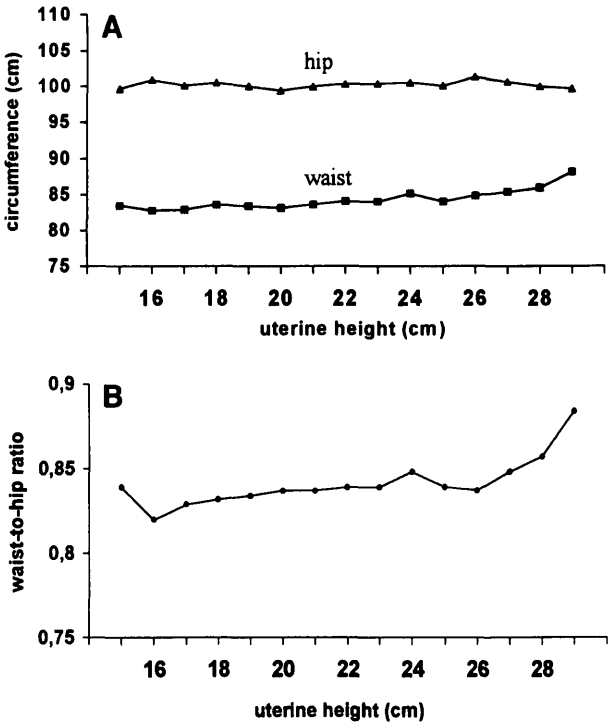

Figure 1—*Variation of waist and hip* (A) *and WHR* (B) *according to uterine height and adjusted by BMI at enrollment* (n = *959*).

parent was present in 15%. Ambient temperature ranged from 5 to 31°C on test mornings. WHR, waist circumference, and 2-h glycemia had approximately normal distributions, with mean ± SD of 0.84 ± 0.06, 83.5 ± 8.0 cm, and 5.7 ± 1.4 mmol/l, respectively. Four women (0.3%) presented gestational diabetes mellitus (2-h glycemia ≥ 11.1 mmol/l) and 71 (6.9%), gestational impaired glucose tolerance (2-h glycemia 7.8–11.0 mmol/l).

Figure 1 shows the variation of waist and hip (*A*) and WHR (*B*) according to uterine height and adjusted by BMI at enrollment. Mean hip circumference showed little variation over this period. Waist increased slightly up to a uterine height of 27 cm. Beyond this point, it increased more notably. This change at 27 cm becomes clearer when the progression of WHR is plotted.

Linear regression modeling of these increases, controlling for the effects of age, BMI, number of previous pregnancies, and prenatal clinic, showed WHR to be only 0.0015 larger for each additional centimeter of uterine height for the 873 women measured with uterine heights ≤26 cm ($P < 0.01$). For the 86 women measured with uterine heights ≥27 cm, the relationship was almost five times larger, with ratio being 0.007 greater per centimeter of uterine height ($P < 0.1$). Similar results were obtained in regression analyses of waist circumference.

Table 1 shows a positive association between the two measures of central fat deposition during pregnancy and gestational 2-h glycemia, independent of age, skinfold thickness, height, ambient temperature, number of previous pregnancies, family history of diabetes in at least one parent, uterine height, skin color, obstetric antecedents, years of education, and prenatal clinic. Uterine height and sum of skinfold thicknesses were included in these analyses, instead of gestational age and BMI, because of their greater association with 2-h glycemia in bivariate analyses and because each one is more closely related, conceptually, to the phenomenon being measured: presence of the uterine fundus at the waistline and global adiposity in pregnancy, respectively. Glycemic level was 0.11 and 0.13 mmol/l greater for each standard deviation increase in WHR (0.06) and waist circumference (8.0 cm), respectively ($P < 0.02$). Repeated analyses including only women with uterine height of 26 cm or less improved the magnitude of the differences (0.13 and 0.19 mmol/l, respectively, $P < 0.02$). For the sake of comparison, in the latter waist circumference model, 1 SD changes in the sum of skinfold thicknesses (24.7 mm) and in age (5.5 years) were associated with glycemia differences of 0.22 and 0.19 mmol/l, respectively.

CONCLUSIONS — To date, few studies have evaluated central fat deposition during pregnancy, these principally investigating the evolution of repeated skinfold measures (16–18). Our data suggest that WHR and waist circumference can be used to estimate body fat distribution during pregnancy, at least until 26 cm of uterine height, which corresponds in average to a gestational age of 26 weeks (19,20). The gradual increase until this point appears to be mainly the result of central fat deposition related to pregnancy, consistent with previously demonstrated increases in central skinfold measurements (16,17). Most official groups recommend that screening for gestational glucose intolerance be performed between 24 and 28 gestational weeks (21–24). Our results suggest that measurements of waist up to this period will be influenced minimally by uterine growth.

Central fat deposition, measured either by WHR or by waist circumference, was

Table 1—*Difference in 2-h glycemia post 75-g glucose load associated with changes in measures of central adiposity of pregnant women ≥20 years old, Porto Alegre, Brazil, 1991–1993*

	Difference in glycemia (mmol/l)			
	Complete sample (n = 955)		Uterine height ≤26 cm (n = 870)	
	For 1 unit change	For 1 SD change	For 1 unit change	For 1 SD change
WHR (1 SD = 0.06)	1.85	0.11	2.20	0.13
Waist circumference (1 SD = 8.0 cm)	0.016	0.13	0.024	0.19

All associations were statistically significant ($P < 0.02$). Data were obtained through multiple linear regression models (separately for WHR and for waist circumference), controlling for height, sum of skinfold thicknesses, age, ambient temperature, number of pregnancies, and prenatal clinic.

independently associated with gestational glucose tolerance. The strength of this association (up to 0.19 mmol/l for a 1-SD difference of waist circumference) approximates those of similarly assessed differences in global obesity and age, the two strongest known risk factors for gestational diabetes. Consistent with previous reports in the nonpregnant state (9,10), waist circumference appears to be a somewhat better correlate of glucose intolerance than WHR, probably due to a small reduction in the association of glucose intolerance with obesity when waist is used instead of WHR (data not shown).

In conclusion, this report suggests that central fat distribution measured in pregnancy is an independent risk factor for gestational glucose intolerance. These findings support the hypothesis that NIDDM and gestational diabetes have similar pathophysiological bases, differing principally in their moment of detection. The usefulness of these anthropometric measurements in identifying pregnant women at high risk of having glucose intolerance merits further investigation.

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