Waist-to-Height Ratio Is Independently and Better Associated With Urinary Albumin Excretion Rate Than Waist Circumference or Waist-to-Hip Ratio in Chinese Adult Type 2 Diabetic Women but Not Men

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Extreme obesity has been shown to be associated with focal-segmental glomerulosclerosis and nephrotic syndrome in a report of four cases (1). However, this association has not gained much attention until recently when histologically proven glomerulopathy was demonstrated in animals (2) and humans (3). The study of renal biopsy taken from humans included mostly patients with clinical proteinuria or proteinuria with renal insufficiency (3). Therefore, whether obesity is associated with nephropathy in the early stage of microalbuminuria is not yet proven. This study evaluated the effects of the commonly used indicators for obesity (i.e., BMI, waist circumference, waist-to-hip ratio [WHR], and waist-to-height ratio [WHeiR]) on the urinary albumin excretion rate (UAER) in the early normo- or microalbuminuric stages in type 2 diabetic patients.

RESEARCH DESIGN AND METHODS

— A total of 569 (282 men and 286 women) type 2 diabetic patients, aged 63.6 ± 11.0 years, were recruited. Measurements of body height, body weight, waist circumference, and hip circumference were described elsewhere (4). BMI was calculated as body weight (in kilograms) divided by the square of height (in meters). WHR and WHeiR were calculated by dividing the waist circumference by the hip circumference and the body height, respectively.

The patients' age, sex, diabetes duration, and systolic (sBP) and diastolic blood pressure (dBP) were recorded or measured. Urine specimens and blood samples were collected in the morning after fasting for 12 h. Fasting plasma glucose (FPG), serum creatinine, HbA_{1c} (A1C), and urinary albumin and creatinine concentrations were measured (5,6). Urinary albumin-to-creatinine ratio (ACR) was calculated by dividing the urinary albumin concentration in micrograms by the urinary creatinine concentration in milligrams. ACR <30.0 μg/mg was defined as normoalbuminuria and 30.0–299.9 μg/mg as microalbuminuria (7). Creatinine clearance (CCr) (in milliliters per minute) was calculated from the Cockcroft-Gault formula as (140 − age in years) × body weight in kg]/(72 × serum creatinine in mg/dl) (8). For women, the calculated values were multiplied by 0.85 (8).

Because the distribution of ACR was highly skewed, the natural logarithm of ACR [ln(ACR)] was used for analyses. A $P < 0.05$ was considered statistically significant, while $0.05 < P < 0.1$ was borderline significant. The baseline characteristics and anthropometric factors were compared between patients with normo- and microalbuminuria by Student's t test for continuous variables and by χ^2 test for categorical variables in separate sexes. Logistic regression models were created to estimate the odds ratios (ORs) for microalbuminuria with adjustment for age, diabetic duration, A1C, sBP, and calculated CCr.

RESULTS

— Table 1 compares the characteristics between patients with normoalbuminuria and those with microalbuminuria. In men, the difference between the two groups was significant for age, sBP, dBP, ln(ACR), and CCr and borderline significant for FPG. None of the anthropometric factors differed significantly. Conversely, FPG, A1C, sBP, dBP, waist circumference, WHR, WHeiR, and ln(ACR) differed significantly and BMI was borderline significant between the two groups in the diabetic women.

None of the adjusted ORs for microalbuminuria for the anthropometric factors was significant in men. But in women the adjusted ORs for waist circumference (every 1-cm increment) and WHeiR (every 0.1-unit increment) were significant and for BMI (every 1-kg/m^2 increment) and WHR (every 0.1-unit increment) were borderline significant. The respective ORs were 1.029 (95% CI

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Abbreviations: ACR, albumin-to-creatinine ratio; CCr, creatinine clearance; dBP, diastolic blood pressure; FPG, fasting plasma glucose; sBP, systolic blood pressure; UAER, urinary albumin excretion rate; WHeiR, waist-to-height ratio; WHR, waist-to-hip ratio.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Comparisons between normoalbuminuria and microalbuminuria by sex*

	Men		Women	
Variables	Normoalbuminuria	Microalbuminuria	Normoalbuminuria	Microalbuminuria
n	181	101	165	121
Age (years)	61.1 ± 11.1	65.7 ± 12.4†	64.0 ± 9.9	65.1 ± 10.6
Diabetic duration (years)	10.0 ± 7.3	10.9 ± 7.1	10.8 ± 7.2	11.2 ± 7.0
Fasting plasma glucose (mg/dl)	167.7 ± 58.1	181.5 ± 79.1‡	169.7 ± 63.6	186.1 ± 71.8*
A1C (%)	8.2 ± 2.0	8.4 ± 2.0	8.2 ± 2.0	8.7 ± 2.1*
sBP (mmHg)	132.9 ± 15.5	136.9 ± 16.1*	135.8 ± 14.8	141.2 ± 18.1†
dBP (mmHg)	85.9 ± 8.0	88.4 ± 7.7*	86.3 ± 8.4	89.2 ± 8.7†
BMI (kg/m^2)	25.3 ± 3.0	24.9 ± 3.2	24.5 ± 3.5	25.3 ± 4.0‡
Waist circumference (cm)	89.9 ± 8.1	89.7 ± 8.7	87.1 ± 10.4	90.1 ± 10.4*
WHR	0.95 ± 0.05	0.96 ± 0.06	0.93 ± 0.08	0.95 ± 0.08*
WHeiR	0.54 ± 0.05	0.55 ± 0.06	0.57 ± 0.07	0.59 ± 0.07†
Ln(ACR) (μg/mg)	2.3 ± 0.7	4.3 ± 0.6†	2.5 ± 0.6	4.3 ± 0.6†
Calculated CCr (ml/min)	75.8 ± 27.0	64.7 ± 27.2†	61.2 ± 17.4	59.3 ± 24.1

Data are means ± SD. *$P < 0.05$; †$P < 0.01$; ‡$0.05 < P < 0.1$.

1.003–1.055), 1.644 (1.129–2.395), 1.070 (0.997–1.149), and 1.318 (0.965–1.799).

CONCLUSIONS — The findings supported that central obesity was associated with increased UAER in the early stages of kidney disease without clinical macroalbuminuria in type 2 diabetic women but not in men. BMI is not a good indicator of central obesity and therefore was not significantly associated with microalbuminuria in either the diabetic men or women (borderline significant, Table 1).

For the measurement of central obesity, a variety of deliberate methods have been used, including magnetic resonance images or computed tomography (9,10). Clinically, these techniques are not practical, and waist circumference, WHR, and WHeiR are used as surrogate markers. In the present study, all of these three measurements were significantly associated with microalbuminuria in women in univariate analyses (Table 1). However, only waist circumference and WHeiR were associated with microalbuminuria in the logistic models in the diabetic women after multivariate adjustment. The magnitude of the OR for WHeiR was larger than for waist circumference, suggesting the superiority of WHeiR to waist circumference. The measurement of WHeiR has only been suggested as an indicator of central obesity in the past decade, but its usefulness has long been neglected. The particular advantages of WHeiR over waist circumference or WHR are its better measurement of the relative fat distribution among subjects of different age and statures (11–13) and its unisex action levels because both sexes have closer values of WHeiR than BMI, waist circumference, or WHR (13,14). This is probably the first study adding the usefulness of WHeiR in its association with elevated UAER in the diabetic women. Therefore, the clinical usefulness of WHeiR should be brought to attention and is worthy of further investigation.

The lack of an association between the anthropometric factors and microalbuminuria in the diabetic men suggested that the risk factors might be different between men and women and that some factors other than central obesity might be more important in the diabetic men. However, another possibility is that the surrogate markers for central obesity used in this study might be less applicable to the diabetic men than to the diabetic women. Therefore, further studies using more sophisticated methods for defining central obesity are necessary to conclude a lack of association in the diabetic men. Whether sex hormones can have a role in the interaction with the association is worthy of further investigation.

Several limitations deserved mentioning. First, the study used surrogate markers for central obesity rather than quantifying the abdominal fat content by more sophisticated techniques. Second, generalization of the findings to nondiabetic subjects requires further confirmation. Lastly, the pathophysiological mechanisms of obesity-induced kidney disease require future investigations.

In conclusion, this study demonstrated a close and independent association between central obesity and elevated UAER in the diabetic women. WHeiR seems to be a better indicator for central obesity in its association with UAER than waist circumference or WHR.

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