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Inverse association between body mass index and chronic kidney disease in older diabetic adults

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ABSTRACT

Purpose: To identify associations among body mass index (BMI), diabetes, and chronic kidney disease (CKD) in older adults in Taiwan.
Methods: This study enrolled 3334 participants aged 65 years and above who underwent an annual health screening at a medical center from January 2006 to December 2010. CKD was defined as an estimated glomerular filtration rate less than 60 mL/min/1.73 m^2. A multiple logistic regression analysis was used to determine associations among BMI, diabetes, and CKD.
Results: The prevalence rate of CKD was 19.7% and 10.5% in diabetic and nondiabetic subjects, respectively. A multivariate model indicated that age, diabetes, hypertriglyceridemia, low levels of high-density lipoprotein cholesterol, and hyperuricemia were associated with an increased risk of CKD. Furthermore, there was an inverse association between BMI and CKD in older diabetic patients, with odds ratios of 3.71, 2.32, 2.12, and 1.31 in underweight, normal, overweight, and obese subjects, respectively, compared with nondiabetic subjects of normal weight.
Conclusions: There was an inverse association between BMI and CKD in older diabetic patients but no such association was found in nondiabetic older adults. More attention should be given to older underweight diabetic patients because they have a higher risk of CKD.

Introduction

Aging has become an important global issue in recent decades [1], and Taiwan is one of the most rapidly aging countries in the world. In 2010, 10.74% of the population comprised individuals aged 65 years and above, and this value increased by 0.2% annually [2]. Older patients with chronic kidney disease (CKD) are more likely than younger patients to have comorbid conditions, including cardiovascular disease [3–5]. Age-associated increases in chronic diseases and disability represent a significant financial burden on the health care system.

Previous studies investigating the association of body mass index (BMI) and CKD have yielded controversial results. Two studies reported that obesity was associated with an increased risk of CKD [6,7]. However, Kalantar-Zadeh et al. [8] demonstrated that higher BMIs were associated with fewer adverse outcomes in CKD. The association between higher BMIs and better outcomes is termed the "obesity paradox," which may be attributed to better nutrition, less inflammation, and fewer comorbidities in patients with CKD who have higher BMIs [8]. A recent study using systemic review and meta-analysis found that overweight (BMI of 25–30 kg/m^2) was associated with significantly lower all-cause mortality compared with normal weight [9].

The obesity paradox also exists in diabetic patients with CKD. Poorly controlled diabetes may lead to weight loss. On the other hand, Ejerblad et al. [10] reported that obesity increases the risk of CKD among diabetic patients. Because there are few data available on the association among BMI, CKD, and diabetes in the older Asian population, the purpose of this study was to determine the association of BMI, CKD, and diabetes in older Taiwanese.

Methods

Study population

This study included 3334 participants aged 65 years and above who voluntarily attended annual health screenings at Shin Kong Wu Ho-Su Memorial Hospital from January 2006 to December 2010. The health screening was sponsored by the Taipei City

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Government; all participants completed the health examination and interview at a specific clinic for this health screening program. This study was approved by the Shin Kong Wu Ho-Su Memorial Hospital Institutional Review Board, and written informed consent was obtained from all participants.

Definition of CKD

CKD was classified according to the National Kidney Foundation Kidney Disease Outcomes Quality Initiative guidelines [11]. In this study, CKD was defined as an estimated glomerular filtration rate (eGFR) of <60 mL/min/1.73 m^2. Glomerular filtration rate (GFR) was estimated using the four-variable Modification of Diet in Renal Disease Study equation [12]: eGFR (mL/min/1.73 m^2) = 186.3 × serum creatinine (mg/dL)$^{-1.154}$ × age (years)$^{-0.203}$ × (0.742, if female).

Risk factors for CKD

Information on demographics and lifestyle characteristics, including age, sex, smoking habits, alcohol consumption, and medical history, was collected during the clinical visits using a standard questionnaire. The interview included questions related to the diagnosis and treatment of hypertension and diabetes.

Subjects' height, weight, waist circumference, and sitting blood pressure were measured. BMI was classified into four subgroups following the World Health Organization Asia-Pacific standard [13]. Underweight was defined as a BMI of less than 18.5 kg/m^2; normal weight, as a BMI of 18.5–22.9 kg/m^2; overweight, as a BMI of 23.0–24.9 kg/m^2; and obesity, as a BMI of 25 kg/m^2 or higher. Blood samples were taken from all subjects after at least an 8-hour fast. From the fasting blood sample, glucose, total cholesterol, serum triglycerides (TGs), high-density lipoprotein cholesterol (HDL-C), and uric acid levels were measured. Proteinuria was measured by a dipstick test (Clinitek Atlas Urine Analyzer; Bayer, California).

Subjects were classified as current smokers or nonsmokers. Positive alcohol consumption was defined as drinking more than one time per week. Hypertension was defined as the use of antihypertensive medications, a systolic blood pressure (SBP) ≥140 mmHg, or a diastolic blood pressure (DBP) ≥90 mmHg. Diabetes was defined as the use of medications to treat diabetes or a fasting blood glucose level ≥126 mg/dL. Metabolic syndrome was defined as the presence of three or more risk factors, according to the National Cholesterol Education Program Adult Treatment Panel III Guideline criteria and modified by the International Diabetes Federation specifically for the Chinese population. These factors included a fasting blood glucose level ≥100 mg/dL, a serum TG level ≥150 mg/dL, an HDL-C level <40 mg/dL in men or <50 mg/dL in women, an SBP ≥130 mmHg, a DBP ≥85 mmHg, and waist circumference ≥90 cm for men and ≥80 cm for women.

Table 1
Demographic and biochemical characteristics of the study subjects with and without CKD

Variables	eGFR ≥ 60 (mL/min/1.73 m^2)	eGFR < 60 (mL/min/1.73 m^2)	*P*
Number	2932	402	
Age (y)	71.9 ± 5.8	75.9 ± 6.9	<.001
Male (%)	33.0	46.0	<.001
Current smoking (%)	5.1	7.5	.043
Alcohol consumption (>1 time/week) (%)	21.2	19.9	.565
BMI (kg/m^2)	24.2 ± 6.0	24.7 ± 3.6	.154
Waist circumference (cm)	85.9 ± 10.2	88.3 ± 10.1	<.001
SBP (mmHg)	129.4 ± 17.4	131.6 ± 16.6	.017
DBP (mmHg)	75.9 ± 9.0	76.1 ± 9.1	.650
Fasting glucose (mg/dL)	104.6 ± 22.8	111.9 ± 33.9	<.001
Total cholesterol (mg/dL)	198.7 ± 34.8	192.6 ± 36.0	.001
Triglyceride (mg/dL)	129.3 ± 73.0	150.5 ± 84.3	<.001
HDL-C (mg/dL)	58.7 ± 16.5	52.8 ± 16.3	<.001
Uric acid (mg/dL)	5.5 ± 1.4	6.9 ± 1.6	<.001

SD = standard deviation.
Data are expressed as means ± SD and percentages.

Table 2
Prevalence of risk factors among study subjects with and without CKD

Variables	eGFR ≥ 60 (mL/min/1.73 m^2)	eGFR < 60 (mL/min/1.73 m^2)	*P*
Obesity (BMI ≥25 kg/m^2)	37.3	42.5	.040
Central obesity*	61.3	63.7	.355
Hypertension	41.6	57.7	<.001
Diabetes	11.6	22.6	<.001
Total cholesterol >200 mg/dL	47.9	42.0	.030
Triglyceride >150 mg/dL	27.3	40.1	<.001
Low HDL-C†	21.7	35.1	<.001
Hyperuricemia‡	12.6	44.0	<.001
Metabolic syndrome	37.6	50.3	<.001

Data are expressed as percentages.
* Waist circumference of 90 cm or higher in men and 80 cm or higher in women.
† HDL-C level less than 40 mg/dL in men and less than 50 mg/dL in women.
‡ Uric acid level of 7.0 mg/dL or higher in men and 6.0 mg/dL or higher in women.

Statistical analysis

Student's *t* test was used for comparison of continuous variables, and the χ^2 test was used for comparison of categorical variables for study subjects with and without CKD. The association between CKD and related covariables was analyzed using multiple logistic regression. A value of *P* less than .05 was considered statistically significant. All statistical analyses were performed using SAS statistical software (SAS for Windows version 8.02; SAS Institute Inc, Cary, NC).

Results

Demographics of study participants

Demographics and lifestyle factors of the study population are presented in Table 1. There were 3334 participants, including 2181 women (65.4%) and 1153 men (34.6%), with a mean age of 72.4 ± 6.1 years. The overall prevalence rate of CKD was 12.1%. Subjects with CKD were significantly older than those without CKD (75.9 ± 6.9 years vs. 71.9 ± 5.8 years, $P < .001$).

Table 3
Multivariate analysis of ORs for CKD

Independent variable	OR (95% CI)	*P*
Age (y)		
70–74	1.46 (1.07–1.98)	.016
≥75	3.47 (2.64–4.54)	<.001
Male	1.15 (0.87–1.51)	.321
Current smoking	1.41 (0.89–2.24)	.140
Alcohol consumption (>1 time/week)	0.75 (0.55–1.02)	.068
Obesity (BMI ≥25 kg/m^2)	1.00 (0.98–1.02)	.858
Central obesity*	0.88 (0.65–1.17)	.373
Hypertension	1.05 (0.82–1.34)	.695
Diabetes	1.72 (1.30–2.27)	<.001
Total cholesterol >200 mg/dL	0.94 (0.74–1.20)	.618
Triglyceride >150 mg/dL	1.43 (1.06–1.94)	.020
Low HDL-C†	1.59 (1.17–2.16)	.003
Hyperuricemia‡	1.73 (1.60–1.87)	<.001
Metabolic syndrome	0.87 (0.61–1.25)	.455

* Waist circumference of 90 cm or higher in men and 80 cm or higher in women.
† HDL-C level less than 40 mg/dL in men and less than 50 mg/dL in women.
‡ Uric acid level of 7.0 mg/dL or higher in men and 6.0 mg/dL or higher in women.